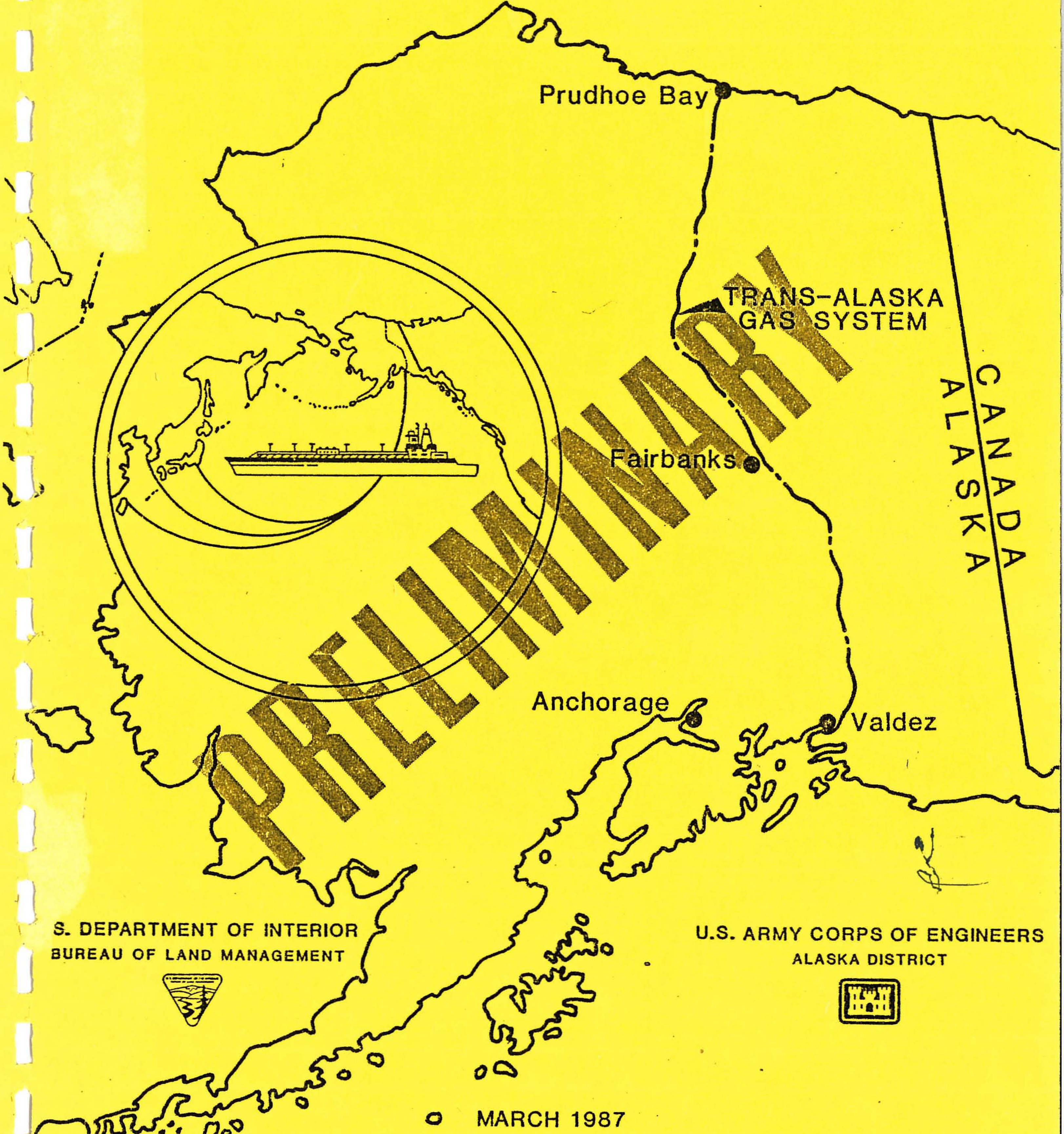
TRANS-ALASKA GAS SYSTEM
DRAFT ENVIRONMENTAL IMPACT STATEMENT



PRELIMINARY

S. DEPARTMENT OF INTERIOR
BUREAU OF LAND MANAGEMENT

U.S. ARMY CORPS OF ENGINEERS
ALASKA DISTRICT

MARCH 1987

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Harding Lawson Associates

March 23, 1987

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BUREAU OF LAND MANAGEMENT
Department of the Interior
701 "C" Street
Post Office Box 30
Anchorage, Alaska 99513

Attention: Mr. Jules Tileston

Gentlemen:

Preliminary Draft EIS Review Copy

Enclosed is a camera-ready copy of the Preliminary Draft EIS for the proposed Trans-Alaska Gas System project.

As we have discussed, this draft is generally complete with only minor exceptions. The References section contains only a partial listing in the current draft. The draft also contains a minimal number of pencilled changes reflecting a review subsequent to our final draft typing. Simultaneously with your review, we wll be conducting an internal review for minor editing, and section authors will be reviewing their sections to verify that editorial changes have not altered their meaning or intent. As you know, the review and findings of the Economic Regulatory Administration (ERA) will need to be incorporated into the document.

We look forward to receiving the comments of the reviewing agencies so that we may complete the draft EIS.

Sincerely,

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SUMMARY

S.1 INTRODUCTION

The Environmental Impact Statement (EIS) for the Yukon Pacific Corporation (YPC) proposed Trans-Alaska Gas System (TAGS) is a document prepared jointly by the Bureau of Land Management (BLM) of the U.S. Department of the Interior (DOI), and the U.S. Army Corps of Engineers (USACE). It is designed to fulfill requirements of the National Environmental Policy Act (NEPA) for issuance of federal authorizations for a right-of-way and fill placement from the BLM and USACE, respectively, and subsequent action by the Economic Regulatory Administration (ERA).

The proposed TAGS project would transport natural gas from the North Slope of Alaska to tidewater, where it would be liquefied for ocean transport to markets in the Asian Pacific Rim. As proposed, the project would transport up to 2.3 billion cubic feet per day (BCFD) of natural gas through 796.5-mile-long, 36-inch outside diameter (OD) buried pipeline.

The proposed TAGS project would be located primarily within the utility corridor developed for the Trans-Alaska Pipeline System (TAPS) project from Prudhoe Bay to Port Valdez in the mid-1970's. A portion of this same utility corridor may be used by the Northwest Alaskan Pipeline Company (NAPC) for its authorized, but yet-to-be constructed Alaska Natural Gas Transportation System (ANGTS) from Prudhoe Bay to Delta Junction. The approved alignment for the ANGTS is reserved, based on the assumption that it will be built.

The primary components of the proposed TAGS project are:

- Pipeline - The proposed TAGS pipeline would consist of 796.5 miles of a buried, chilled gas pipeline designed to transport gas at a maximum operating pressure of 2220 pounds per square inch (psi) from Prudhoe Bay to a tidewater site at Anderson Bay on Port Valdez.

- Compressor Station - Ten mainline compressor stations would be located along the proposed pipeline route to maintain required system operating pressures (from 1100 to 2220 psi) and the appropriate operating temperatures for system compatibility with ground temperatures.

- Liquefied Natural Gas (LNG) Plant - The proposed LNG plant would be located at Anderson Bay and would include LNG process trains to reduce the temperature to -259°F, condensing it to the liquid state.

- Marine Terminal - Proposed marine facilities would include a trestle with cryogenic loading lines, two LNG tanker berths, and dock facilities for support vessels adjacent to the LNG plant.

- Maintenance and Operations Locations - The headquarters and administration of TAGS would be in Anchorage. A maintenance facility would be in Fairbanks, which is accessible to rail and road transportation. An operations and control center would be at the LNG marine terminal in Valdez. All compressor statons would be manned.

S.2 SCOPING

The EIS scoping process provides the first step to involve the public and resource agencies in the environmental review process. The scoping process provides an opportunity for members of the public, special interest groups, and agencies to define environmental issues and concerns related to the project. Six scoping meetings were held in Alaska between December 8 and 13, 1986. Approximately 170 people attended these meetings. Additionally, written comments were received from federal, state, and local entities, industry, and the public The following issues were identified during the TAGS scoping process.

S.2.1 Cook Inlet Alternative

Several commentors favored a Cook Inlet alternative route, saying there would be more benefit to more people due to the available infrastructure and compatability with development goals of the Kenai Peninsula Borough.

S.2.2 Pipeline Route Issues

Several environmental issues emerged. Some commentors urged the use ofa corridor that has been designated for road and pipeline development, and has already been disturbed from prior development,over any alternative that would disturb new areas. Concerns were also expressed that the pipeline be routed to avoid Galbraith Lake, Sukakpak Mountain, and Keystone Canyon. Locations of compressor stations and construction camps were also questioned. Commentors wanted to know whether sufficient gravel resources would be available for the project.

S.2.3 Socioeconomics

Most comments supported the project on the basis of opportunities for local and state businesses, Alaska hire, state benefits, and usage of existing surface transportation systems. Some comments were directed to possible taps for local use of gas along the route; whether there was enough gas for two pipelines, and the economic viability of the project.

S.2.4 Subsistence

Commentors were concerned that fish and wildlife subsistence resources for communities along or near the corridor would be negatively affected during construction and possibly operation.

S.2.5 Recreational Resources

Concern was expressed about disturbance of viewsheds along the Salcha River and Summit Lake, crossing of designated Wild and Scenic Rivers, and avoiding existing state and federal recreational/historic areas.

S.2.6 Fish Resources

Concern was expressed for the anadromous fish resources of several highly productive and heavily used streams along the route. These comments included concern for fish overwintering habitat sensitive areas such as Jim River and the Upper Gulkana, and for the Anderson Bay commercial salmon fishery.

S.2.7 Endangered Species

It was noted that the route would pass quite near nests of the endangered Arctic peregrine falcon and protected bald eagles.

S.3 ALTERNATIVES TO THE PROJECT

Alternatives considered but eliminated on the basis of general feasibility included alternative modes for transporting natural gas, regional routes to western and southeastern Alaska, and transportation of natural gas or natural gas liquids in existing TAPS pipeline facilities.

One major regional pipeline route alternative and six alternative LNG plant and marine terminal locations were considered along with the main proposal. The Cook Inlet alternative alignments would deviate from the proposed project near Livengood (Milepost 395) and proceed south to the Cook Inlet area, where three alternative LNG plant and marine terminal locations at Harriet Point, Boulder Point, and Cape Starichkof were considered. Three other alternative LNG plant and marine terminal locations at Gravina, Gold Creek, and Robe Lake were considered in the Prince William Sound-Valdez area. The No-Project alternative was also evaluated.

After screening the alternative tidewater sites and pipeline routes, the Cook Inlet-Boulder Point route represented the most viable and environmentally acceptable alternative to the proposed project.

This evaluation of various important criteria resulted in the matrix presented in Figure S-1. Using those factors, the Anderson Bay route was determined to be the most desirable alternative.

Detailed comparison of the Cook Inlet-Boulder Point alternative with the proposed Prince William Sound-Anderson Bay project showed the following important differences in the two:

- Land Use/Land Status: The Cook Inlet alternative requires crossing of Minto Flats, an important subsistence area; transit thorugh a major national "conservation system unit"--Denali National Park and Preserve; and crossing Susitna Flats. The pipeline for the proposed Prince William Sound-Anderson Bay route follows an existing utility corridor with a pipeline system already in place.

- Constructability: The Cook Inlet-Boulder Point alternative involves a major submarine pipeline crossing of Cook Inlet, raising potential cost, constructability, safety, and environmental considerations.

- Environmental Disturbance: The Cook Inlet-Boulder Point alternative includes 178 miles of pipeline through areas with no current utility corridors or roads. The proposed Anderson Bay site minimizes new construction of access roads and campsites due to the presence of considerable amounts of infrastructure.

- Feasibility: An Act of Congress would be required for the Cook Inlet-Boulder Point alternative to cross the Denali National Park and Preserve under ANILCA Title XI. This action requires a finding by the National Park Service, the President, and Congress that there is no environmentally acceptable alternative. Since the Anderson Bay route is available, such a basis does not exist.

S.4 EXISTING ENVIRONMENT

Since the Anderson Bay route site was deemed to be the mose desirable, the rest of the material in this summary concerns that route and site and is referred to as the proposed project.

The approximately 800-mile route of the proposed project passes over three mountain ranges, six physiographic provinces, four climate zones, and more than 200 rivers and streams. Nearly all vegetation types known in Alaska would be traversed, as would the habitat of most types of big game, small mammals and bird species found in the state.

Only a few small communities exist along the route and landownership is primarily state and federal. Land use lies primarily in subsistence hunting and fishing and wildlife habitat, with a small amount of agriculture and timber cutting.

The route would pass through only two boroughs and two incorporated cities. Most of the major rivers have some glacial origin and clear tributaries. Fish resources are considerable and valuable both in the rivers and off the coast in the marine environment. Several protected and some endangered terrestrial species inhabit the route area and several marine species inhabit the nearshore area near Valdez.

how many threatened & endangered species

S.5 ENVIRONMENTAL CONSEQUENCES

The following discussion focuses on the potential environmental consequences of implementation of the proposed TAGS project. The effects are characterized as either major, moderate, minor, or negligible for the physical, biological, and socioeconomic features of the proposed TAGS project, as defined in Table S-1. This discussion assumes that all laws, regulations, and orders would be implemented as part of the project and that the applicant implements proposed mitigation measures.

The gas conditioning facilities required in the Prudhoe Bay area to deliver pipeline

Figure S-1 Criteria Evaluation Matrix for Proposed TAGS Project and Alternative Evaluations

	Prince William Sound				Cook Inlet		
	Proposed Project to:	Alternatives			Alternatives		
	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
Pipeline Criteria							
- Minimize length of pipeline	Favorable	Moderately Favorable	Favorable	Favorable	Favorable	Unfavorable	Unfavorable
- Maximize use of existing infrastructure	Favorable	Unfavorable	Favorable	Favorable	Moderately Favorable	Moderately Favorable	Unfavorable
- Maximize use of proven construction techniques	Favorable	Unfavorable	Moderately Favorable	Favorable	Unfavorable	Unfavorable	Unfavorable
- Maximize opportunity for parallel construction techniques	Favorable	Moderately Favorable	Favorable	Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Avoid areas of potential geohazards	Moderately Favorable	Unfavorable	Moderately Favorable	Moderately Favorable	Unfavorable	Unfavorable	Unfavorable
- Minimize potential conflicts with sensitive environments	Favorable	Moderately Favorable	Favorable	Favorable	Moderately Favorable	Moderately Favorable	Unfavorable
- Maximize compatibility with current and planned land use	Favorable	Unfavorable	Moderately Favorable	Favorable	Unfavorable	Unfavorable	Unfavorable
- Minimize the number of water crossings	Moderately Favorable	Unfavorable	Moderately Favorable	Moderately Favorable	Favorable	Favorable	Moderately Favorable
- Avoid permitting conflicts	Favorable	Moderately Favorable	Favorable	Favorable	Highly Unfavorable	Highly Unfavorable	Highly Unfavorable
- Minimize potential threat to national security	Favorable	Moderately Favorable	Favorable	Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Maximize availability of gas to Alaska consumers	Moderately Favorable	Unfavorable	Moderately Favorable	Moderately Favorable	Favorable	Favorable	Favorable

	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
LNG Plant Criteria							
- Adequacy of available land	Favorable	Favorable	Favorable	Highly Unfavorable	Moderately Favorable	Unfavorable	Favorable
- Avoid areas with poor foundation characteristics	Favorable	Favorable	Favorable	Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Avoid areas with faults	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Avoid sites potentially exposed to seismic sea waves	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable	Favorable
- Minimize length of pipeline to marine terminal	Favorable	Favorable	Favorable	Highly Unfavorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Maximize use of existing community infrastructure	Moderately Favorable	Highly Unfavorable	Moderately Favorable	Moderately Favorable	Favorable	Favorable	Unfavorable
- Avoid sensitive environmental habitat	Moderately Favorable	Unfavorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Unfavorable	Unfavorable
- Public safety considerations	Favorable	Favorable	Moderately Favorable	Highly Unfavorable	Moderately Favorable	Moderately Favorable	Favorable
- Maximize value added industrial opportunities	Moderately Favorable	Highly Unfavorable	Moderately Favorable	Moderately Favorable	Favorable	Favorable	Unfavorable
- Minimize site preparation requirements	Moderately Favorable	Moderately Favorable	Unfavorable	Moderately Favorable	Favorable	Favorable	Favorable

	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
Marine Terminal Criteria							
- Minimize exposure to extreme oceanographic conditions	Favorable	Favorable	Favorable	Favorable	Unfavorable	Unfavorable	Unfavorable
- Minimize distance from shore to 60' MLLW depth	Favorable	Moderately Favorable	Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Maximize suitability of tanker maneuvering and anchorage area	Favorable	Favorable	Favorable	Unfavorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Minimize potential hazards to navigation	Favorable	Moderately Favorable	Favorable	Moderately Favorable	Unfavorable	Moderately Favorable	Moderately Favorable
- Minimize potential problems related to soils and geohazards	Favorable	Moderately Favorable	Unfavorable	Unfavorable	Moderately Favorable	Moderately Favorable	Moderately Favorable
- Minimize threat to national security	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable	Moderately Favorable

○ Favorable
Moderately Favorable
Unfavorable
● Highly Unfavorable

Table S-1 Definitions Assumed for Environmental Impacts

Effect Level	Definition
Physical Resources:	
Major	Widespread modification of considerable severity inland forms, surface appearance, or contamination of surface resources lasting more than 20 years. (long-term)
Moderate	Local modification of considerable severity in land forms, contamination of physical resources lasting more than 20 years, or widespread modifications lasting less than 20 years. (short term)
Minor	Localized, relatively isolated change lasting less than 10 years, with no observable modification in surface appearance.
Negligible	Little or no change in surface appearances.
Biological Resources:	How many years is long-term
Major	Widespread, long-term change* in habitat quality, abundance, or distribution of species.
Moderate	Widespread, short-term modification or local long-term modification – " " short term
Minor	Short-term local change
Negligible	Nondetectable change in habitat, etc.
Social/Cultural Resources:	
Major	Substantial change in government policy and planning or likely to have long-term effect on residents' social or cultural resources.
Moderate	Some modification of policy or has short-term effect on local residents.
Minor	Minor modification in government policy required or predictably marginal or barely detectable effect.
Negligible	Has nondetectable effect on social/cultural resources of area residents.

Note: *Long-term is defined as 20 or more years
Short-term is defined as less than 20 years

quality gas are not part of the TAGS project. This EIS, however, has assumed that a potential site is available and the air quality impacts attendant to such additional facilities at Prudhoe Bay would not significantly affect the air quality of the area.

A brief summary of the environmental consequences for the proposed Prince William Sound-Anderson Bay preferred route and site is presented below.

S.5.1 Socioeconomics

The most significant socioeconomic impact of the TAGS project during preconstruction and construction phases would be increased population and employment. Direct employment on the project, however, would be only about a third of that experienced during TAPS construction.

Pipeline employment could create some labor shortages in both rural and urban areas. In rural areas a serious concern would be that highly skilled workers now maintaining village utility systems and other facilities might be attracted to higher-paying pipeline jobs.

At the present time Fairbanks would be able to accommodate TAGS-induced growth. However, the community's surplus housing and other infrastructure could be absorbed by the time the project would be built due to an influx of military personnel expected in the next two years. The Glennallen/Copper Center area, where the construction work force could outnumber local residents, would likely experience the highest relative negative impacts and the lowest relative benefits. The five-year construction period in Valdez would strain the local housing supply and the infrastructure of community services, especially if a proposed $900 million refinery is built prior to or during TAGS construction.

During the operations phase, statewide employment would total only 550 people. The largest proportional long-term employment impact would be in Valdez, where 100 people would be employed at the marine terminal and LNG plant.

By far the largest socioeconomic impact of the TAGS operations phase would be increased state government revenues from property taxes, severance taxes, and royalties. The project would generate $188 million annually in property taxes, $64 million in severance taxes, and more than $100 million in corporate taxes.

S.5.2 Land Use

The pipeline route, LNG plant, and marine terminal would change or influence land uses on about 22,900 acres. Other land-use changes would be on a local basis, mostly very near the existing TAPS corridor. Land use of the corridor itself would be relatively unchanged.

S.5.3 Transporation

The existing transportation system could handle the increased traffic quite well with minimum upgrading. There would be delays along the highway system during the several-year construction period which would affect tourist and local traffic. Maintenance frequency would increase during and immediately after the construction period.

S.5.4 Noise

Impacts of construction noise would be of short duration along the entire system. Some adverse impacts to threatened or endangered raptors could occur if activities take place within the critical range of peregrine falcons and other sensitive species. Operational impacts would be minimal except for Compressor Station No. 1, which is located within the critical 2-mile limit identified for peregrine falcon nests.

S.5.5 Air Quality

Construction and operation of the pipeline, compressor stations, LNG plant, and marine terminal would result in some degradation of air quality. The emissions judged to have the greatest potential impact are the gas turbines used for liquefying the pipeline gas and gas turbine generators. A dispersion model analysis of these emissions indicated that the LNG plant would be well within national ambient air quality standards.

S.5.6 Geologic Environment

Several potential impacts are possible from construction of the pipeline. Those considered to be most important are differential heave, erosion, frost bulb formations, and possibly construction at such "pinch points" as Atigun Canyon, Phelan Creek, and Keystone Canyon. Appropriate design engineering and construction techniques would alleviate most of the effects.

S.5.7 Surface and Ground Water

Construction of TAGS would cause a wide range of potential impacts to both surface and subsurface waters along the route. These impacts would be minimized by the mitigating measures proposed and by special conditions in various required permits. Impacts would include changes in stream geometry, introduction of sediment and pollutants, and depletion of water supplies. These impacts would in turn affect other resource values and possibly property and habitat both up and downstream of the TAGS. Impacts caused by TAGS would be very similar to and frequently cumulative with those created by TAPS and the state highway system or postulated for authorized ANGTS.

S.5.8 Marine Environment

Impacts to the marine environment would result from fill operations during construction, operation of the marine terminal, and aquatic discharges from the LNG plant. There would be direct loss of subtidal habitat and organisms. Subtidal sediments in the vicinity of Anderson Bay are generally characteristic of those for the entire western Port Valdez. Organism and habitat loss would be moderate since the area involved and the number of organisms lost would not be great.

The LNG plant and marine terminal would have minimal impacts on recreational or commercial fishing in the area. Much of Anderson Bay would be closed to recreational and commercial fishing during construction. Permanent restricted safety zones would remove a small portion of the nearshore area from use for commercial or recreational fishing.

Effluent discharges would meet state and federal water quality standards. Waters of Port Valdez have a reasonably short residence time (four to six weeks), and there should be limited potential for pollutant buildup. No waste products would result from the conversion of natural gas to LNG. LNG tankers would have segregated ballast tanks and would not have an oily water ballast discharge.

S.5.9 Fish

Although there would be a definite potential during construction and operation of the TAGS project to have major impacts to the local and regional fish populations, most would be prevented or mitigated by using state-of-the-art arctic pipeline engineering and construction techniques and by construction during the least sensitive period. Effects could also be reduced by utilizing appropriate resource management techniques, such as restricting access and setting fish catch and size limits along the corridor, especially for construction personnel.

This combination of possible impacts and proposed mitigation procedures should result in localized and short-term effects to the fish populations. There is no indication that anadromous fish populations would be decreased or threatened.

S.5.10 Vegetation and Wetlands

The primary impact on vegetation and wetlands during construction of the proposed project would be direct mortality to vegetation on an estimated 22,910 acres. This loss represents an adverse impact that cannot be avoided. The severity of impacts would be moderate to minor on the right-of-way, material sites, and near facilities. Natural revegetation would mitigate impacts to some extent. The area necessary for operation would require 8,119 acres, although much of this acreage would also be revegetated.

Alteration of local surface drainage patterns would cause moderate to minor impacts through upslope flooding, downslope drying, and mortality to some vegetation.

A variety of other impacts could occur from construction of winter roads and workpads, accidental spills, dust, right-of-way maintenance, emergency repairs, effluents, and emissions; however, those impacts would primarily be minor to negligible. There would be some positive aspects or results from clearing mature timber and fire. In many areas of the southern part of the route, this would improve moose forage.

S.5.11 Wildlife

The impacts of the proposed project on large mammals and birds may be divided into several categories. Direct loss of habitats would occur during construction and operation. Artificial and natural revegation would restore or improve some habitat by providing the new growth stages preferred as forage by some species, such as moose. The impacts of direct habitat loss would be minor.

Direct mortality, energetic stress to wildlife, and loss of habitat indirectly through avoidance and displacement would also occur. Mortality due to collisions with vehicles and structures, increased poaching, legal hunting, and destruction of "nuisance" bears and foxes would occur to some extent during the life of the project. Proposed mitigative measures would reduce these impacts to minor or negligible.

Disturbance by humans could increase stress on wildlife populations during critical life-history periods. Such disturbance would be greater during construction but could be mitigated by appropriate scheduling of activities. Reduced human activity and habituation by wildlife would reduce impacts during project operation. The proposed route and LNG plant site are quite near bald eagle nest sites in some areas. Adherence to requirements of the Eagle Protection Act would result in moderate impacts to eagles impacts during construction and minor during operations.

S.5.12 Threatened and Endangered Species

The proposed route and LNG plant site are quite near peregrine falcon nesting sites in some areas. The marine transporation routes also pass through areas with endangered whale species. Similar facilities and transportation routes to TAGS already exist in both and no significant impacts have been noted. Implementation of proposed mitigation measures and compliance with stipulations in the Peregrine Falcon Recovery Plan, would minimize the potential impacts to these species. Though Compressor Station No. 1 which would be located within 2 miles of peregrine falcon nests and not in compliance with the Recovery Plan., impacts would be expected to be moderate during construction and minor during operation.

S.5.13 Recreation, Wilderness, and Aethestics

Due to the length of the area disturbed, impacts to recreation and aesthetics would be widespread, but the band of disturbance would be quite narrow in most sections.

Disturbance would primarily occur during construction and would involve present uses and users, especially tourists, sightseers, and wilderness enthusiasts. Impacts to aesthetics and wilderness values would be moderate and more long-lasting than recreational effects. Visual impacts would include long linear stretches where vegetation has been cleared and many new access roads and borrow sites where vegetation has also been removed. The visual linear scar from the berm over the pipeline as well as new structures (temporary camps, compressor stations, and the LNG plant site and marine terminal) would also intrude on the viewscape. There would be no effects on potential or designed wilderness areas.

S.5.14 Cultural

Disturbance to cultural resources, including site excavation, has the potential for impact. The cultural resource protection program that has been planned for the proposed project would reduce impact risk to a minor or negligible level. Such a program also has the potential to contribute to the cultural history of Alaska.

S.5.15 Subsistence

Several categories of impacts to subsistence uses and activities might occur, including impacts to fish and wildlife; interference an access; increased competition from sport hunting, fishing, and trapping; relocation of effort or increased effort; economic impacts; and social impacts. These impacts would typically be temporary during the 34-month period in any given construction spread. Some life-of-the-project impacts would result, including habitat loss due to placement of borrow sites and facilities, restrictions of access and limitations that may be imposed on hunting, fishing, and trapping near the right-of-way.

These impacts would be moderate to subsistence uses or activities. Some temporary impacts, such as wildlife avoidance of the area and associated increased harvest effort and economic and social impacts, would result in major but temporary effect in Glennallen and for utility zone communities between the Brooks Range and the Yukon River. This "significant restriction" would only occur during construction.

S.5.16 Public Safety

TAGS would be designed, constructed, and operated in accordance with all applicable codes, standards, and regulations to reduce the possibility and consequences of catastrophic system failures, such as fires, explosions, LNG spills, and other impacts to public safety.

Design criteria for such parameters as seismic hazards, wave run-up, or corrosion would be based on existing information, supplemental studies, and the technical and economic feasibility of specific design criteria. Operating procedures and mitigation measures would be in accordance with a variety of regulatory agency requirements as well as good engineering practice. Proper training of operations staff would further ensure system safety by reducing the probability and severity of accidents.

S.6 FORMAT OF THE EIS

The general format of the EIS follows BLM and USACE regulations implementing NEPA (40 CFR 1502.1). Each section has a specific purpose and is required to include certain information. Following is a brief summary of the contents of each major EIS section.

S.6.1 Section 1.0 - Introduction, Purpose, Need, and Scoping

Section 1.0 provides the necessary background to understand the project, the role of the EIS process for this project, major permits, and other approvals that will be required for the project to proceed. Of special importance are issues related to the approved ANGTS and to the TAPS, as these routes parallel that proposed for TAGS. These issues include the availability of confidential and proprietary information and the availability of ANGST or TAPS federal rights-of-way for co-use by TAGS. It describes important assumptions upon which the TAGS EIS process is based and summarizes key results of the scoping process.

This section also describes initial options considered for this project and why many were eliminated. Pipeline, LNG plant, and marine terminal siting evaluation criteria are presented and used to evaluate alternatives and compare them with each other and with the proposed project.

S.6.2 Section 2.0 - Description of the Proposed Action and Alternatives

Section 2.0 describes major components of the pipeline route, LNG plant, and terminal sites. It briefly summarizes development of the project schedule, preconstruction, construction, and operation and maintenance activities and discusses viable project awlternatives.

S.6.3 Section 3.0 - Affected Environment

Section 3.0 describes the existing environment within the area that would be affected by development of the proposed TAGS project and the Cook Inlet-Boulder Point alternative. Disciplines considered included those commented on during the scoping meetings as well as areas of special concern. An effort was made to address only those aspects of the existing environment relevant to environmental impact analysis of the TAGs project.

S.6.4 Section 4.0 - Environmental Consequences

This section details the potential environmental impacts that would be expected should the proposed TAGS project or Cook Inlet-Boulder Point alternative be built and put into operation. Mitigation measures included in the applicant's proposed project (ROW Application, December 5, 1986) are considered an integral part of the project approach, and impact considerations assume that these measures would be implemented.

Environmental consequences of the proposed project are considered for the same disciplines discussed in Section 3.0. This section also describes areas of special concern, public safety, cumulative impacts, unavoidable adverse impacts, irreversible or irretrievable commitments of resources, the relationship between local short-term uses of the human environment, the maintenance and enhancement of long-term productivity, and mitigation measures.

S.6.5 Section 5.0 - Consultation and Coordination

This section describes the process for soliciting input from agencies and the public, the contract with a consulting firm for preparation of the EIS, and other agency participation in the EIS process. It also includes a list of EIS preparers.

S.6.6 Permits

YPC has applied for a grant of right-of-way from BLM and the State of Alaska to cross federal and state lands and has applied to the USACE for the required Section 10 (River and Harbors Act, 1899) and Section 404 (Clean Water Act) permits. The State must determine coastal zone management consistency and the 401 water quality compliance to complete the USACE permit process. In addition, YPC must also file an application with the federal Economic Regulatory Administration (ERA) for authorization to export liquefied natural gas. The president is required to make findings under Section 12 of the ANGTS as part of any export decision for Alaska North Slope natural gas. Numerous other federal, state, and local permits would be required at design approval stages prior to actual construction.

SECTION 1
INTRODUCTION
PURPOSE, NEED AND SCOPING

SECTION 1.0 INTRODUCTION, PURPOSE, NEED, AND SCOPING

The National Environmental Policy Act (NEPA) of 1969 requires preparation of an Environmental Impact Statement (EIS) whenever a proposed major federal action could significantly affect the quality of the human environment. For the proposed Trans-Alaska Gas System (TAGS) project the issuance of several major permits and authorizations required before the project could proceed constitutes the major federal actions. These actions include Bureau of Land Management (BLM) grant of right-of-way across federal lands, the U.S. Army Corps of Engineers (USACE) Section 404 and Section 10 permits authorizing dredge and fill operations within the waters of the United States and work; including structures placed in navigable waters of the U.S., and the Economic Regulatory Administration authorization to export liquefied natural gas.

The objective of the EIS process is to ensure that decisionmakers and the general public have an opportunity to review available environmental information before permit decisions are made and actions taken. The environmental process provides for public involvement in major actions which could affect the quality of the human environment.

1.1 PURPOSE AND NEED FOR THE PROJECT

YPC has identified a purpose and need for the TAGS project, based on what it believes to be a significant opportunity in the mid-1990's to market Alaska North Slope natural gas in the Asian Pacific Rim. To meet this opportunity, YPC proposes to develop the TAGS project which would transport Alaska North Slope gas to a tidewater facility in the Valdez area where it would be liquefied for ocean transport to Asia. Prime markets for the liquefied natural gas (LNG) exist in Japan, South Korea, and Taiwan.

The TAGS project would generate approximately 2.5 billion dollars a year in gas sales, assuming that fourteen million tons of gas is sold per year at four dollars per thousand cubic feet (MCF). Although gas sales contracts are not yet complete, a reasonable breakdown of gas volumes by customer could be:

Japan	7 million tons/year
Korea	6 million tons/year
Taiwan	1 million tons/year

Project development could be phased over a period of years to allow controlled integration into the marketplace. When fully operational, the TAGS would export 14 million tons of LNG per year. It is projected that new demand for LNG in Japan, South Korea, and Taiwan would exceed the 14 million-ton capacity of TAGS by the year 2000. In view of this forecast, YPC expects that the total output of the TAGS project would be fully integrated into the Asian market before the turn of the century.

Current State of Alaska estimates show a North Slope natural gas reserve of 28.7 trillion cubic feet (TCF). Of that, 27.3 TCF is in Prudhoe Bay. U.S. Geological Survey estimates of undiscovered, recoverable, conventional resources of natural gas on Alaska's North Slope and adjacent offshore areas average 189.5 TCF. At full development, TAGS would use 2.3 billion cubic feet per day (BCFD) of raw natural gas.

Approximately 2.5 BCFD of North Slope natural gas is currently produced and reinjected during oil extraction. Prior to reinjection, water and some heavier hydrocarbons are removed. Additional gas conditioning would be required to meet pipeline quality specifications. Conditioning at Prudhoe Bay would result in 2.3 BCFD of pipeline-quality gas. A small amount would be used for operation of the TAGS compressor stations and LNG terminal, leaving approximately 2.1 BCFD of pipeline gas for conversion to LNG.

In order to initiate operations by the mid-1990s, the projected schedule of development for TAGS calls for major permits to be issued by the first quarter of 1988. Detailed design, engineering, and construction permit acquisition would be complete by the last quarter of 1990 or 1991. Construction of the project would require four years. Operation would be scheduled to begin the last quarter of 1995. A project schedule is presented in Figure 1.1-1.

Liquefied natural gas from the TAGS project would be marketed in Japan, the Republic of South Korea, and Taiwan. These three Pacific Rim countries depend on imported energy for at least 75 percent of their needs. Each has established reduced dependence on crude oil as a national objective. Natural gas provides approximately one-fifth of the world's energy. Wide use in Asia began only recently but continues to grow quickly.

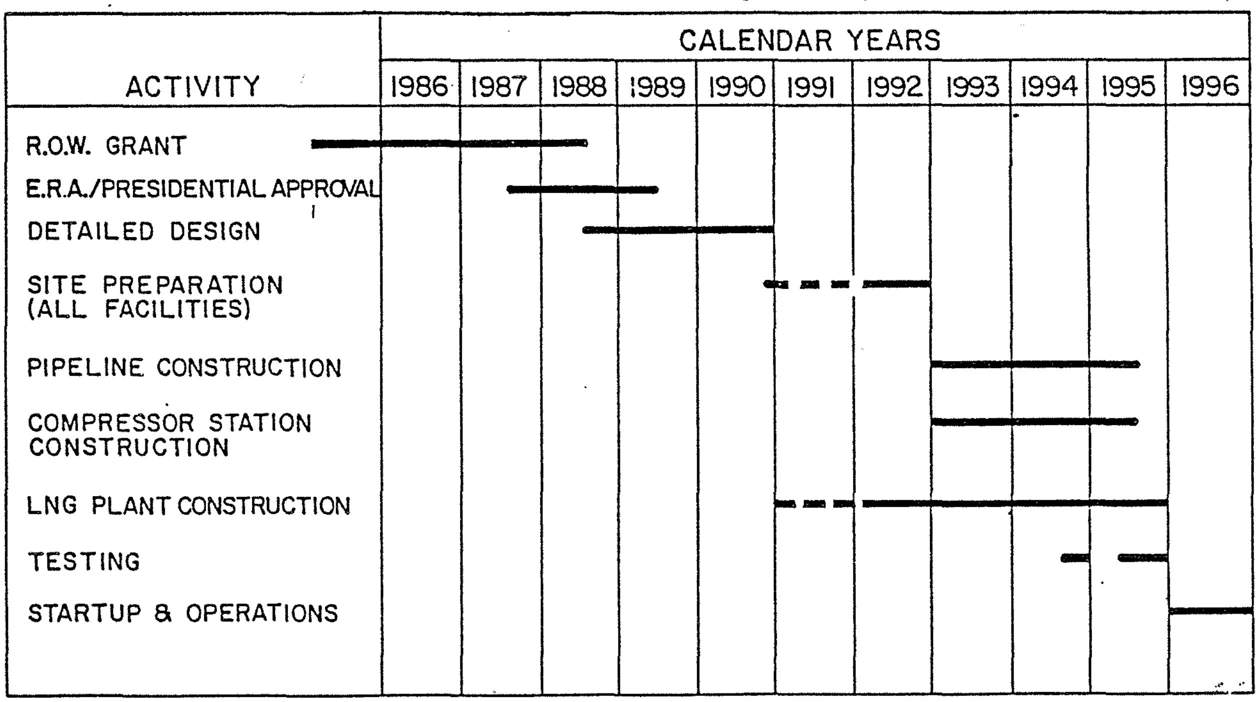
YPC proposes to sell LNG to all three nations to encourage market diversity. However, need for the TAGS project could be demonstrated in Japan alone, where forecasted increases in total demand for energy in the year 2000 are more than eight times that provided by the TAGS project.

All three nations have substantial trade imbalances with the United States which could be offset to some degree by LNG trade with the TAGS project. A major sale of Alaska LNG could be the largest single U.S. export to help balance the U.S. deficit.

Japan

Infrastructure for the importation of LNG into Japan is already in place. Today, there are 10 LNG importing facilities located near major population and industrial centers (i.e., Tokyo, Osaka, Nagoya, Niigata, and Kita Kyushu), and three new import terminals are under construction. The distribution systems in Tokyo and Osaka obtain more than 75 percent of their natural gas supply from imported LNG. During the 1960's, 80 percent of Japan's primary energy came from petroleum; a large majority of that came from the Middle East. By 1984 Japan's dependency on petroleum was reduced

Figure 1.1-1 Trans-Alaska System Project Schedule



to 58 percent, and there is a national objective to further reduce the dependency on petroleum to about 40 percent by the turn of the century. LNG was first exported to Japan in 1969 (from the Kenai, Alaska, project). By 1984 LNG use had increased to approximately 10 percent of Japan's primary energy requirements.

Today, 110 LNG storage tanks are in operation in Japan with a total capacity of approximately 50 million barrels. Approximately 0.6M barrels of LNG per day or 14 million tons per annum would be produced by the TAGS project. Japan is currently using approximately 26 million tons of LNG per annum, with 75 percent going to electric power generation and 25 percent into city gas systems. This use is projected to reach 40 million tons per annum by 1995. Until recently, Japan has made little effort to penetrate the industrial gas market. (In 1984 only 1.4 percent of Japan's industrial market was supplied by natural gas.)

A large potential market exists, particularly if the Japanese government promulgates strong air quality controls, as it did in the late 1960s and early 1970s with electrical power generation. Alaska's ability to play a role in expanding this market depends on its ability to project and limit transportation costs.

Republic of South Korea

Korea Gas Corporation (a wholly owned government corporation) was established in August 1983 under the Korea Gas Corporation Act of December 1982. The prime aim of this corporation is to "promote improvement of the South Korean national lifestyle and to contribute to the rising standard of public welfare by establishing the foundation for supplying a pollution-free and safe gas on a stable and long-term basis."

Korea Gas Corporation (KGC) is in the process of completing an LNG import terminal at Pyong-Taek, south of Inchon, which began operation in late 1986. Future plans call for a second LNG terminal to be located in the Pusan area.

Taiwan

Taiwan has a natural gas distribution system in the Taipei area that handles about 100 million cubic feet per day of local production. Taiwan has agreed to purchase 1.5 million tons of LNG per annum from Indonesia, commencing about 1991.

An LNG import terminal is under construction at Hsingta on the southwest shore of Taiwan. It will be connected to the present gas distribution system near Taipei by a 200-mile gas transmission system, providing gas service to the major population areas of western Taiwan. With a gas system in place by 1991, Taiwan will be in a position to capitalize on these markets once LNG is available and would be able to expand its need for additional supplies of natural gas. Taiwan is a potential market for some additional 2 million tons per annum of LNG.

1.2 BACKGROUND OF THE PROJECT

The BLM and the USACE are preparing a federal EIS for the proposed TAGS project to construct and operate a natural gas pipeline transportation system from Prudhoe Bay to Port Valdez, Alaska with liquefaction natural gas (LNG) facilities and a marine terminal located at Anderson Bay. The proposed TAGS project would transport a maximum of 2.3 billion cubic feet per day of natural gas from Alaska's North Slope for liquefaction at tidewater and export to markets in the Asian Pacific Rim.

An application for the proposed TAGS projects right-of-way across federal lands was initially filed with the BLM and with the USACE for Section 10 and Section 404 permits on May 1, 1984. At that time, Yukon Pacific Corporation (YPC) considered a joint development with the Northwest Alaskan Pipeline Company (the holder of an approved federal gas pipeline right-of-way from the

North Slope to the Alaska/Yukon border) from the Alaska North Slope to Livengood, Alaska. At Livengood the initial YPC route would proceed south to an LNG plant and marine terminal located on the Kenai Peninsula. Further analysis by YPC concluded that this was not a feasible or prudent alternative for the development of the TAGS project. YPC therefore amended their original filing with the BLM on December 5, 1986. In addition to the amended filing with the BLM, YPC filed applications with the USACE for Section 10 and Section 404 permits to authorize dredge and fill operations within waters of the United States. Those applications triggered the preparation of this EIS.

The proposed TAGS pipeline would be constructed and operated within an existing transportation and utility corridor from Prudhoe Bay to Port Valdez, generally parallel to the existing Trans-Alaska Pipeline System (TAPS) and a segment of the approved but unconstructed Alaska Natural Gas Transportation System (ANGTS) from Prudhoe Bay to Delta Junction. Environmental review activities related to this transportation and utility corridor include:

- TAPS Final (FEIS) completed in 1972 by the BLM with project construction initiated in 1974 and initial operation beginning in 1977.

- Alaska Arctic Gas Pipeline Company proposed to construct a natural gas pipeline from Prudhoe Bay across the North Slope of Alaska to Canada to the domestic market, FEIS completed by DOI in 1976.

- El Paso Alaska Company proposal to construct a natural gas pipeline from Prudhoe Bay to Gravina in Prince William sound; FEIS completed in 1976 by the FPC.

- Northwest Alaskan Pipeline Company (formerly ALCAN) proposed to construct a natural gas pipeline from Prudhoe Bay adjacent to TAPS to Delta Junction and on to the Alaska/Yukon Border to serve domestic markets, supplemental FEIS completed by the FPC in 1976.

The proposed LNG plant site and marine terminal would be located approximately 3.5 miles west of the existing TAPS oil terminal on the south shore of Port Valdez.

1.3 GENERAL PROJECT LOCATION

The proposed TAGS project would transport natural gas via a pipeline that extends from Prudhoe Bay to Port Valdez where the LNG plant and marine terminal site would be located at Anderson Bay. The primary components of the proposed TAGS system would be 796.5 miles of buried 36-inch outer diameter (OD) pipeline with 10 compressor stations located along the route. The pipeline would terminate at the LNG plant site and marine terminal. The pipeline and other project facilities are located on lands administered primarily by the BLM and the State of Alaska. Other federal ownerships include portions of several military bases and a small portion of the Chugach National Forest.

1.3.1 Prudhoe Bay to Prince William Sound

The proposed TAGS pipeline route alignment would begin at Prudhoe Bay, immediately downstream of a gas conditioning facilities, and proceed south, paralleling the Sagavanirktok River and traversing the Brooks Range through Atigun Pass. The alignment proceeds southerly through the Dietrich River and the Middle Fork of the Koyukuk River valleys into the Jim River Valley. The route then proceeds southeast towards the Yukon River, crossing the river on its own suspension bridge. The proposed Yukon River crossing location would be approximately 1,000 feet upstream of the existing highway bridge. The pipeline route would continue south, passing east of

Fairbanks and Fort Wainwright. Proceeding southeast parallel to the Tanana River valley, the route crosses the Tanana River near Big Delta. The route passes east of Delta Junction and parallels the Delta River southward and crosses the Alaska Range near Summit Lake. The alignment then traverses the Copper River valley. Upon entering the Chugach Range, the route would parallel the existing Richardson Highway. The route would continue to parallel highway alignment through Thompson Pass, entering the Lowe River valley. Through Keystone Canyon it would use the existing Richardson Highway ditch. From the mouth of Keystone Canyon the route follows a westerly course for approximately 21 miles to Anderson Bay, where it would traverse generally north-facing bedrock slopes along the south side of Port Valdez. The route would follow along Port Valdez behind the TAPS oil terminal. West of the TAPS terminal, the route would again follow along the south shore of Port Valdez before terminating just east of Anderson Bay.

The Anderson Bay site is located 5.5 miles southwest of the city of Valdez. The TAPS terminal is approximately 3.5 miles east. Valdez is both a fishing and an industrial community and could offer the industrial, commercial, and residential infrastructure support required by the TAGS project. The city is accessible by road, sea, and air. An airport is located approximately 7.5 miles northeast of the site and is serviced by several major airlines and a number of smaller charter service and private planes. Many dock and harbor facilities, some industrial, are also located near the east end of Port Valdez.

The Anderson Bay site extends from the east end of Anderson Bay about 7,000 feet to the east and about 2,000 feet south from the shoreline of Port Valdez. The elevations across the site range from water level to about 350 feet. The majority of the site lies below 200 feet.

Generally, the area is comprised of a series of east-west trending bedrock ridges, mantled with glacial till and infilled with unconsolidated sediments to depths possibly up to 40 feet. Till cover is shallow along ridges. Shallow lakes and wet areas in the grooves suggest a high water table; drainage is good.

The site is in a high seismic area, but no active fault zones are known in the vicinity, though several lineaments are evident. There is no evidence of ground rupturing, subsidence, or uplift at the site. There are 30- to 50-foot bluffs along the coastline of the site. The substrate is coarse (gravel to boulders or bedrock). In the vicinity of the marine terminal, the 60-foot isobath, a water depth suitable for even the largest LNG tankers, lies approximately 500 feet from shore. Area for offshore anchorage is available, and there is ample area for maneuvering vessels.

The shape of Valdez Arm suggests it would be susceptible to seiching action. During the 1964 earthquake, submarine landslides at Shoup Bay did in fact, trigger large seismic waves within Port Valdez. The configuration and orientation of Port Valdez and Valdez Narrows limits the risk that tsunamis generated in Prince William Sound would have a major impact in Port Valdez. Earlier bathymetric studies showed no offshore bathymetric features that might amplify a tsunami within the basin. Maximum wave run-up at Anderson Bay was 78 feet (Retherford 1975) during the 1964 earthquake.

Mountains surrounding Port Valdez would shelter the terminal from the severe winds experienced in other parts of Prince William Sound. Prevailing winds are east-westerly and seldom exceed 18 mph; average wind speed is 6 mph. Certain local conditions can intensify winds, and winds can intensify currents. In the absence of meterological effects, tidal current may be about 1.2 knots but average less.

Wave activity would probably be slight. Waves less than 1 foot occur about 90 percent of the time; waves from 1 to 3 feet occur about 10 percent of the time. Wave action is highest in midwinter and lowest in midsummer. A significant wave is estimated at 5 feet/5 sec; the maximum wave at 9 feet.

Port Valdez is generally ice free year round. Occasionally, shore ice develops in the intertidal zone, but poses no serious problems; ice rarely occurs as a sheet. Shoup Glacier has the remote potential of calving icebergs into Shoup Bay that might get into Port Valdez (FPC 1976a). There is some concern about calved icebergs in the Valdez area from the Columbia Glacier.

1.4 RELATIONSHIP TO OTHER PROJECTS

The proposed TAGS project would be located within the utility corridor developed for the TAPS project in the mid-70's. Located within this utility corridor are the constructed TAPS pipeline, pump stations, and the Northwest Alaskan Pipeline Company for its approved but yet to be constructed ANGTS from Prudhoe Bay to Delta Junction as identified in approved Revision Alignment 4 to the ANGTS project. This alignment would be reserved for the ANGTS project.

1.5 AVAILABILITY OF ANGTS OR TAPS FEDERAL RIGHTS-OF-WAYS FOR CO-USE BY TAGS

Federal rights-of-way regulations (43 CFR 2881.1-1) " . . . retains a right to use a right-of-way and temporary use permit area or authorize the use in any manner not inconsistent with pipeline construction, operation, maintenance and termination . . . " Later at 43 CFR 2881.1-3(c) the federal government reserves the right on federal lands to " . . . make, issue, or grant right-of-way grants, temporary use permits, easements, leases, licenses, contracts, patents, permits, and other authorizations to or with third parties for compatible uses on, under, or adjacent to the federal lands subject to a right-of-way grant or temporary use permit."

YPC asserts its intention to keep reasonable distance from the existing TAPS facilities and the authorized but unconstructed ANGTS alignment as shown by the approved Revision 4 noted to the official master title plats of the Bureau of Land Management. Accordingly the amended TAGS application dated 12/5/86 proposes to use a 200-foot separation from both TAPS and ANGTS as appropriate. An exception would be where there is insufficient room due to topographic or environmental constraints. These existing valid federal rights will be recognized in the processing of the TAGS project.

1.6 ASSUMPTIONS THE EIS PROCESS IS BUILT UPON

This EIS document is built upon the following assumptions:

- Previous EIS's covered environmental issues similar to those associated with the proposed TAGS project and are incorporated in appropriate sections of this document by reference.

- In 1980 the administration and Congress approved the construction of ANGTS, a large-diameter pipeline to serve the domestic market. That decision identified environmental, social, and economic features that are considered equally applicable to this project from Prudhoe Bay to Delta Junction where the two pipelines would bifurcate (TAGS and authorized ANGTS are similar).

- The utility corridor has experienced an actual on-the-ground construction phase and a 10-year operations and maintenance program for the TAPS project. Information from the TAPS experience provides an idea of what might happen with the TAGS project under similar construction and operational/maintenance conditions.

- The assumption that since TAPS and authorized ANGTS were determined to be compatible, the application of similar standards to the proposed TAGS would result in comparable conditions. There is a question as to what technical standards of compatibility between two buried chilled pipelines would be. But for this EIS they are considered compatible. (See Appendix A.)

- For the purposes of the environmental analysis and the social and economic impacts it is assumed that TAGS and authorized ANGTS are not being constructed simultaneously. The assumption is that ANGTS will be built as authorized using the ANGTS Revision 4 alignment.

1.7 CONFIDENTIAL AND PROPRIETARY INFORMATION

During its history Alyeska Pipeline Service Company had collected much information on design, construction, operation, and repair of the Trans-Alaska Pipeline System. Northwest Alaskan Pipeline Company assembled similar information during design of the Alaska Natural Gas Pipeline System (ANGTS).

Under provisions of the Council of Environmental Quality (CEQ) regulations (40 CFR 1502.21) " . . . Material based on proprietary data which is itself not available for review and comment shall not be incorporated by reference." Accordingly, such data are not available for evaluation of the proposed TAGS during the EIS phases.

1.8 SCOPING PROCESS

The scoping process for the proposed TAGS project identified issues and concerns associated with construction, operations, and socioeconomic issues that should be included in the DEIS.

The first step in the federal NEPA process is to publish a Notice of Intent (NOI) for the preparation of an EIS in the Federal Register. The NOI for TAGS was published by the BLM and the Corps on November 17, 1986. The second step in the NEPA process, termed "scoping," determines the significant issues and concerns relating to a proposed action that would be included in the draft EIS. Therefore scoping meetings were held to identify major issues and concerns. Six scoping meetings were held in cities and towns in the general vicinity of the proposed pipeline route:

Location	Date
North Slope Borough Assembly Room, Barrow, Alaska	December 8, 1986
North Star Borough Assembly Chamber, Fairbanks, Alaska	December 9, 1986
Glennallen High School Gym, Glennallen, Alaska	December 10, 1986
Valdez City Hall Council Chambers, Valdez, Alaska	December 11, 1986
Peninsula Borough Assembly Room, Soldotna, Alaska	December 12, 1986
BLM Anchorage District Office, Anchorage, Alaska	December 13, 1986

At each of these location, a public workshop occurred from 2:30 to 5:00 p.m., with the public scoping meeting held from 7:00 to 11:00 p.m. Approximately 170 people attended the workshops and public scoping meeting and about 40 written responses were received prior to the December 23, 1986 final date for comments.

Table 1.8-1 presents a summary of comments and issues that arose during the scoping process.

Table 1.8-1 Summary of Issues and Remarks Raised During Scoping

Issue	Treatment of Remarks 1/	REMARKS
1. Cook Inlet Alternative	2	Denali National Park - Recreational and visual impacts; visitor access to park should not be curtailed; TAGS routings involves critical visitor interpretation and wildlife areas. Don't use Denali as there are other ways to get gas to Tidewater.
	2	Minto Flats - native subsistence area, waterfowl area, could be adversely affected if new access provided.
	2	Susitna River and Flats - major waterfowl area, major fish habitat area, significant hunting and fishing area, relatively unimpacted area, poor soils.
	2	Alaska Railroad - route TAGS along Alaska Railroad alignment.
	2	Railbelt - make natural gas available to communities; value added industrial development; construction/operation jobs; community impacts; a major portion of Alaska's population resides in the railbelt.
	2	Cook Inlet - ice conditions; soil conditions; depth of water; tidal fluctuations; submarine pipeline across Cook Inlet.
	2	Compressor Station may affect the Class I air shed at Denali National Park and Preserve.
	2	Unstable terrain between Denali National Park boundary and McKinley Park Station.
	3	Revegetation techniques within Denali National Park and Preserve.
	2	Game refuges and state 4(f) lands.
	2	Kenai/Soldotna - local short-term and long-term employment; highly qualified labor pool; infrastructure such as schools under-utilized.
	2	Kenai/Soldotna - value-added industrial development, already an industrial area that can handle another LNG plant to attract new energy or natural gas product dependent industries.
2. Pipeline	2	Adjacent to TAPS - use of existing right of way corridor including access roads, work pad and material sites to reduce gravel requirements and surface impacts.
	2	Adjacent to proposed ANGTS - multiple pipeline use of existing corridor; reuse of existing camps, airfields, material sites.
	2	TAGS routings at Galbraith Lake and Summit Lake could present environmental issues.
	2	Review alignment at Sukakpak Mountain.
	2	Salcha River area - pipeline alignment adjacent to TAPS; alternative south of highway; location of Compressor Station No. 7; visual and noise impacts of Compressor Station; borrow site locations.
	2	Consider reducing the separation distance from 200 feet to 70 feet; maintain 200 foot separation.
	2	Is there adequate borrow material available?
	3	Location of borrow material sites.
	2	Avoid wetlands; in-kind replacement of acquatic must be proposed.
	2	Gas conditioning facilities will be required on the North Slope.
	2	Noise related to activities for material removal near towns and villages.
	2	Keystone Canyon - pipeline alignment along roadway; impact to visual resources; traffic diversions; tourist impacts; construction timing; material disposal; alternates.
	3	Material disposal - location of sites.
	3	Conduct a terrestrial habitat evaluation of that portion of the route not already surveyed.
	3	Local access over pipeline, access roads and work road; weight limits over buried pipeline.

1/Treatment of Remarks
1 - Not germane to EIS
2 - Will be treated in EIS
3 - Will be treated at a subsequent time

Issue	Treatment of Remarks 1/	REMARKS
	2	Timing of construction near towns and villages; community impacts; impacts to hunting and fishing.
	2	Land use conflicts - Atigun Pass, Sukakpak Mountain, Keystone Canyon, Phelan Creek, Salcha River.
	2	Special construction areas - Keystone Canynn, TAPS Terminal, Atigun Pass, Sukakpak Mountain, Yukon River.
3. Socioeconomic	3	Project planning schedule to provide the state, communities and local businesses an opportunity to be responsive, tourist impacts.
	2	Will new access be created; is there threat to existing surface transportation routes at Atigun Pass, Phelan Creek and Keystone Canyon in the event of catastrophic failure of buried pipeline.
	2	Will existing highway travel be shutdown during TAGS construction.
	3	YPC should pay state for damage to highways.
	1	State should protect affected communities; small business set-asides.
	2	Benefits to the state, communities, and local communities.
	2	Infrastructure - public safety, schools, medical facilities.
	2	Balance of trade - project impacts on international, national and state levels.
	2	National security - co-location of TAGS and TAPS terminal facilities.
	2	State benefit - increased tax revenues.
	1	Use of state's 12.5% royalty gas.
	1	Fairbanks Northstar Borough one-window approach for borough coordination.
4. Job Opportunity	3	Alaskan hire - native, minority and local hire; constitutionality of specific Alaskan hire; union hire.
	2	How many will be hired; when
	1	Qualifications of workers.
	3	Statewide recruitment; zone hire goals; project labor agreement, training program.
5. Use of North Slope Gas	2	Gas taps - Anaktuvuk Pass, Stevens Village, Fairbanks and other communities along the alignment; use for scattered populations along the route.
	3	Use gas to enhance oil recovery of Prudhoe Bay and other north slope oil fields.
	3	All gas from Alaskan north slope is committed to ANGTS.
	3	Canada - US Treaty Commitments must be reflected in TAGS project.
	2	Not enough gas for two pipelines.
	1	Value added use - industrial use of gas for various types of industries.
6. Subsistence	2	Review of previous impacts of TAPS to subsistence resources.
	2	Avoid creating facilities and restrict public access to subsistence use areas.
	2	Construction related hunting; fishing and trapping pressures by workers; disturbances would shift game population movements; construction workers adhere to ADFG regulations.
	2	All possible methods of transporting north slope natural gas need evaluation.
7. Project Economics	2	Economic feasibility of the proposed TAGS project; need for gas nationally or instate; need for project gas supply in the Pacific Rim; value added benefits.

Issue	Treatment of Remarks 1/	REMARKS
	1	How will state use its 12-1/2 percent.
	3	Cost benefit analysis; need for two gas lines.
	3	Does applicant have technical and financial capability to build project.
	2	Use of existing infrastructure; inject gas and/or condensates into TAPS oil line; convert gas to liquid and inject in TAPS.
8. Valdez Area	2	Air quality impacts - composition of gas stream; process emissions, blowdowns, flaring of gas, fog potential due to air cooling.
	2	Water quality impacts - ballast water; plant site runoff; sewage treatment plant.
	2	Recreational use of Anderson Bay - safe harbor for small boats; mooring areas; sports fishing; will uses within National Forest be restricted.
	2	Safety of LNG facility.
	2	The TAGS project must evaluate the cumulative environmental effects from the proposed Alaska Pacific Refining, Inc.
	2	Alternative sites in Valdez Area - Sheep Bay, Point Gravina, ALPETCO, Robe Lake.
	2	How will TAGS get around TAPS terminal?
9. Recreational Use	2	Salcha River area - location of Compressor Station No. 7, noise impacts, access roads, pipeline crossing.
	2	View shed considerations - Salcha River, Keystone Canyon, Sukakpak Mountain, Summit Lake, Denali Highway.
	2	Avoid dedicated state and local recreation/historic areas.
	2	Remain outside wild and scenic river corridors - Delta and Gulkana Rivers.
	2	Compliance with Section 106 of the National Historic Preservation Act.
	2	Recreational boating in Port Valdez.
	2	Land use conflicts - Denali National Park, Keystone Canyon, Stevens Village, Salcha River, Anderson Bay.
10. Fish Resources	2	Impact to salmon fisheries of the Jim, South Fork Koyukuk, Gulkana and Little Tonsina Rivers and Canyon Slough.
	2	Protect overwinter fish habitats.
	2	Anderson Bay - fisheries near LNG marine terminal site.
11. Construction Camps	2	Fuel leaks at camps where large supplies of fuel are stored, Galbraith Camp and Prospect Creek Camp leaks during TAPS.
	2	Reuse of existing camp pads to prevent opening of new sites; reuse will reduce gravel requirements.
	3	How will TAGS solve low flow and metals contamination problems that existed for portable water supplies at TAPS construction camp sites?
12. Compressor Stations	2	Location of Compressor Station No. 7 near the Salcha River, access roads, noise.
	1	Use waste heat from compressor stations for cogeneration or other uses.
	2	Visual and noise, frequency of blowdowns and impacts.
	2	Use of existing roadways to compressor station sites.
	2	Compressor Station No. 3 near landing strip and mining area.

Table 1.8-1 Summary of Issues and Remarks Raised During Scoping (continued)

Issue	Treatment of Remarks 1/	REMARKS
13. Existing Data	2	Make use of existing data from TAPS and ANGTS.
	2	Insufficient detailed economic location and engineering information to proceed.
	1	Proprietary data should be used instead of developing data again.
14. Endangered Species	2	Peregrine falcons and marine mammals could be affected by TAGS.
15. Permits	3	A NPDES permit for the LNG plant will be required from EPA; application must be filed 180 days prior to discharge.
	3	Cape Starichkof and Harriet Point LNG alternative sites may require an ocean discharge criteria evaluation by EPA.
	2	Compliance with 43 CFR 36 is required for TAGS project should Denali National Park and Preserve be crossed.
	2	What type of wastes will be generated and how will they be handled.
	3	ANGTS environmental protection program is significantly out of date with regard to existing environmental regulatory programs.
	2	Air quality permits for LNG terminal may require one year data collection period and one year for approval.
	3	Permits will be required for TAGS crossing of highways, railroad, salmon streams and road closures.
	1	FERC and OFI must issue approvals.
	2	Title XI congressional action to authorize pipeline through Denali could result in significant uncertainty on whether TAGS would receive right-of-way which could effect project economics.
	2	Coastal zone management program.

1.9 ALTERNATIVES

1.9.1 Introduction

Alternatives to the proposed TAGS project are discussed in this section. It includes several route options to tidewater to supply the export market and a no-project alternative. Transport of Prudhoe Bay natural gas to Lower 48 markets has been addressed in previous proposed projects and will not be addressed here. Information on optional proposals to transport Prudhoe Bay natural gas to the domestic markets is presented in EIS's published for three projects: Alaskan Arctic Pipeline Company proposal (DOI 1976), El Paso Alaska Company proposal (FPC 1976a), and Northwest Alaskan Pipeline Company (formerly ALCAN) proposal (FPC 1976b). This EIS assumes that the authorized but unconstructed ANGTS project will be built and does not represent an alternative to the proposed TAGS project.

This section presents information on alternatives to the proposed project, to describe the process through which alternatives were evaluated, and to present the conclusions of the evaluation. The discussion of alternatives to implement the proposed project includes:

- Consideration of alternative transportation modes and systems
- Consideration of statewide alternative pipeline routes and coastal terminal sites
- Evaluation of specific alternative regional pipeline routes and sites for LNG facilities/terminals
- Comparison of the environmental impacts of feasible combined routes and sites to the proposed TAGS project
- Consideration of the no-action alternative

1.9.2 Alternative Transportation Modes and Systems Considered

Various alternative modes for transporting Alaska North Slope oil and/or gas to domestic markets were considered in detail to the ANGTS in the DOI's Final EIS Alternatives Volume of March 1976 (pp. 116-168) and adoption by reference. The systems considered were: land routes, including dense-phase and methanol pipelines, railway, and monorail; marine routes, including ice-breaking tankers and submarines; air routes, including airplanes, helifloats, and dirigibles; conversion of natural gas to other energy sources, including electrical generation and transmission; and possible alternative combinations of various modes. For each system, the EIS (FPC 1976) presented a description of the system and its required facilities, its feasibility, and its environmental impact. Since none of these alternative modes of transportation was considered feasible to engineer or economically viable, they were eliminated.

1.9.2.1 Natural Gas Comingled with Crude Oil in TAPS

During the scoping process the question was raised as to whether natural gas and/or natural gas liquids could be transported in the existing TAPS pipeline system. The answer is that the existing TAPS crude oil pipeline is not designed to handle two-phase flow. The injection of natural gas into crude oil under pressure would result in substantial quantities of the natural gas coming out of solution at points of low pressure along the TAPS route, such as at the Brooks Range, causing serious vapor locks within the system. Additionally, as the natural gas enters the pump stations, serious cavitation problems would occur at some of the pumps. There would be serious jeopardy to continued safe operation of TAPS. Therefore, this alternative is not considered a viable option to the proposed action.

1.9.2.2 Convert Natural Gas to a Liquid at Prudhoe Bay and Comingle with Crude Oil in TAPS

During the public scoping process, a suggestion was made to convert natural gas to a liquid at Prudhoe Bay and then use the existing TAPS to transport both oil and gas to Valdez.

This alternative is possible only to the extent the natural gas, as a liquid, would be compatible with the operating potentials of the TAPS crude oil delivery system.

Natural gas liquids (NGLs) comprise a group of hydrocarbons that occur naturally in gaseous form or in solution with oil in a reservoir. NGLs are recoverable as liquids by condensation or absorption processes.

The average composition of gas reinjected in the Prudhoe Bay reservoir is shown in Table 1.9.2-1. That table also shows the composition of pipeline-quality gas that the proposed TAGS project would receive at Prudhoe Bay.

Table 1.9.2-1 Comparison of Gases Reinjected in Prudhoe Bay Reservoir Since 1978 to TAGS Feed Gas Composition

Constituent	Average Reinjected Since 1978[1] Percent (Volume)	TAGS Proposed Feed Gas[3] Percent Molecular
N_2 (nitrogen)	.48	.75
CO_2 (carbon dioxide)	12.77	None
C_1 (methane)	73.72	91.60
C_2 (ethane)	6.97	2.67
C_3 (propane)	3.56	3.40
iC_4 (iso-butane)	.48	.35
nC_4 (normal-butane)	1.15	1.12
iC_5 (iso-pentane)	.23	.06
nC_5 (normal-pentane)	.29	.04
C_6+ (hexanes and heavier)	.37	.01
	100.20%[2]	100.00%

1 (Personal communication - Russell Douglass, February 1987)
2 Does not add to 100 percent because of rounding within constituent averages
3 Source: Yukon Pacific Corporation

TAPS was designed to transport large volumes of crude oil. The maximum temperature of the oil at injection is 145°F. The design operating pressure of the pipeline is 1180 psi.

Through addition of long chain polymers and project modifications, Alyeska Pipeline Service Company has determined the present 145°F injection temperature for TAPS can be lowered to about 110° to 111°F. At this lowered temperature and at atmospheric pressure, approximately 40,000 barrels more of NGLs (as a liquid) can be comingled daily with the crude oil in TAPS. Methane, the principal component of the feed gas for the proposed TAGS project, is a gas at these temperatures and pressures and, therefore, is not compatible with the design of TAPS. At a temperature of -259°F, liquid natural gas (LNG) is not compatible with the TAPS design or operating requirements.

Accordiongly, the option of converting natural gas to a liquid to be comingled with crude oil in TAPS is not considered a practicable alternative to TAGS.

1.9.3 Regional Overview of Alternatives Considered

1.9.3.1 Introduction

To evaluate the feasibility of an alternative to the basic economic and physical requirements of the project one must also consider the ability of the alternative to conform to existing environmental, social, and safety objectives. The basic physical requirements were that a pipeline from Prudhoe Bay to a coastal port be constructable and that the coastal location be able to accommodate the consequent construction and operation of the LNG plant and marine terminal. This dictates that the operational conditions provide for safe and economic transportation of LNG with minimum downtime.

The coastal region of Alaska was subdivided into three general regions--western, southcentral, and southeastern. The northernmost coastal areas were not considered due to the well-documented extreme climatic conditions and sea ice that covers the entire area with the opening of nearshore leads only during summer season, normally not more than eight to 12 weeks.

General criteria were used for this initial screening to evaluate characteristics of alternative regional pipeline routes and coastal regions. The general criterion was that they had to be capable of transporting natural gas from Prudhoe Bay to tidewater year-round for export to markets in the Pacific Rim. Alternatives in previous EIS's, including TAPS and the Alaska Natural Gas Transportation Systems, which includes the El Paso, Northwest Alaskan and Alaskan Arctic proposals were reviewed. Those studies evaluated various Alaska pipeline routes and terminus sites, including Norton Sound, Bristol Bay, Cook Inlet, Prince William Sound, Yakutat Bay, and Lynn Canal/Chatham Strait.

1.9.3.2 General Criteria

The following list of general criteria focus primarily on the ability of tidewater ports to support a year-round marine export operation, and the feasibility of constructing and operating a pipeline to ports in that region.

- Continuous operation of marine terminal - Ability of the marine terminal facility to operate on a year-round basis. Natural gas flow through the pipeline would be continuous and storage capacity would be low.

- Minimize length of pipeline - Reducing the length of pipeline reduces the amount of environmental disturbance, the need for additional compressor stations, and the need for additional energy use for the system.

- Maximize the use of existing utility/transportation corridors - Restricts the environmental disturbances to areas previously unaffected by a linear project. A new utility corridor would open an undisturbed area to other development with environmental impacts beyond that associated with a single project. More information is available on existing corridors, which would facilitate planning and mediation of specific impacts.

- Maximize use of existing infrastructure - Locate project facilities to maximize use of existing roadways, workpads, construction camps, material sites, airports, and other facilities. This reduces impact on new areas and reduces the requirements for foundation materials.

- Avoidance of environmentally sensitive areas - Generally avoid sensitive environmental areas such as conservation system units, state and local parks, state refuges, wetlands, and roadless areas.

1.9.3.3 Evaluation of Statewide Route Options

1.9.3.3.1 Introduction

The criteria effectively demonstrate that pipeline routes to western Alaska and southeastern Alaska coastal areas would not warrant further consideration. The following subsections present the major reasons for elimination of these regional pipeline routes to tidewater.

These criteria and the evaluations conducted by the FPC in the FEIS (1976a) for the El Paso project (pp. II-376 through II-449) and the DOI in the FEIS (1976) for the Alaskan Arctic project (Alternative Volume pp. 623 to 684) are adopted by reference and were used to evaluate the routes to various coastal regions as summarized in Figure 1.9.3-1.

1.9.3.3.2 Western Alaska

Norton Sound

- Heavily massed sea-ice conditions from October through July which would prevent reliable year-round operations.

- Major ice floes, sea ice, and fog during remainder of year would affect safety of tanker operations.

Figure 1.9.3-1 Summary of Criteria Evaluation for Statewide Route Option

	Western Alaska		Southcentral			
	Norton Sound	Bristol Bay	Cook Inlet	Prince William Sound	Yakutat Bay	Lynn Canal/ Chatham Straight
Continuous Operation of a Marine Terminal	●	⊗	○	○	⊘	○
Minimize Length of Pipeline	○	●	○	○	●	●
Maximize Use of Existing Utility/ Transportation Corridor	●	●	○	○	●	○
Maximize Use of Existing Infra- structure	●	●	○	○	⊗	○
Avoidance of Environmentally Sensitive Area	●	●	⊘	○	●	●

○ = Favorable
⊘ = Moderately Favorable
⊗ = Unfavorable
● = Elimination

- Adverse impact to subsistence and the Native life-style.

- Significant disturbance to previously unaffected areas, including the Kobuk Valley National Park, Cape Krusenstern National Monument, Chukchi-Imuruk National Wildlife Reserve, Koyukuk National Wildlife Refuge, and the Selawick National Wildlife Refuge. The route would also traverse the Gates of the Arctic National Park and Preserve.

- Minimal use of existing utility/transportation corridors or existing infrastructure.

Bristol Bay

- Seasonally very heavy weather which could delay tanker traffic through the Aleutian Chain.

- Length of the pipeline would be approximately 150 miles lonter with three additional compressor stations.

- Significant disturbance to major unimproved areas on the southern portion of the route, including the crossing of Denali and Lake Clark National Parks and Preserves.

- Minimal use of existing utility/transportation corridor or existing infrastructure for the approximately 300 miles of route.

1.9.3.3.3 Southeastern Alaska

Lynn Canal/Chatham Straight

- Route would add an additional 210 miles of pipeline and three to four additional compressor stations.

- Route would traverse more than 200 miles in the Yukon Territory crossing the Kluane National Park and affecting the Kluane Territorial Game Sanctuary.

- Pipeline would cross the Tetlin National Wildlife Refuge.

- LNG tanker would be mixed into an area of confined navigation and inceasing tourism and commercial vessel traffic.

Yakutat Bay

- Route would add approximately 200 miles of pipeline and three to four additional compressor stations.

- Route would traverse more than 200 miles in the Yukon Territory crossing the Kluane National Park and affecting the Kluane Territorial Game Sanctuary.

- Pipeline would cross Tetlin National Wildlife Refuge.

- Significant disturbance of Tongass National Forest and the Wrangell-Saint Elias National Park and Preserve.

- Constructability concerns for the crossing of the Saint Elias Mountains.

- Minimal use of existing utility/transportation or existing infrastructure for the final 100 miles of alignment.

1.9.3.3.4 Southcentral Alaska

Initial screening for general criteria (Section 1.9.3.2) as well as evaluations of both the El Paso Alaska Project (FPC 1976a) and Alaskan Arctic Project (DOI 1976), determined that there were pipeline routes to southcentral Alaska, including Prince William Sound, and the Cook Inlet, that would be feasible routes to tidewater ports and warrant further consideration.

1.9.3.3.5 Summary

Based on evaluation criteria of feasibility of constructing and operating a pipeline and of suitability of tidewater ports for year-round operation of a marine terminal, any alternatives to western or southeastern Alaska was eliminated from further consideration. Each alternative was eliminated by one or more factors. Routes to the southcentral region of Alaska appear to be viable and warrant further consideration as acceptable routes and tidewater sites to the proposed TAGS project.

1.9.4 Evaluation of Alternatives or to the Proposed Project

1.9.4.1 Introduction

This subsection addresses regional pipeline route alternatives to Cook Inlet and alternative LNG sites in both the Prince William Sound and Cook Inlet areas. In the Cook Inlet region three alternatives were identified for LNG plant and marine terminal sites: Harriet Point, Boulder Point, and Cape Starichkof (Figure 1.9.4-1).

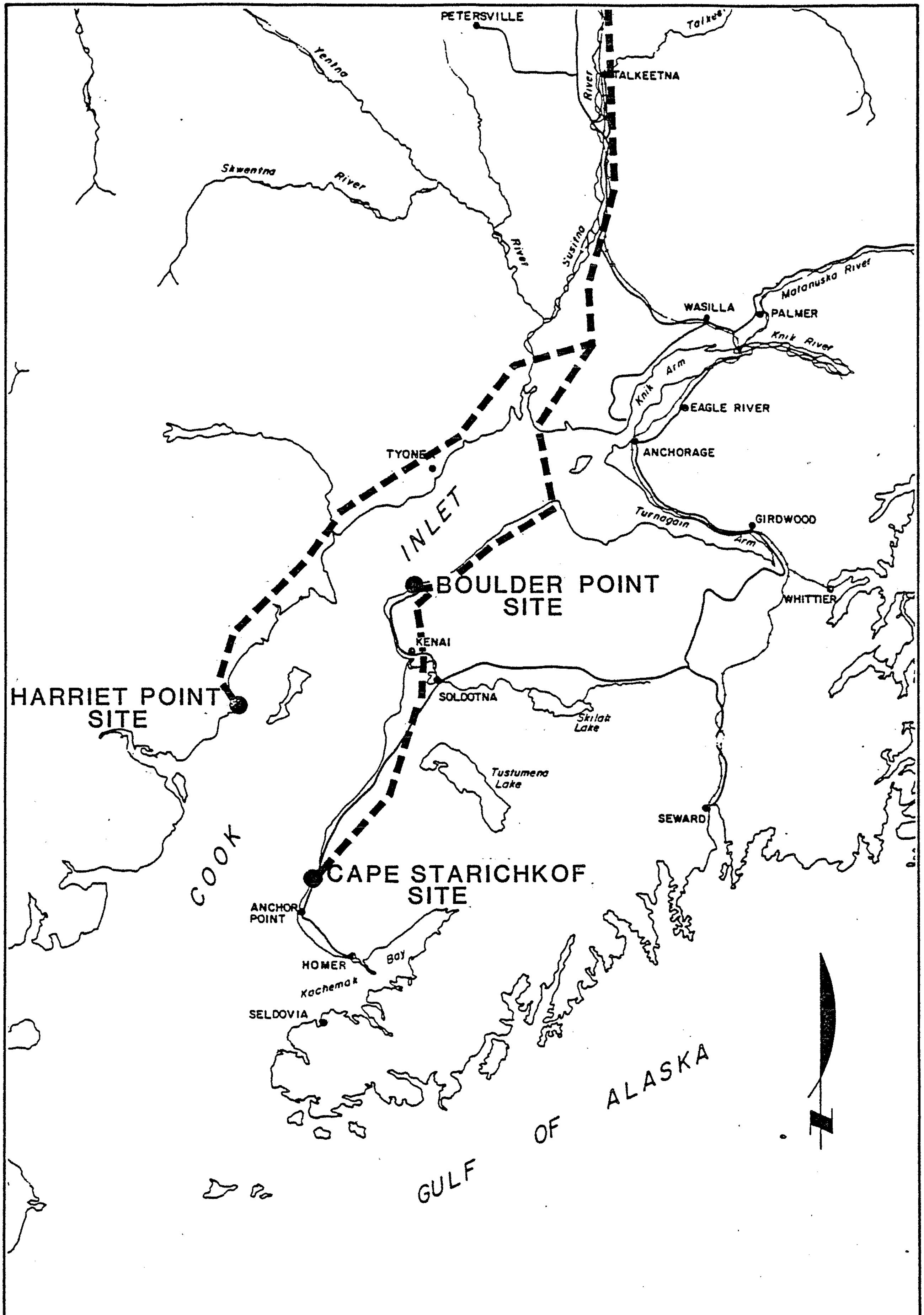


Figure 1.9.4-1. Alternative Cook Inlet Site Locations

The proposed project's LNG plant site and marine terminal are located at Anderson Bay in Port Valdez. Two sites at Port Valdez (Gold Creek and Robe Lake) and one in eastern Prince William Sound (Gravina) were considered as alternatives to Anderson Bay (Figure 1.9.4-2). During the scoping process, a fourth, known as the ALPETCO site, was identified but was subsequently removed from consideration because the site has been leased for development of a petroleum refinery.

A number of additional LNG plant sites and marine terminal locations were evaluated for both Prince William Sound and Cook Inlet in the FEIS for the El Paso project (FPC 1976a) in the discussion of "Alternatives to the Proposed Action" (pp II-376 to II-520) and in the EIS for the Western LNG Project (FERC 1978) in the discussion of "Alternatives to the Proposed Action" (pp. 233 to 296). Several sites were determined to warrant further consideration. Several sites previously determined to be acceptable for a smaller project, requiring many fewer LNG tanker calls per year, were determined to be unacceptable for the proposed TAGS project, which would require almost daily LNG tanker calls.

Several environmental studies have been conducted through the area of the Cook Inlet alternative alignments and are adopted by reference--the Anchorage-Fairbanks Transmission Intertie, Environment Assessment Report (1983) and the Susitna Basin Hydroelectric Project (1984).

1.9.4.2 Alternative Pipeline Route and LNG Facility Sites

1.9.4.2.1 Alternative Cook Inlet Regional Pipeline Route

Both the proposed TAGS pipeline alignment and the alternative Cook Inlet regional route are the same for the first 395 miles, from Prudhoe Bay to the vicinity of Livengood. Therefore, the comparative discussion in this alternative section considers only the differences from Livengood to Prince William Sound and Cook Inlet as shown in Alignment Map 3 at the end of the document.

From Livengood the alternative Cook Inlet regional pipeline route would diverge from the proposed pipeline route at and southward, following along the eastern margin of Minto Flats before crossing the Minto Fault. The route would continues southward through Nenāna with an elevated crossing at the Tanana River. From Nenana the route follows the Alaska Railroad, with an elevated crossing of the Nenana River near Liaho. The route then generally follows the Parks Highway to a point just south of Healy, where it parallels the Alaska Railroad for several miles before again joining the Parks Highway, traversing a portion of the Denali National Park and Preserve and using two elevated crossings of the Nenana River.

The route continues south, paralleling the highway just inside the park boundary before leaving the park near McKinley Village. As the route proceeds south, it again crosses the Nenana River with an elevated crossing. It passes through Cantwell and Summit and enters into Broad pass. In this area the route crosses the McKinley strand of the Denali Fault system, also thought to be active.

Once through Broad Pass the route traverses the upper Chulitna River valley, requiring an aerial crossing at Hurricane Gulch as it continues to follow the Parks Highway through Denali State Park and into the Susitna River valley south of Talkeetna. Following the highway south, this pipeline route crosses the Susitna River near Sunshine and Montana Creek in an elevated mode. Between Kashwitna and Willow the pipeline route departs the highway right-of-way, proceeding south around Nancy Lake State Recreation area toward Flat Horn Lake near the mouth of the Susitna River and the Susitna Flats State Game Refuge.

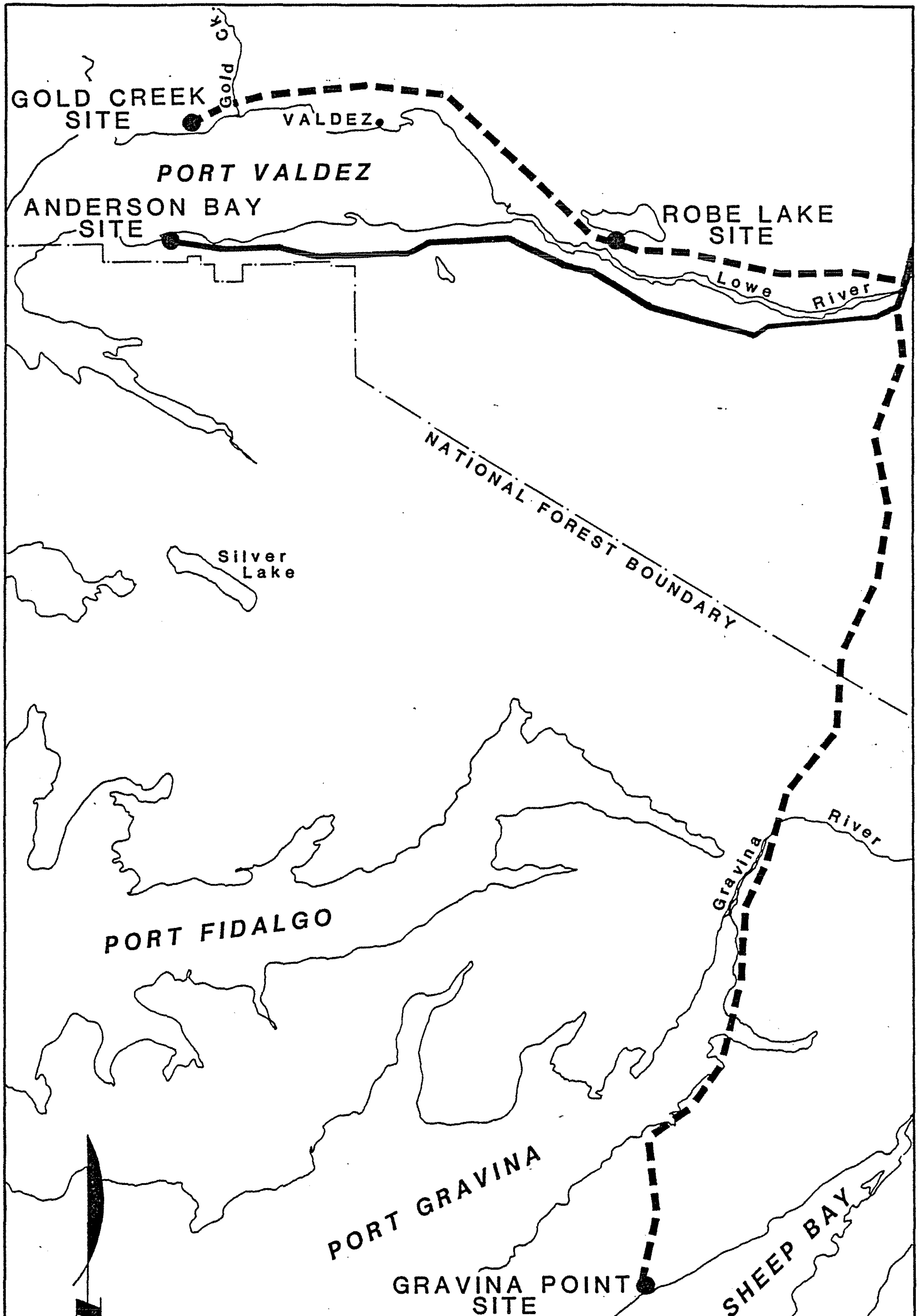


Figure 1.9.4-2. Proposed TAGS Anderson Bay Site Location and Alternative Prince William Sound Site Locations

Two alternate routes could be followed from this point. The first proceeds west to Harriet Point along the western side of Cook Inlet. The second goes due south with a submarine pipeline crossing of the Cook Inlet and along the western shore of the Kenai Peninsula to Boulder Point or Cape Starichkof.

1.9.4.3 LNG Sites for the Cook Inlet Pipeline Alternative

1.9.4.3.1 Harriet Point

To reach Harriet Point the alternative pipeline route extends from the north side of Cook Inlet and proceed southwesterly crossing the Susitna River through the Susitna Flats State Game Refuge, taking a more southerly course along the Beluga Power Plant transmission line and across the Beluga River. The route along the northwest shore of Cook Inlet lies primarily in an extensive coastal plain that borders a low-lying, marshy coastline, extending south to Harriet Point. Extensive muddy tidal flats of impermeable fine-grained sediments are found along the coast (ESL 1980a).

The Harriet Point site is located on the west side of Cook Inlet approximately 60 miles south of the village of Tyonek as shown in Figure 1.9.4-1. The closest development is an oil pipeline terminal and marine port facility at Drift River, 15 miles north. There is no nearby community development. The site proximity to Mount Saint Augustine and Mount Redoubt volcanoes and poor access keep continual constraint on development of any kind in the area.

Harriet Point is surrounded by Cook Inlet. Relief generally is low, but some grading would be required. Soils are reported to be suitable for development. Bedrock is probably more than several hundred feet deep, mantled with glacial till, outwash, and alluvial silt (OIW 1975). Site terrain and topography would allow the LNG plant to be located near the marine terminal. There are no active faults nearby.

Distance from shore to the 60-foot isobath would be more than 4,500 feet. Coastal bluffs border the point. Muddy tidal flats of impermeable, fine-grained sediments are found along the shorelines. A number of rock promontories along the northeast side of Harriet Point and some shoaling exist in the inlet between the Point and Kalgin Island.

Tanker maneuverability would probably be impeded by currents and inherently poor tanker berth configurations possible at this site. Anchorage would be available (OIW 1975). The port site might offer some natural protection. Wave, tide, and current conditions are acceptable, though tidal currents are quite strong. The velocity of the current between Harriet Point and Kalgin Island during a large tidal exchange has been estimated at more than 8 knots. Tsunamis also are a possibility (USDOI 1972).

Ice and icing conditions are not well defined. Generally, prevailing winds force ice to the west side of Cook Inlet. Ice conditions at Drift River are reportedly more hazardous than at Nikiski. During 1972 pack ice from 6 to 18 inches thick extended south of Harriet Point as far as Chiskik Island (OIW 1975). Fog can also hamper marine operations.

1.9.4.3.2 Boulder Point

To reach Boulder Point the alternative pipeline route would require a 15-mile Cook Inlet crossing to Point Possession on the Kenai Peninsula. From the Point Possession area the pipeline would parallel an existing gasoline pipeline right-of-way southwesterly for about 50 miles along the coast, terminating at Boulder Point just north of Nikiski, one of the Cook Inlet sites previously considered for location of the LNG plant and marine terminal as shown in Figure 1.9.4-1. This route avoids the Kenai National Moose Range, but traverses the Susitna Flats State Wildlife Refuge and the Captain Cook State Recreation Area for about 1.5 miles.

The Boulder Point site is located on the east side of Cook Inlet on the Kenai Peninsula approximately 17 road miles north of the city of Kenai and 6 miles north of an existing petroleum, petrochemical, refining and LNG industrial complex at Nikiski. Boulder Point is located northeast of East Forelands, a designated reserve for navigational purposes.

Commercial and residential development is not common, particularly near the site. Good infrastructure is in place for supporting construction and operations, but land availability could be a problem. Possible conflicts with nearby shipping and docking operations at Nikiski might exist (DOI 1976).

The north Kenai Road passes within 1.5 miles of the Boulder Point site, ending at Captain Cook State Recreation Area. The Nikishka airstrip is approximately 1.5 miles inland from Boulder Point; a regional airport at Kenai approximately 14 air miles south.

Boulder Point has fair proximity to deepwater; coastal bluffs are of moderate height; the shoreline is stable. It is the northernmost feasible industrial site with deep water marine access on the east side of Cook Inlet and the closest site to Anchorage (ESL 1980b).

Soils are suitable for development (loess over glacial outwash), and terrain above the cliffs is gently sloping to hilly (SCS 1962). Bedrock foundation may be lacking. Faults, volcanoes, and glacial floods should not be a problem. The water table is low, and liquefaction potential is low (OIW 1975; SCS 1962).

Site terrain and topography would allow construction of the LNG plant an acceptable distance from the marine terminal. Distance from the 60-foot isobath to shore is approximately 4,000 feet. Earlier studies (OIW 1975) indicated acceptable anchoring at depths less than 200 feet and an acceptable maneuvering area (2,000 feet minimum). Good navigational aids are present. A licensed state coastal pilot is required for vessels moving up Cook Inlet above Kachemak Bay.

There are a number of prominent rock outcrops along the shoreline of Boulder Point, particularly on the north side. NOAA National Ocean Survey charts warn of numerous uncharted and dangerous submerged boulders in the eastern portion of Cook Inlet. Some shoaling also exists along the east side of the Inlet. Projected dangers from tsuanmis are minimal due primarily to low predicted wave height, historical resistance of central Cook Inlet to earthquake-caused tsunämis, and existence of the Alaska Regional Tsunami Warning System (OIW 1975).

Severe floating ice and icing conditions may exist, and extreme tidal exchanges are generally strong in this area (USDOI 1976; OIW 1975). Ice in Cook Inlet would be an inherent winter hazard, requiring ice strengthening of LNG tankers and advance scheduling and two berths. Six out of 13 accidents recorded in Cook Inlet during a four-year study period (1971-1974) were due to ice. From January through April 1972, ten ships were damaged by ice in Cook Inlet. The ice problem is most severe in the upper inlet, particularly north of the forelands. LNG shipments to/from the existing Nikiski facility have been delayed due to ice or strong winds, though only for short periods of time (OIW 1975). Increased LNG tanker traffice due to the TAGS project might, however, increase the incidence of such delays.

1.9.4.3.3 <u>Cape Starichkof</u>

Cape Starichkof is located approximately 64 miles south of Boulder Point. The route from near Boulder Point proceeds southwest with two crossings of the Kenai National Wildlife Refuge. It then continues almost due south, again crossing a portion of the Kenai National Wildlife Refuge and the Kenai River.

The Cape Starichkof site is located 13 miles south of Ninilchik, 25 miles northwest of Homer, and 7.5 miles north of Anchor Point as shown in Figure 1.9.4-1.

The primary industry in this part of Cook Inlet is fishing. Substantial residential development has occurred in the immediate area, and both developed and undeveloped recreational lands are in the vicinity. A radio tower is just east of the proposed site. The Sterling Highway would run either adjacent to or through the LNG plant site on the east; a school land patent borders the plant site. An airstrip is located at Anchor Point, and a controlled airport is located in Homer. Some industrial and commercial infrastructure would be available at Anchor Point and Homer (OIW 1975).

Cape Starichkof is the only location between Kenai and Homer with nearshore deep water, with suitable uplands for industrial develpment and beach access. To the north and south of the Cape, two upland sites have been identified and designated for marine-related industry (ESL 1980b); however, neither of these is appropriate for the LNG plant site. The most suitable site lies in an area with high recreational use and scenic value since the high bluffs provide scenic overlooks of the Cook Inlet and the panorama of the mountains in the background.

Sufficient land at suitable elevations would be available, though there might be some jurisdictional constraints. Much of the site is nearly level, though some grading would be required with consideration for surrounding wetlands. Soil may be marginal for foundations (ESL 1980c). Soil borings taken 1 mile south and 5 miles north of the site showed silt in the tip 3 to 5 feet, overlying 40 to 50 feet of dense gravelly material. Subbituminous coal seams may occur below 50 feet. The water table is high, around 10 feet below ground surface (OIW 1975). Drainage is usually good. Surface waters are generally confined to streams and marshes; a few shallow lakes are present.

Geologic hazards are few. There are no nearby faults or glaciers. Coastal bluffs generally less than 300 feet high are found along the shoreline; they are susceptible to landslides and slumps (USGS 1976; OIW 1975; FERC 1978). Volcanic activity in lower Cook Inlet could disrupt facility operation. Liquefaction potential is not well defined. Gravelly soil is not typically susceptible to liquefaction, but the high water table may affect this susceptibility (OIW 1975). During the 1964 earthquake, Cape Starichkof subsided 0.5 feet.

With respect to marine terminal siting, moorage and anchorage areas would be sufficient. Tidal currents and wave heights are reported to be relatively moderate compared to those further north near the Boulder Point site. Average currents at Cape Starichkof are 2.3 knots during floodtide; maximum is 3.5 knots. Maximum wave heights of 10 to 12 feet generally occur several times a year (FERC 1978). Swells occur but apparently result in few navigation problems. Tsunami risk is somewhat greater than at Boulder Point but still considered moderate. LNG plant facilities would be located above the historical high-flood water mark (OIW 1975).

Distance from the 60-foot isobath to shore is approximately 4,200 feet (FERC 1978). Although bathymetry might be adequate for navigation and offshore anchoring (60- to 200-foot depth), significant longshore drift and shoaling are found in the area. Extensive dredging would be required to remove local shallow shoal areas (OIW 1975; DOI 1976; ESL 1980c).

Large-scale mobile bedforms are reported along the bottom of lower Cook Inlet off the coast of Cape Starichkof. Migration of bedforms can affect offshore structures and navigation (NOAA 1979).

The marine terminal would not be exposed to the ice and icing conditions present above the East Forelands owing to its location in lower Cook Inlet. Cape Starichkof is generally ice free, though pack ice has developed as far south as Anchor Point in severe winters (OIW 1975).

1.9.4.4 Alternative LNG Sites in Prince William Sound

1.9.4.4.1 Gold Creek Site

To reach the Gold Creek site, the pipeline would be routed to deviate from the proposed alignment and pass just northeast of the city of Valdez as shown in Figure 1.9.4-2. The Gold Creek site lies on the northwest shore of Port Valdez, approximately 4.5 miles west of the city of Valdez, 2 miles east of Shoup Bay, and 4.5 miles across Port Valdez from the TAPS oil terminal. The Valdez airport lies about 8 miles east of the site.

The site is comprised of a bedrock ridge and a bench mantled with glacial till. Above elevations of 500 feet, slopes are extremely steep. Sufficient space could be developed for an LNG plant by excavation of terraces in the hillside and grading the bedrock ridge. Most of the site lies between the 300- and 500-foot elevation.

Drainage varies from good to poor. An unnamed stream cuts through the site in an east-west direction. Another part of the area is flat and marshy. There are no known active faults in the vicinity.

The eastern face of the site is bound by a steep rocky shoreline. To the south the coastline is less steep and has a coarse, rocky substrate. In the vicinity of the marine terminal the 60-foot isobath lies approximately 500 feet offshore. Navigation charts do not show any rock hazards along the shoreline. Offshore anchorage is available, and there is ample area for maneuvering vessels.

General wind, wave, tide, and current data were not specifically extracted for this site, though detailed data are available from several sources. Seiche run-up during the 1964 earthquake was 124 feet near Gold Creek.

1.9.4.4.2 Robe Lake Site

The Robe Lake site is located along the south shore of the lake, approximately 6.5 miles southeast of Valdez, 4 miles southeast of the Valdez airport, and 4.5 miles east of the TAPS terminal as shown in Figure 1.9.4-2. The site is bound on the south by the Richardson Highway.

The area is comprised of an east-west bedrock ridge mantled with till. An LNG plant would be developed on the site by excavating and grading the ridgetop. This would reduce the ridge from a natural elevation of 400 feet to approximately 200 feet. Bedrock foundations would be available for critical LNG plant facilities.

All Prince William Sound and Cook Inlet sites are in a Uniform Building Code Zone 4 seismic (High-Seismic Zone) area. Recent (postglaciation in bedrock) displacement has not been observed or documented anywhere in the Valdez area, even though many lineaments and old inactive faults exist. Five areas on or adjacent to the site have been identified as avalanche zones; four areas have potential for mass wasting (Valdez CDD 1984).

Robe Lake is a valuable local resource used for recreational boating, swimming, fishing, and hunting. It is also used as a floatplane base. Several homes are scattered around the lake; a 150-home subdivision is just to the west. A state land disposal for residential use is located on the east side of the lake.

The LNG loading lines would leave the site along a westerly route, cut south across the Lowe River floodplain and continue west to the marine terminal site near Solomon Gulch Creek. The total length of the LNG loading line route would be approximately 5 miles.

1.9.4.4.3 Gravina Site

To reach the Gravina site the pipeline route would deviate from the proposed TAGS pipeline route just south of Keystone Canyon. through a 2.1-mile tunnel from Browns Creek to Dead Creek, and then follow Dead Creek along the Gravina shoreline. A marine crossings at Beartrap Bay and Comfort Cove would occur prior to reaching the Gravina site near Sheep Bay as shown in Figure 1.9.4-2. The total length of this route would be approximately 807 miles. The route traverses rugged, heavily glaciated ridges of the Chugach Mountains.

The majority of this route and the LNG facility site are within the Chugach National Forest. There is little road access. The FPC's El Paso EIS and the USFS, 1984 Chugach National Forest EIS are incorporated by reference for a description of natural resources along the pipeline corridor to Gravina.

The Gravina site is located on the southeastern shore of Gravina Peninsula, approximately 35 miles south of Valdez, 14 miles northwest of Cordova, and 4 miles northeast of Gravina Point. There is no nearby community development or infrastructure.

The closest developments would be Cordova and Valdez, both accessible to the site only by air or sea. Cordova is primarily a fishing community with limited industrial and commercial support and access is by air or sea. Valdez is also an important fishing and recreation community that has been industrialized to some extent by the TAPS terminal development. Valdez is accessible to the rest of the state by air, sea, and the road system.

The Gravina site has a southeasterly exposure to Orca Bay, Sheep Bay, and Prince William Sound. The site is on a sloping terrace with low and rolling topography and occasional irregular ridges. Elevation is about 500 feet. North of the site, the terrain rises steeply to 1,100-foot peaks 4,000 feet from shore.

Bedrock on the terrace is believed to consist of pointed and fractured slate and is generally less than 30 feet below the surface with some outcropping. Soil cover on the terrace consists of organic silts underlain with gravel and peat. Steeper slopes are generally covered with 5 to 10 feet of organic material. Glaciated valleys adjacent to the site may have granular soils 20 feet thick over silty glacial till (FPC 1976a).

Drainage on steeper slopes is good. Flatter slopes and low-lying areas with organic soils are poorly drained, resulting in ponding.

The Gravina site is in a highly seismic area, though no active fault zones are known in the immediate vicinity.

The shoreline at Gravina is characterized by bluffs ranging from 50 to 100 feet high, oriented in a northeasterly direction (FPC 1976a). The 60-foot isobath lies approximately 1,300 feet from shore (FPC 1976a).

At the marine terminal site, Orca Bay is approximately 6 miles wide, allowing ample maneuvering room. Waters in the immediate vicinity range from 50 to 300 feet deep, and anchorage is considered adequate. No underwater obstructions are noted on navigation charts. The entrance to Sheep Bay is about 4 miles wide with water depth averaging less than 60 feet. There are several small islands and shoal areas. Tidal and wind drift currents would be of an acceptable nature. Wave height could be up to 24.5 feet at the marine terminal site. Locally generated tsunami wave height is estimated to be from 10 to 16 feet/ 6 min. Maximum run-up height is estimated to be between 30 to 40 feet above mean sea level.

Ice and icing problems would be minimal. Prince William Sound is essentially ice free except for icebergs from nearby glaciers. Some sheet ice has been reported, probably the result of freshwater inflow at the head of various bays. Some shore ice could develop but not to significant levels. Calving by Columbia Glacier would probably not be a factor.

Navigation might be affected because, geographically the Gravina site tanker route would not be in the Valdez vessel traffic system. Periods of reduced visibility (0.5 miles) occur primarily at night, especially during summer.

1.9.5 System Components for the Alternatives

The basic project components for the proposed TAGS project or for any of the alternatives, discussed in Section 2, would be similar. The pipeline route from Prudhoe Bay to near Livengood for the proposed project and all alternatives considered would be the same. Likewise, the proposed project's approach to road crossings, elevated and below-ground river and stream crossings, fault crossings, and other basic construction techniques would be the same for all alternatives.

The major differences in construction would be for those conditions specific to the Cook Inlet alternative route that would require different construction techniques, such as the subsea pipeline under Cook Inlet, the approach to the pinch point near Denali National Park and Preserve, and the major access roads required for access to the compressor stations located in Minto and Susitna Flats. To reach the Gravina site in eastern Prince William Sound, a 2.1-mile tunnel and 1/2-miles of subsea pipeline would be required.

Table 1.9.5-1 summarizes the major facility components that would be required for the alternatives when compared to the proposed project.

1.9.5.1 Mainline Pipeline and Compressor Stations

With the exception of the routes to Harriet Point and Cape Starichkof, the proposed project and the other alternatives would require the construction of approximately 800 miles of pipeline and 10 compressor stations. The pipeline route to Harriet Point and Cape Starichkof would each require more than 800 miles of pipeline and an additional compressor station.

1.9.5.2 Elevated River Crossings

For the entire length of pipeline from Prudhoe Bay, six elevated crossings would be required for the Cook Inlet alternative at the Yukon, Tanana, and Nenana (two crossings) rivers and at Hurricane Gulch and Montana Creek. These crossing techniques are discussed in Subsection 2.3.4 for the Yukon River and Subsection 2.3.3 for the remaining river crossings and shown in Figures 2.3.3-2 and 2.3.4-4.

1.9.5.3 Subsea Pipeline

To reach the two sites on the Kenai Peninsula for the Cook Inlet alternative, a 15-mile subsea pipeline would be required to cross beneath Cook Inlet. The alternative pipeline route to Gravina, an alternative in the Prince William Sound area, would require two subsea crossings of Beartrap Bay and Comfort Cove for a length of between 0.5 and 2 mile.

Construction of the Cook Inlet subsea pipeline crossings would require the use of a large pipeline lay barge capable of handling the concrete coated 36-inch diameter pipe. Welding of pipe joints and completion of the coating process at the joints would be accomplished on the lay barge, and the completed section would then be lowered to the sea floor. The pipe would then be buried using a jet sled equipped with high-capacity airlift pumps. Provisions for excavating and removing occasional boulder size material from the pipe alignment and trench would be incorporated in the construction plan.

Due to the extreme tidal fluctuations and currents found in Cook Inlet, a multipoint anchoring system would be required to hold the lay barge in position. The presence of the lay barge and its multipoint anchor system would result in the

Table 1.9.5-1 Summary of Major Facility Components for the Proposed Project and Alternatives

	Prince William Sound				Cook Inlet		
	Proposed Project	Alternatives			Alternatives		
	Anderson Bay	Gravina	Gold Creek	Robe Lake	Harriet Point	Boulder Point	Cape Starichkof
Pipeline to LNG Site (miles)	797	807	797	783	826	791	856
Compressor Station	10	10	10	10	11	10	11
Elevated River Crossings	4	4	4	4	6	6	6
Subsea Pipeline (miles)	None	2	None	None	None	15	15
Length of Loading Line (miles)	<1	<1	<1	5	>1	>1	>1
Ferry Loading	yes	no	no	no	yes	no	no
Construction Camp at LNG Plant/ Terminal Site	yes	yes	yes	yes	yes	yes	yes

need for a traffic control system for vessels bound to and from the Port of Anchorage during the construction phase. Additionally, pipe burial depth should be sufficiently deep to provide adequate protection from anchor dragging and protection from scour.

1.9.5.4 Loading Lines

All three of the Cook Inlet area alternative locations would require a loading line greater than 1 mile in length from the LNG storage tanks to the loading berth as described in Subsection 2.5. The cryogenic loading lines between the LNG storage tanks and the marine terminal would be less than a mile for the proposed Anderson Bay site and the Gravina and Gold Creek alternative sites in Prince William Sound area. The Robe Creek alternative site, also in the Prince William Sound, would require a cryogenic loading line of 5 miles in length.

1.9.5.5 Ferry Landings

A ferry landing would be required at the proposed site at Anderson Bay since there would be no road access. The Harriet Point alternative on the western side of Cook Inlet would also require a ferry landing due to the lack of roads in the area as described in Subsections 2.5 and 2.6.

1.9.5.6 Temporary Construction Camps at LNG Plant Site and Marine Terminal

Due to the lack of road access to the proposed Anderson Bay Site, a 1,700-bed temporary camp would be required. The remoteness of both the alternative Gravina and Harriet Point site would also require a temporary camp of about the same size as described in Subsection 2.3.1 Although Gold Creek, Robe Lake, Boulder Point, and Cape Starichkof are reasonably accessible to existing infrastructure by roadways, each site would probably require a construction camp, somewhat smaller than the remote sites.

1.9.6 Project Evaluation Criteria

1.9.6.1 Introduction

The following set of evaluation criteria was developed to identify and evaluate environmentally acceptable and economically feasible routes to transport Prudhoe Bay natural gas to tidewater and on to Asian Pacific Rim markets. The criteria were separated by major project components--pipeline system, LNG plant site, and marine terminal--and reflect project design, construction and operational requirements. The criteria are presented below and their applicability and importance are described.

1.9.6.2 Pipeline

1.9.6.2.1 Minimize Length of Pipeline

Minimize pipeline length to reduce total area of environmental disturbance, land commitments, and resources used, including gravel and water resources. The pipeline length also has a direct relationship to construction, operational, and maintenance costs; construction schedules; need for additional compressor stations; and fuel usage.

1.9.6.2.2 Maximize Use of Existing Infrastructure

Use of existing construction infrastructure (access roads, construction camps, airports, materials, and disposal sites) as well as transportation corridors and existing, developed residential and commerical facilities in cities and towns along the route reduces the need to develop such infrastructures for project needs and reduces resource requirements.

1.9.6.2.3 Maximize Use of Proven Construction Techniques

Maximum use of construction techniques which have been used in the Arctic or for projects in similar topography, terrain and soils, wetlands, and water crossings to minimize potential construction and operational problems and potential environmental impacts. Avoid extremes of topography and terrain, soils, and hydrologic conditions that require the use of new or innovative engineering techniques.

1.9.6.2.4 Maximize Opportunity for Parallel Construction Techniques Along Existing Facilities

Where facilities are compatible the use of parallel pipeline construction adjacent to existing pipelines, transmission lines, and roadways would maximize construction efficiency and minimize the level of environmental impacts.

1.9.6.2.5 Avoid Areas of Potential Geohazards

Avoid, if possible, areas of known or potential geohazards that could affect the integrity of the system, cause environmental disturbance, and/or cause unsafe conditions during either construction, operations, or maintenance. Potential geohazards include slope instability, seismic fault lines, and areas subject to soil liquefaction and avalanches.

1.9.6.2.6 Minimize Potential Conflicts with Sensitive Environments

Minimize conflicts with sensitive environmental areas by generally avoiding proximity to those environments. To the maximum extent practicable, pipeline routes should avoid conservation system units such as national parks, preserves and forests, endangered species feeding or breeding areas, and wetlands.

1.9.6.2.7 Maximize Compatibility with Current and Planned Land Use

Maximizing land-use compatibility as well as avoiding direct land-use conflicts to avoid use of undeveloped areas, recreation areas, subsistence use areas, wildlife habitat, and residential areas for the pipeline and compressor stations.

1.9.6.2.8 Minimize the Number of Water Crossings

Pipeline route selection should reduce the number of river and stream crossings to minimize environmental impacts to fisheries, bank stability, and other potential effects especially to areas of significant habitat value for fish movement, spawning, overwintering, and rearing.

1.9.6.2.9 Avoid Permitting Conflicts

Avoid areas that would require a potentially protracted approval processes or unnecessary schedule delays, such as in conservation system units and state 4(f) lands.

1.9.6.2.10 Minimize Potential Threat to National Security

Joint use of areas with facilities designated as important for national security should be evaluated for its direct bearing on the achievement of national security goals that depend on uninterrupted economic activity.

1.9.6.2.11 Maximize Availability of Gas to Alaska Consumers (if feasible)

The location of the gas pipeline in proximity to the greatest number of users of natural gas provides a potential highest future benefit of the project to consumers along the route.

1.9.6.3 LNG Plant Site

1.9.6.3.1 Adequacy of Available Land

A minimum of 250 acres of suitable terrain for construction of facilities would be required with an adequate buffer safety zone to ensure public safety and security of operations.

1.9.6.3.2 Avoid Areas with Poor Foundation Characteristics

A foundation of bedrock or a dense glacial till with well-drained gravelly material that has a low potential for soil liquefaction during earthquakes and frost action would provide good foundation support for engineering integrity and safety of operation.

1.9.6.3.3 Avoid Areas with Faults

Avoid areas with active earthquake faults to ensure safety of operations and integrity of facilities and minimize extensive engineering design requirements.

1.9.6.3.4 Avoid Sites Potentially Exposed to Seismic Sea Waves

The LNG plant should be sited so that facilities are located above the highest expected seismic sea wave run-up or with adequate elevation to prevent flooding.

1.9.6.3.5 Minimize Length of Pipeline to Marine Terminal

Minimize the length of the cryogenic LNG pipeline from the storage tanks to the marine terminal site for engineering feasibility and operational safety. (Maximum distance is 2.5 miles.)

1.9.6.3.6 Maximize Use of Existing Community Infrastructure

The LNG plant site should have reasonable access to existing community infrastructure to provide for construction and operational support, housing, adequate transportation, and public services.

1.9.6.3.7 Avoid Sensitive Environmental Habitat

Site location should minimize impact to sensitive or unique environmental areas or wildlife habitat in vicinity of the site.

1.9.6.3.8 Public Safety Considerations

The LNG plant site should be sufficiently distant from residential areas, airports, or critical facilities to ensure adequate public safety in the event of an accident or spill.

1.9.6.3.9 Maximize Value-added Industrial Opportunities

The LNG plant, where the commerical use of natural gas for value-added industrial use could be developed, offers the greatest potential for development of this type of industry.

1.9.6.3.10 Minimize Site Preparation Requirements

Avoid sites with topographic conditions that require extensive preconstruction site preparation and material requiring disposal.

1.9.6.4 Marine Terminal

1.9.6.4.1 Minimize Exposure to Extreme Oceanographic Conditions

The site should be located in an area protected from extreme winds, high tides, strong currents, presence of sea ice, and exposure to waves from storms and seismic events.

1.9.6.4.2 Minimize Distance from Shore to 60-foot MLLW Depth

The distance from shore to the LNG tanker berthing area (60' MLLW depth) directly affects the length of cryogenic pipeline required from the LNG plant to the ship-loading terminal facility with engineering design, project safety, and cost considerations.

1.9.6.4.3 Maximize Suitability of Tanker Maneuvering and Anchorage Area

Area of marine terminal must have 50-foot water depth close to shore and an adequate navigation channel and turning basin to meet safety requirements (minimum 2,000-foot turning diameter) and suitable anchorage area with water depths less than 200 feet.

1.9.6.4.4 Minimize Potential Hazards to Navigation

Optimum tanker approach channels should have a minimum width of 450 feet, minimum water depth of 50 to 60 feet, and require no sharp channels, turns, or obstructions to shipping. Ports of entry should have a well-defined vessel traffic control system.

1.9.6.4.5 Minimize Potential Problems Related to Soils and Geohazards

Potential seismic activity and marine subsoil conditions (shear strength, bedrock depth, liquefaction possibilities) must be factored into final site selection. Geohazards considerations include magnitude and probability of the occurrence of earthquake and seismic sea waves created by a subsurface slide.

1.9.6.4.6 Minimize Potential Threat to National Security

Minimize interaction with facilities designated as important for national security goals of uninterrupted economic activity.

1.9.7 An Evaluation of Reasonable Range Alternatives to the Proposed Action

1.9.7.1 Introduction

This section presents the results of the application of evaluation criteria for the pipeline route, LNG plant site, and marine terminal criteria, listed in Subsection 1.9.6, for the proposed TAGS project and the project alternatives in the Prince William Sound and Cook Inlet regions. Section 1.9.7.2 summarizes important aspects of rating each alternative for each criterion and provides the rationale for the ratings listed in Table 1.9.7-1. Section 1.9.7.3 includes an evaluation of each alternative with respect to the criteria established.

Results summarized in Table 1.9.7-1 indicate the degree of favorability of the proposed project alternatives considered for each specific criterion under discussion. Categories are defined as follows.

Favorable - based on this criterion, the site/alignment offers no impediments to construction and operation of the proposed facility.

Moderately Favorable - the site/alignment has negative conditions that could be mitigated with a reasonable effort and expense within a reasonable time frame and with a high probability of success.

Unfavorable - the site/alignment has major negative conditions that could probably be mitigated but with unreasonably high expense, time frame, and/or uncertainty of success.

Highly Unfavorable - the site/alignment has major negative conditions that could not be adequately mitigated with a reasonable effort and expense, within a reasonable time frame, and/or with a high probability of success.

1.9.7.2 Evaluation of Pipeline Criteria

1.9.7.2.1 Minimize Length of Pipeline

The distance to Boulder Point is similar to the proposed action and is also favorable. The magnitude of additional pipeline length for both Cape Starichkof and Harriet Point (of 59 to 29 miles, respectively), however, would require one more compressor station with attendant increases in costs for construction and operations and environmental impacts associated with the presence of the facility and would be rated unfavorable.

The total length of the pipeline right-of-way from Prudhoe to Anderson Bay would be 796 miles. With a maximum variance in pipeline length of only 14 miles from the proposed route, the Prince William Sound alternative alignments are not significantly different from each other or from the proposed route. In general, such a difference in length alone would not be expected to greatly affect cost, time of construction, or total area disturbed by the pipeline and would therefore be rated favorable. Gravina pipeline would be approximately 10 miles longer than that proposed for Anderson Bay and would rate moderately favorable.

1.9.7.2.2 Maximize Use of Existing Infrastructure

Along the Cook Inlet regional alignments, available infrastructure is variable and discontinuous. From Livengood through Minto Flats and again from north of Willow through the Susitna Flats, there would be no infrastructure to support construction. For the Harriet Point site, there would be little supporting infrastructure for the more than 100 miles of alignment from Willow beyond the minimal amount associated with the power lines to the Chugach Electric Association Beluga generating facility and the Susitna to Tyonek road system. More than 100 miles of workpad and access roads would be required to construct the pipeline segment between

Figure 1.9.7-1 Criteria Evaluation Matrix for Proposed TAGS Project and Alternative Evaluations

	Prince William Sound				Cook Inlet		
	Proposed Project to:	Alternatives			Alternatives		
	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
Pipeline Criteria							
- Minimize length of pipeline	○	⊘	○	○	○	⊗	⊗
- Maximize use of existing infrastructure	○	⊗	○	○	⊘	⊘	⊗
- Maximize use of proven construction techniques	○	⊗	⊘	○	⊗	⊗	⊗
- Maximize opportunity for parallel construction techniques	○	⊘	○	○	⊘	⊘	⊘
- Avoid areas of potential geohazards	⊘	⊗	⊘	⊘	⊗	⊗	⊗
- Minimize potential conflicts with sensitive environments	○	⊘	○	○	⊘	⊘	⊗
- Maximize compatibility with current and planned land use	○	⊗	⊘	○	⊗	⊗	⊗
- Minimize the number of water crossings	⊘	⊗	⊘	⊘	○	○	⊘
- Avoid permitting conflicts	○	⊘	○	○	●	●	●
- Minimize potential threat to national security	○	⊘	○	○	⊘	⊘	⊘
- Maximize availability of gas to Alaska consumers	⊘	⊗	⊘	⊘	○	○	○

	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
LNG Plant Criteria							
- Adequacy of available land	○	○	○	●	⊘	⊗	○
- Avoid areas with poor foundation characteristics	○	○	○	○	⊘	⊘	⊘
- Avoid areas with faults	⊘	⊘	⊘	⊘	⊘	⊘	⊘
- Avoid sites potentially exposed to seismic sea waves	○	○	○	○	○	○	○
- Minimize length of pipeline to marine terminal	○	○	○	●	⊘	⊘	⊘
- Maximize use of existing community infrastructure	⊘	●	⊘	⊘	○	○	⊗
- Avoid sensitive environmental habitat	⊘	⊗	⊘	⊘	⊘	⊗	⊗
- Public safety considerations	○	○	⊘	●	⊘	⊘	○
- Maximize value added industrial opportunities	⊘	●	⊘	⊘	○	○	⊗
- Minimize site preparation requirements	⊘	⊘	⊗	⊘	○	○	○

	Anderson Bay	Gravina	Gold Creek	Robe Lake	Boulder Point	Cape Starichkof	Harriet Point
Marine Terminal Critieria							
- Minimize exposure to extreme oceanographic conditions	○	○	○	○	⊗	⊗	⊗
- Minimize distance from shore to 60' MLLW depth	○	⊘	○	⊘	⊘	⊘	⊘
- Maximize suitability of tanker maneuvering and anchorage area	○	○	○	⊗	⊘	⊘	⊘
- Minimize potential hazards to navigation	○	⊘	○	⊘	⊗	⊘	⊘
- Minimize potential problems related to soils and geohazards	○	⊘	⊗	⊗	⊘	⊘	⊘
- Minimize threat to national security	⊘	⊘	⊘	⊘	⊘	⊘	⊘

○ Favorable
⊘ Moderately Favorable
⊗ Unfavorable
● Highly Unfavorable

Willow and Harriet Point, making this alternative unfavorable with regard to infrastructure requirements.

In addition to the infrastructure requirements for Minto Flats and Susitna Flats, the Boulder Point route would require infrastructure support for a 15-mile subsea pipeline from the north shore of the Cook Inlet near the mouth of the Susitna River to Point Possession on the Kenai Peninsula and about 15 more miles of road construction along a roadless pipeline right-of-way from Point Possession to the first existing road access to that right-of-way. For the overall route the existence of suitable infrastructure along much of the route, including a parallel railroad and highway system and population and commercial centers in the Railbelt and Kenai areas, would be somewhat counterbalanced by a lack of infrastructure in specific areas to yield Boulder Point a rating of moderately favorable.

From near Boulder Point the route to Cape Starichkof would be accessible to the Sterling Highway and, thus, to the full support capabilities of the Kenai Peninsula. This route is also considered to be moderately favorable.

From Livengood southward the proposed project alignment to Anderson Bay generally follows the existing TAPS utility pipeline corridor and benefits directly from the potential use of a number of existing access roads and camp pads used for TAPS construction used for TAPS construction. The route also makes maximum use of the existing highway systems, airports and airstrips, and population centers that have supported similar construction and operations activities in the past. The route variations for Gold Creek and Robe Lake are insignificant as related to available infrastructure, and these routes are also considered to be favorable in this regard.

The Gravina alignment is the same as for Anderson Bay, Gold Creek, and Robe Lake to the vicinity of Keystone Canyon near Valdez. From Keystone Canyon to the terminus at Gravina, the alignment has no infrastructural support. Construction requirements would include roads and camps for most of the 32 miles of mountainous terrain between Keystone Canyon and Gravina. Similarly, operation of this segment of pipeline would rely on infrastructure support from Valdez and Cordova by marine or air service. Even with consideration of the highly favorable infrastructure of the route to Keystone Canyon, the overall Gravina route infrastructure would be considered unfavorable.

1.9.7.2.3 Maximize Use of Proven Construction Techniques

Constructability for the Cook Inlet alternative routes from Livengood to Cook Inlet in general would not be expected to pose greater problems than for the proposed TAGS alignments. The much smaller existing data base upon which to base engineering design could lead to construction delay as problems are found along the route (e.g., a complicated aerial crossing of Hurricane Gulch), potentially less suitable soils and drainage conditions in the Susitna Flats, and difficulties with the subsea pipeline crossing of the Cook Inlet.

For Boulder Point, the need for a 15-mile subsea pipeline across Cook Inlet represents an important additional constructability consideration. Extension of the pipeline route to Cape Starichkof adds crossings of several heavily utilized sport fishing streams, including the Kenai River. It also traverses extensive areas of poor drainage and areas where there was extensive ground breaking as the result of the 1964 earthquake that might be expected to have a similar response to future seismic events. On the basis of these factors, both the Boulder Point and Cape Starichkof sites are considered unfavorable in terms of constructability.

Constructability considerations for the route to Harriet Point--in addition to those mentioned for the route from Livengood to Cook Inlet excluding the subsea Cook Inlet crossing--are seismic activities, crossing extensive wetlands, and the potential for flooding by the Drift and Chakachatna rivers due to bursting of glacial lake dams or glacial melt. Volcanic activity is also severe in the area. Seismic considerations include a crossing the the Castle Mountain Fault, extensive ground breaking and cracking, and seismic activity associated with several nearby active volcanoes. Overall these factors would be considered to be unfavorable for this route.

Construction of the TAGS pipeline through the terrain types found from Livengood to Anderson Bay would rely on engineering designs and construction techniques proven through construction of the TAPS pipeline along the same corridor as well as with the authorized ANGTS gas pipelines which had an approved design for basically the same system as the proposed TAGS through Delta Junction. Pipeline routes to alternative sites at Robe Lake and Gold Creek would similarly rely on proven construction techniques in known geological and geotechnical environments. Robe Lake would be considered as favorable. However, because the last 3 miles of pipeline alignment to Gold Creek would be located on steep sideslope, this route would be rated as moderately favorable. The pipeline route to Gravina would require routing through 32 miles of glaciated mountainous terrain through the Chugach National Forest and a 2.1-mile mountain tunnel. In terms of constructability, this route alternative would have to be considered as unfavorable.

1.9.7.2.4 Maximize Opportunity for Parallel Construction Techniques Along Existing Facilitiies

Each of the three Cook Inlet alternatives also has lengthy stretches with no parallel access. These include lengths through Minto Flats for approximately 70 miles and Susitna Flats for approximately 50 miles, Cook Inlet submarine crossings, and that portion of the route to Boulder Point and Cape Starichkof on the northern part of the Kenai Peninsula, prior to convergence with an existing pipeline corridor. Boulder Point and Cape Satrichkof would be moderately favorable.

Construction efficiency would be maximized and environmental impacts minimized for the routes that closely follow existing pipeline and transportation corridor. The proposed route to the Prince William Sound sites in Port Valdez all benefit from a close association with TAPS and its existing access roads and have been rated favorable for this criterion.

Gravina departs from the TAPS line at Keystone Canyon and then proceeds through the Chugach Mountains and the Chugach National Forest for approximately 32 miles--an area with no existing access from which to utilize parallel construction--and is rated as moderately favorable.

For the Harriet Point Alternative, the pipeline would be routed along the west side of Cook Inlet, partially paralleling an existing small-diameter gas pipeline and an existing oil pipeline near Drift River, and would be moderately favorable.

1.9.7.2.5 Avoid Areas of Potential Geologic Hazards

Alignments to the Cook Inlet must pass through a similar range of geohazardous conditions as the proposed alignment, including crossings of the Minto Fault and the McKinley strand of the Denali fault system, marshlands, the Tanana River with its multiple shifting channels. The Boulder Point and Starichkof alignments must cross the Cook Inlet with a 15-mile subsea pipeline and cross the Castle Mountain fault system. The Cape Starichkof alignment further traverses 15 miles of terrain susceptible to seismically-induced failure. As geohazards are much less well-known along both the Boulder Point and the Starichkof alternatives, these routes are rated unfavorable for geohazards.

The Harriet Point alignment runs parallel to the Basin Bay Fault which intersects the Castle Mountain Fault. The Castle Mountain Fault has and is the site of many earthquakes. This route also transits areas which could be susceptible to seismically induced cracking and ground breakage and is located with the vicinity of two active volcanoes. Harriet Point is rated as unfavorable.

Geologic hazards are natural or man-made geologic conditions that potentially endanger life and property. Geologic hazards that TAGS may encounter during its design life include mass wasting, ground subsidence or heave, earthquake-induced ground failure, glaciating, snow avalanche, erosion, flooding, and tsunamis or seiche. As TAPS demonstrated, technology is available to identify these hazards, determine their probable severity, and to mitigate their effects in siting, design, and construction.

Geohazards are considered as moderately favorable for the proposed alignment because the hazards have been identified and taken into consideration in the siting and design of TAPS.

The difference in geohazards between routes to Robe Lake and Gold Creek differ from the proposed alignment in passing through some additional avalanche and landslide areas but are not considered overall to present major differences in engineering design requirements. These are also rated as moderately favorable.

The 32 miles of alignment, unique to Gravina alternative, pass through the heavily glaciated Chugach Mountains, through areas with avalanches and landslides near tunnel entrances, and crosses the Jack Bay and Gravina faults. This alignment is considered to be unfavorable.

1.9.7.2.6 Minimize Potential Conflicts with Sensitive Environments

Cook Inlet alternatives impinge on several sensitive areas avoided by proposed action. South of Livengood to Tanana, the Cook Inlet pipeline traverses Minto Flats, an important waterfowl and subsistence use area for Alaska Natives. A compressor station and an access road would also be required in this general area for the life of the project. The alternative pipeline route passes through the eastern edge of Denali National Park and Preserve, which, aside from any question of obtaining congressional approval for this part of the right-of-way, is the most heavily visited park in Alaska. Pipeline construction activities could directly interfere with park traffic and disturb the aesthetics and scenic qualitites for park visitors from north of the park on through Broad Pass and south through Denali State Park. South of Willow, the Cook Inlet route passes through the Susitna Flats, which are characterized by high waterfowl use, several highly productive anadromous fish streams, and associated high recreational use. Whether potentially increased access is considered as positive in promoting use and development or as negative in disturbing the ecosystem and changing the character of this area for recreational use, it is quite likely that construction of a pipeline through this area would produce changes in the Susitna Flats area. A compressor station and access road would be required in the Susitna Flats for the life of the project.

In addition, the Boulder Point route crosses a small part of the Captain Cook State Recreation Area. The Cape Starichkof route would cross the Kenai River Management Zone, heavily used by both sport and commercial salmon fishermen.

The Harriet Point route passes through critical waterfowl habitat, including nesting areas of the rare tule goose and the Trading Bay State Game Refuge with critical moose, brown bear, and other habitat and significant salmon streams.

Boulder Point and Cape Starichkof were considered as moderately favorable and Harriet Point unfavorable on basis of these factors.

The proposed TAGS route follows existing utility corridors for the entire length and poses minimal change in character or use of environments along the 800-mile corridor. A few specific areas are near areas known to be used by threatened or endangered species, mainly peregrine falcons near Grapefruit Rocks and along the Tanana River and bald eagles south of Keystone Canyon. Minor routing adjustments and other mitigation such as timing of construction should effectively avoid any potential impacts. The routes to Anderson Bay, Gold Creek, and Robe Lake are considered as favorable. The route to Gravina must continue across 15 miles of undeveloped Chugach National Forest land. With the linear aspect of the intrusion, the low potential for postconstruction impacts of a buried pipeline, and the absence of conflict with current use of this forest land, this route is considered as moderately favorable.

1.9.7.2.7 Maximize Compatability With Current and Planned Land Use

The three Cook Inlet alignments (from Livengood to Cook Inlet) traverse the eastern end of Denali National Park and Preserve, which would pose a major potential land-use conflict due to the Alaska National Interest Lands and Conservation Act (ANILCA). Aside from problems related to permits and approvals with ANILCA Title XI (see Subsection 1.9.7.2.9 discussion), pipeline construction activities would interfere with the current use by visitors to the park in terms of both aesthetics and traffic flow. The pipeline also would cross approximately 70 miles of roadless fish and wildlife subsistence habitat in the vicinity of Minto Flats; would traverse highly utilized fishing and recreational areas along the Alaska Railroad/Parks Highway corridor, including McKinley Village, Denali State Park, and the Nancy Lakes Recreation Area; and would cross approximately 50 miles of undeveloped area in the Susitna Flats area. The alignment to Boulder Point would traverse 17 miles of the Susitna Flats State Game Refuge, the edge of the Kenai National Wildlife Refuge, and the Captain Cook State Recreation area. From Boulder Point to Cape Starichkof the alignment crosses several heavily utilized sport salmon fishing streams and the Kenai National Wildlife Refuge. The route to Harriet Point on the west side of Cook Inlet is largely undeveloped. It is an area undergoing significant change. In addition to an established timber harvest area, a major coal export program is being started. It also would cross more than 20 miles of the Susitna State Game Refuge. All three of the Cook Inlet routes are considered unfavorable because of land-use conflicts at Minto and Denali National Park and Preserve.

The proposed alignment from Livengood to Anderson Bay follows a designated transporation and utility corridor through the Prince William Sound area. The proposed alignment traverses portions of Quartz Lake State Recreational Area (SRA), Dry Creek State Recreation Site (SRS), Worthington Glacier SRS, and Blueberry Lake SRS. The alignments to Robe Lake and Gold Creek alternative sites pass near several existing or proposed recreational sites in the vicinity of Robe Lake, including the Salmonberry Ridge Ski Hill and the proposed bike trail extension No. 3. Beyond Robe Lake, the route to Gold Creek passes near the Robe River Neighborhood Park and the proposed Robe River Fishing Platform (Valdez CDD 1986). The Gold Creek route would also pass through state lands proximate to the city of Valdez, the Valdez Airport, and the proposed Gold Creek Trail (CSS 1986). Because the final pipeline segment represents such a small proportion of the total alignments and nearly any impacts on these existing and planned land uses would be due to constructon only, the Gold Creek and Robe Lake alignment has been rated overall as favorable and similar to the proposed Anderson Bay route.

The pipeline alignment to Gravina transits approximately 15 miles of the

Chugach National Forest. The Forest Service has defined a management direction for the Gravina Management Area that includes maintenance of landscape character and "dispersed recreational opportunities" as well as enhancement of marine oriented recreational opportunities and fish habitat. Installation of 36-inch gas pipeline would not necessarily interfere with these objectives. This alternative is considered as moderately unfavorable on the basis of its potential conflict with the Chugach National Forest Plan (USFS 1984).

1.9.7.2.8 Minimize the Number of Surface Water Crossings

Approximately 100 streams are crossed by Cook Inlet regional pipeline alignments between Livengood and Cook Inlet. Though total stream crossings are fewer for the Cook Inlet routings to Boulder Point and Cape Starichkof, many of these are heavily utilized by anadromous fish and receive much heavier recreational use than the streams along the proposed route. By comparison with streams crossed by the proposed alignment, the Boulder Point and Starichkof are considered to be favorable and Harriet Point to be moderately favorable due to the sensitivity of those streams crossed.

The pipeline route from Livengood to Valdez would have to cross approximately 150 streams and rivers. Most of these streams were also crossed by the TAPS pipeline and will be crossed by ANGTS. The difference in total stream crossings between Gold Creek, Robe Lake, and the proposed Anderson Bay project site is two less for Robe Lake, two more for Gold Creek. Each of these three alignments is considered to be favorable with respect to stream crossings. The alignment to Gravina has approximately six additional streams, plus it crosses Charter Bay and Comfort Cove on Prince William Sound and would therefore rate unfavorable.

1.9.7.2.9 Avoid Permitting Conflicts

The Livengood to Cook Inlet alternative alignment passes through several areas that pose major permitting issues regarding permits and approvals. Subsistence use in the Minto Flats area, heavily used anadromous fish streams, and crossing the presence of the Denali State Park and Susitna Flats State Wildlife Refuge make the difficulty of obtaining permits through these areas potentially difficult. However, the most difficult segment to permit along the Cook Inlet alignments would be for that required through the Denali National Park and Preserve.

On the basis of the requirement of ANILCA, Title IX, a Congressional approval would be required for a right-of-way through Denali National Park and Preserve and a suitable alternative to that alignment designated, namely the action proposed to construct the TAGS project to Anderson Bay. All three Cook Inlet alternatives are considered to be highly unfavorable due to the project time delays that would be involved in any attempt to secure Congressional approval when the proposed route to Anderson Bay would avoid the Denali National Park and Preserve entirely.

The procedure under 43 CFR 36 for authorizing a pipeline through Denali National Park and Preserve would require among other things:

> Joint preparation of the environmental impact statement by all appropriate federal agencies, including the Department of Transportation.
>
> No federal approvals for any part of the proposed pipeline system until all the provisions of 43 CFR 36 are met.
>
> A determination that there are no other alternative modes of access or any economically feasible and prudent alternative.

Since the National Park Service lacks authority to issue rights-of-way for pipelines under Section 28 of the Minerals Leasing Act of 1920 (30 USC 185), approval of the proposed TAGS project through a portion of the Denali National Park and Preserve therefore would require:

A specific determination that ". . . there is no economically feasible and prudent alternative route for the system."

A recommendation by the National Park Service to the president that the TAGS should cross a portion of the Denali National Park and Preserve.

A presidential recommendation to Congress supporting legislation to authorize construction of the TAGS project through Denali National Park and Preserve; and finally

An act of Congress approving a TAGS alignment through Denali National Park and Preserve.

Since an acceptable environmental and cost-effective alternative has previously been reviewed and approved as discussed in Appendix C , the Cook Inlet alternatives are unfavorable from a permit standpoint.

Number and type of permits discussed in Section 1.0 generally apply to both routes. However, the process and timing to obtain these permits is quite different. The proposed alignment from Livengood to Anderson Bay generally follows existing transportation and designated utility corridors and probably has less potential permitting conflicts since it is basically adjacent to constructed TAPS and authorized ANGTS to Delta Junction.

Additional technical reviews would be necessary whenever TAGS would lie close to ANGTS or to TAGS. Routings to Prince William Sound would have more proximity reviews than those to Cook Inlet.

Both Cook Inlet and Prince William Sound routes involve military installations. Cook Inlet has one, Prince William Sound two. Cook Inlet routings would require permits from the Alaska Railroad; Prince William Sound would not.

Air quality permitting for the LNG plant near Valdez would probably require a monitoring program as discussed in Subsection 5.6. Preliminary emissions calculations indicate no major air emission increase from the facility as identified in Subsection 5.6. The route alignments to Anderson Bay, Robe Lake, and Gold Creek would differ only in permits related to land use near Valdez. Though they might elicit a difference in response from local agencies relative to current land use plans, there is no current information to suggest that either of these sites would be less favorable in terms of securing necessary permits, and all are considered favorable. The alignment to Point Gravina would pass through approximately 15 miles of the Chugach National Forest.
The forest is managed for multiple use, there are no specific provisions for a utility right-of-way. On the basis of potential permitting problems which could delay or halt the proposed project, the Gravina alignment would have to be considered moderately favorable.

1.9.7.2.10 Minimize Potential Threat to National Security

Three questions must be answered with regard to pipeline alternative alignments and potential national security impacts. First, would any of the alignments potentially affect U.S. dependence on foreign energy supplies during a time of international conflict when supplies might be curtailed? Secondly, do any of the proposed alternative alignments pose a greater risk to the security of the supply from an action of war or terrorism? Finally, do the alignments pose any greater or lesser ability to establish effective security measures to protect them?

No matter what the selected alignment, with 800 miles of pipeline, there would always be the potential for terrorism. None of the alignments offers any greater or lesser exposure to disruption. The only obvious potential difference vis-a-vis national security rests in the proximity of the TAGS pipeline to the existing TAPS and the authorized ANGST systems. Should it ever become necessary to attempt to protect the TAGS line from possible terrorist actions, it would seem that security measures to protect a single TAPS, TAGS, and ANGTS corridor would have a greater potential for success than trying to secure two separate alignments through uninhabited areas. On this basis the proposed alignment to Anderson Bay and the alternatives to Robe Lake and Gold Creek are all considered favorable, and the Gravina and three Cook Inlet alignments are considered as moderately favorable.

1.9.7.2.11 Maximize Availability of Gas to Alaska Consumers

Cook Inlet alternative alignments also pass near Fairbanks, and potential future gas use would be considered favorable. In addition, the route parallels the Railbelt from Fairbanks through the Matanuska-Susitna Borough, providing potential direct future gas supplies to the population along this corridor. The Boulder Point and Cape Starichkof alignments provide a potential future gas supply to an area (Kenai/Soldotna) with the population and industrial infrastructure to maximize the potential for any possible future uses. The Harriet Point alignment, though it veers away from the prime population and infrastructure areas as it heads to the west side of the inlet, would pass through an area that has current industrial facilities (Beluga Power Plant, Drift River petroleum facility) and is proposed for future development (expansion of Beluga Power Plant and development of Diamond Chuitna coal mine and export terminal). On the basis of this overall analysis, all Cook Inlet alignments are considered to be favorable.

Though there is no specific plan to provide access lines to tap natural gas flowing through the proposed TAGS for use by public or commercial facilities along the route, this criterion considers the possibility of greater access to potential future uses as a favorable characteristic. The proposed alignment from Livengood to Anderson Bay passes close to the Fairbanks area, affording potential access to the second-largest population center in the state. With the recent completion of the Anchorage-Fairbanks electrical intertie and with the presence of the Alaska Railroad line from Fairbanks through Anchorage to Seward, both future public and commercial uses for natural gas are potentially favorable. Other than the Fairbanks area, the route passes through only small population centers through the remainder of the route to the Valdez terminus, where additional future possibilities may exist for use of natural gas.

The Robe Lake and Gold Creek alignments are essentially the same as the proposed project for this criterion and would be moderately favorable. Gravina differs mainly in that the alignment does not pass as close to Valdez, where existing infrastructure and resident population provide greater potential for wanting a gas supply or value-added industries than does Gravina. Therefore, the Gravina route would be rated unfavorable.

1.9.7.3 LNG Plant Site

1.9.7.3.1 Adequacy of Available Land

At both Boulder Point and Cape Starichkof, there would be adequate land available to construct the LNG plant and probably provide an adequate buffer. However, the lands at the LNG plant site and for the buffer zone are under private or Native ownership and development would be uncertain. The site at Cape Starichkof is adjacent to several residences and a recreational use area. The Boulder Point site is rated as moderately favorable while the Cape Starichkof site has been given a rating of unfavorable. The Harriet Point site is isolated from any other use and has adequate acreage for the construction of the LNG plant site and an adequate buffer zone. This site is rated as favorable.

The proposed LNG site at Anderson Bay contains approximately 300 acres of developable land with a 3,000-acre uninhabited buffer zone surrounding the shore side of the site which provides an adequate zone to ensure public safety. The site itself would be located on state-owned land and the buffer zone is within both state and federal lands. The Gold Creek and the Gravina sites would be located on state-owned possibly the Chugach Natives' corporation land and have adequate land area suitable for the development of an LNG plant site and buffer zone. All three of these sites are rated as favorable. The Robe Lake site, though located on state lands with adequate acreage for the construction of the LNG plant, abuts to privately owned land proximate to existing residential development and a high recreational use area. This site is considered highly unfavorable.

1.9.7.3.2 Avoid Areas With Poor Foundation Characteristics

The three Cook Inlet sites have an abundance of glacial till, gravel outwash, and alluvial site. Each site appears to contain foundation materials which are acceptable though not as desirable as the bedrock base found at the four Prince William Sound area sites and therefore would be considered as moderately favorable in this evaluation.

The Anderson Bay site is composed of a series of bedrock ridges mantled with glacial till, presenting a good base for facility foundations. Robe Lake, Gold Creek, and Gravina sites are similar in structure, presenting similarly favorable foundation conditions.

1.9.7.3.3 Avoid Areas With Faults

None of the sites considered has active faults identified that could pose design and safety problems. Therefore, the proposed Anderson Bay site and all alternatives would be considered as favorable with regard to this criterion.

1.9.7.3.4 Avoid Sites Potentially Exposed to Seismic Sea Waves

Boulder Point and Cape Starichkof would be well above historical high water levels. Harriet Point site would be elevated high enough to withstand waves from seismic or volcanic events. On the basis of potential exposure to seismic sea waves, all Cook Inlet alternative sites were considered favorable.

The configuration and orientation of Port Valdez minimizes the potential that any major tsunami generated in Prince William Sound would have a major impact in the port. The proposed facility at the Anderson Bay site would be located above the highest anticipated seiche that might be expected to develop through submarine landslides such as occurred in Shoup Bay during the 1964 earthquake when the site was exposed to a maximum wave run-up of 78 feet (FPC 1976). The Gold Creek site, at 300 to 500 feet, would be well above any potential seismic seawave, even though the 1964 run-up was 124 feet. The Robe Lake site (at 200 to 400 feet above sea level) would be both well away from the port and above the critical height.

The Gravina site would be located well above the predicted 10- to 16-foot wave height and 30- to 40-foot wave run-up elevation (FPC 1976). All sites were evaluated to be favorable.

1.9.7.3.5 Minimize Length of Piping to Marine Terminal

All three of the alternative Cook Inlet sites have marine terminals located between

4,000 and 5,000 feet from shore. The length of the loading lines would be within 2.5 miles and each would be considered moderately favorable.

The required loading line length is a factor of the distance from the LNG plant to the shore and the shore to the marine berth. At the proposed Anderson Bay and Gold Creek sites the distance from shore to marine terminal would be approximately 500 feet as is Gold Creek, and Gravina would be on the order of 1,500 feet. At Gravina it would be about 1,500 feet. All of these sites are rated as favorable for this characteristic since LNG storage tank facilities are close to the shoreline and a minimal length of loading line would be required. The Robe Lake site would require approximaely 5 miles of loading line between the LNG plant and the marine terminal since the LNG plant site would be situated a considerable distance from the marine terminal. This site would receive an unfavorable rating; in fact, this length of cryogenic loading line would be sufficiently beyond the 2.5-mile limit set by the FPC (1976a) that the site would be eliminated from further consideration.

1.9.7.3.6 Maximize Use of Existing Community Infrastructure

Of the three Cook Inlet sites, the two on the Kenai Peninsula, Boulder Point, and Cape Starichkof, would have excellent infrastructural support, including highway access, a commercial airport, available support industry, population base, and communities oriented toward expansion. These are considered as highly favorable for this criterion. Harriet Point, on the other hand, has no infrastructural base and would be considered as unfavorable.

The proposed Anderson Bay LNG facility site has several positive attributes associated with its proximity to Valdez. These include a small population base, housing, schools, airport, and highway access. Undoubtedly, these would require some expansion, but there is an excellent infrastructure base to develop. The same is true for the Robe Lake and Gold Creek sites. All three of these would be considered favorable.

Gravina offers no existing infrastructure from which to expand. All roads, airports, housing, and services would have to be built. All support services would either be developed or imported by air or water. Gravina would be rated as highly unfavorable by this criterion.

1.9.7.3.7 Avoid Sensitive Environmental Habitat

The proposed Anderson Bay site is similar to much of the land surrounding Port Valdez and Prince William Sound in general. It does not have any particularly high concentrations of shorebirds or waterfowl and is not noted for use by marine mammals. An active bald eagle nest has been spotted to the west and outside of the buffer zone. Of two streams that cross the site, one is utilized by anadromous fish. Assuming that disturbance to the eagle nest can be minimized, the site is considered to be moderately favorable with respect to this criterion.

The Gold Creek site is similar to Anderson Bay with the exception that there is important waterfowl use of nearby Island Flats. There is an active bald eagle nest within 0.5 miles of the site and an anadromous fish stream crosses just north of the site.

The Robe Lake site is upland of an important salmon spawning area and migratory pathway but is itself not of major importance as a sensitive environment. Gold Creek and Robe Lake sites are considered moderately favorable on the basis of limited potential to impact sensitive environments.

Sensitve aspects of the Gravina include the presence of numerous bald eagle nests and utilizaion of the area by sea otters, harbor seals, and sea lions (FPC 1975). Gravina is rated as unfavorble on this basis.

Among the Cook Inlet sites considered, Boulder Point has the least potential for impact on critical habitat. All three sites have various amounts of spruce woodland and mixed wetlands used by moose, bear, and other small mammals. Separating Cape Starichkof is the site's proximity to important anadromous fish streams, beach set net sites, important salmon migratory travel route to Upper Cook Inlet, and clamming areas with attendant high recreational use. Harriet Point is distinguished by designation as critical habitat for moose, Harriet Creek is an anadromous stream, and the coastal intertidal zone is considered critical for razor clams and harbor seals. Boulder Point is considered moderately favorable, and Harriet Point and Cape Starichkof are rated as unfavorable with respect to potential impacts to sensitive environments.

1.9.7.3.8 Public Safety Considerations

Of the Cook Inlet sites, Boulder Point and Cape Starichkof areas both have a small number of nearby residences, recreational use in the area and are considered as moderately favorable and large areas of privately held land in the vicinity which could be developed in the future. At Boulder Point residences in the vicinity of the LNG plant site could be required to relocated depending on the need for a specified exclusion zone. Harriet Point is well away from any population and would be rated as favorable.

The Anderson Bay site is well away from residential, commercial areas and airports and the Alyeska marine terminal. With respect to public safety, in the event of a major accident or spill (as discussed in Subsection 4.2.19) the Anderson Bay site would be considered as favorable. The Gold Creek site is away from residential or commercial areas but in a heavy recreational use area. The Robe Lake site is surrounded by residences and is also heavily used for recreation. Gold Creek would be considered as moderately favorable and Robe Lake highly unfavorable from the point of public safety in the event of a major accident or spill. Gravina would be well away from any population and is rated favorable.

1.9.7.3.9 Maximize "Value-added" Industrial Opportunities

Of the Cook Inlet alternatives, those sites with access to the strong infrastructural base of the Kenai Peninsula, Boulder Point and Cape Starichkof, are rated as favorable. For Harriet Point, potential secondary development would have to wait additional infrastructure to support the expansion, so this site would be considered as favorable.

The proposed Anderson Bay site, as well as the other two sites on Port Valdez, offer some potential for development of secondary industries in that the requisite infrastructure and economic base are extant in Valdez. With the presence of the TAPS terminal operation and the proposed Alaska Pacific Refinery, it could be expected that future expansion would be limited only by space and the community's ability to absorb additional population. The potential for industrial value-added opportunities for these sites would be considered as moderately favorable. With virtually no infrastructural development, Gravina would be considered as highly unfavorable with respect to this criterion.

1.9.7.3.10 Minimize Site Preparation Requirements

Boulder Point, Cape Starichkof, and Harriet Point sites would require the least site work for LNG plant construction and are considered as favorable.

The proposed Anderson Bay site would require a substantial amount of earthwork before construction. Soils are of good quality overlaying bedrock, and site preparation whould not pose major difficulties. Excess material could be used to develop the construction wharf, off-loading area, construction support, and laydown area. The situation is similar for the Robe Lake and Gravina sites, and all are considered as moderately favorable. The Gold Creek site would require extensive earthwork with the added problem of spoil disposal for the vast amount of excess material created during site preparation. Gold Creek would be rated as unfavorable for this criterion.

1.9.7.4 Marine Terminal

1.9.7.4.1 Minimize Exposure to Extreme Oceanographic Conditions

Each of the three Cook Inlet sites must deal with high currents and waves, sea ice that can include solid iced-up conditions at Boulder Point, common occurrence of floating ice "pancakes" in the range of 6 to 18 inches thick, and the possibility of seismic sea waves. Tsunami risk is perhaps greatest at Harriet Point due to the presence of active volcanoes near the site. Currents and sea ice are greatest at Boulder Point. Overall oceanographic conditions that could affect operations and safety would be considered to be unfavorable at all three sites.

The proposed marine terminal site at Anderson Bay is in an area with low currents and waves of less than 1 foot about 90 percent of the time, very little sea ice, and a less than average potential impact from seismic sea waves. This situation would be similar at the other three alternative Prince William Sound sites considered in this analysis. The presence of icebergs calved from Columbia Glacier in ship channels of Prince William Sound is closely monitored by the U.S. Coast Guard and reported through the Valdez Vessel Traffic Service and is not considered an obstacle to operations. All Prince William Sound sites evaluated would be considered favorable with respect to oceanographic conditions that would be encountered in Alaska coastal waters.

1.9.7.4.2 Minimize Distance to 60-Foot Depth Isobath

At Boulder Point, Harriet Point, and Cape Starichkof, the 60-foot isobath is between 4,000 and 5,000 feet offshore. Boulder Point, Harriet Point, and Cape Starichkof are classified as moderately favorable.

The 60-foot isobath is located within 500 feet of the shoreline for the proposed Anderson Bay site as well as for alternative Gold Creek. The alternative Robe Lake site 60-foot isobath is approximtely 2,500 feet offshore but several miles from the LNG plant site. The berthing area for the Gravina alternative lies about 1,000 feet offshore. On the basis of the distance to tanker berthing depth from the shoreline, Anderson Bay, Gold Creek, and Gravina would be considered favorable, but Robe Lake would be ranked as unfavorable.

1.9.7.4.3 Maximize Suitability of Tanker Maneuvering and Anchoring Areas

Each of the three Cook Inlet sites has adequate room for maneuvering and anchoring, however, at Cape Starichkof these are areas of significant longshore drift and shoaling which could require dredging. Boulder Point and Harriet Point rate favorably, and Cape Starichkof is moderately favorable.

The area for anchoring and maneuvering vessels is excellent at the proposed Anderson Bay marine terminal location and for alternatives Gold Creek and Gravina due to the broad expense of open water with excellent anchorage depth of less than 200 feet (FPC 1976a). These three locations would be rated as favorable. The terminal facility location wth the alternative Robe Lake site would be proximate to the main aggregation of Valdez recreational and commercial vessels and located at the head of the Port Valdez, which would restrict maneuvering room and limit anchorage areas. The Robe Lake location would be considered unfavorable with respect to this criterion.

1.9.7.4.4 Minimize Potential Hazards to Navigation

All three of the Cook Inlet sites benefit from a good system of navigational aids and the requirement for vessels to be accompanied by a state licensed coastal pilot north of Kachemak Bay. All three of these sites must contend with problems associated with winter sea ice, shoaling, and submerged outcrops. The Cape Starichkof site in particular could require dredging to remove shoals. Uncharted submerged outcrops and boulders at Boulder Point pose definite hazard. With major consideration to navigation safety, Cape Starichkof and Harriet Point sites are considered as moderately favorable, and the Boulder Point site is rated as unfavorable.

The Automated Vessel Traffic Service already in place for the Valdez Arm, Valdez Narrows, and Port Valdez and the limited potential navigational hazards (except for icebergs from Columbia Glacier and those related to shoaling and rock outcrops) make the proposed Anderson Bay site and alternative Gold Creek site favorable from a navigability standpoint. The alternative Robe Lake marine terminal site located near the main aggregation of Valdez recreation and commercial vessels and in the general vicinity of a sunken wreck would be rated as unfavorable. Gravina does not have the benefit of the Automated Vessel Traffic Service but otherwise has favorable navigation conditions and would be rated favorable.

1.9.7.4.5 Minimize Potential Problems Related to Soils and Geohazards

Cook Inlet marine terminal sites would all be subject to erosion and accretion problems associated with the high current regime and documented movement of large-scale mobile bedforms. Proximity to active volcanoes would expose facility operations to added risk of seismic sea wave. General engineering soil characteristics related to shear strength and liquefaction potential are considered to be favorable, and the Cook Inlet terminal sites are rated overall as favorable.

At the proposed Anderson Bay site there is minimal probability of a major submarine slide in the area of the marine terminal. The situation is similar in most respects to the Alyeska marine terminal site. A slide elsewhere in the harbor, such as occurred in Shoup Bay during the 1964 earthquake, would be expected to generate a sea wave that could affect any terminal site in Port Valdez. Such conditions would be incorporated into facility engineering design. At the Robe Lake terminal site there is some degree of sediment instability as evidenced by recurring submarine slides. Also, there is considerable potential for soil liquefaction and ground failure during a seismic event. Little information exists regarding submarine soils at Gold Creek; however, the submarine slopes along the front of the alluvial fan at the mouth of the creek are probably similar to those that underwent failure in Shoup Bay during the 1964 earthquake. The Gravina site has favorable subsurface conditions with minimal probability of submarine slides (FPC 1976). On this basis, the Anderson Bay and Gravina sites are considered to be favorable, but the Robe Lake terminal site is considered as unfavorable because marine-specific information on potential hazards for the Gold Creek site was not available. However, based on the fact that the sites similarity to Shoup Bay, the Gold Creek site should probably be classed as unfavorable until site-specific information could be developed to suggest otherwise.

1.9.7.4.6 Minimize Threat to National Security

None of the sites considered poses any major advantage or disadvantage to national security from an economic point of view. The proposed TAGS LNG terminal and the Alyeska marine terminal are located within

3.5 miles of one another. Operations to secure and protect the two facilities in time of national crisis would be facilitated by their proximity. Due to the balance between these two factors, the proposed Anderson Bay site and all alternatives considered would be rated as favorable with respect to this criterion.

1.9.7.5 Evaluation of Proposed TAGS Project and Alternatives Considered

1.9.7.5.1 Introduction

The summary of evaluation criteria analyses (Table 1.9.7-1) provides a matrix for comparing the proposed action and the alternatives considered. The overall results of the criteria evaluation for the proposed project at Anderson Bay are summarized below, followed by a synopsis of the evaluation of each of the alternatives.

1.9.7.5.2 Proposed Project - Anderson Bay

Evaluation criteria considered for the proposed TAGS project was rated either favorable or moderately favorable for each criterion.

Among criteria for the Livengood to proposed Anderson Bay route, only the number of water crossings and the potential access of the pipeline to possible future uses along the right-of-way were rated higher than for other alternatives.

LNG siting criteria for the Anderson Bay site were: LNG plant and marine terminal siting criteria for Anderson Bay were all favorable or moderately favorable.

1.9.7.5.3 Boulder Point

Evaluation of the pipeline route from Livengood to the Boulder Point site identifies numerous criteria for which this alternative is less desirable to the applicant's proposed project, including a 15-mile subsea crossing of Cook Inlet. Most significant are those factors ranked as unfavorable. These include use of proven construction technology, geohazards, and land-use incompatability. Permitting is rated as highly unfavorable, largely on the basis of the passage through Denali National Park and Preserve. As discussed under evaluation of individual criteria (Subsection 1.9.7.2.9), this alignment for this routing would require congressional approval.

For all criteria related to siting of the LNG plant, the Boulder Point site rated at favorable or moderately favorable. The Boulder Point ratings exceeded those for the proposed Anderson Bay site only for infrastructure, value-added development, and site preparation. For all other criteria, Anderson Bay was rated equal to or better. Public Safety and marine terminal acceptability are superior at Anderson Bay. The existing Kenai Peninsula infrastructure would be better able to support construction and operation of the facility with existing community resources. The Kenai Peninsula would probably be better situated to support expanded ancillary projects should they be possible. Third, site preparation at the Boulder Point site would require less construction terrain disturbance. For land availability, soil foundation characteristics (presence of bedrock), and the distance from the LNG plant to the marine terminal, the advantage lies with the proposed project.

Though characteristics of the marine terminal also all favor selection of the Anderson Bay site, the Boulder Point site is generally favorable. Rated as less favorable were two criteria for a Boulder Point marine terminal--the distance from shore to water deep enough for maneuvering and berthing is more than 4,000 feet and navigational hazards, including shoaling, submerged boulders, outcrops, ice conditions, and excessive currents. Despite these constraints the Boulder Point site appears to be a feasible alternative.

1.9.7.5.4 Cape Starichkof

Cape Starichkof, which shares a common alignment with the Boulder Point site as far as Boulder Point, has one distinct disadvantage--the extra pipeline length and additional compressor station required to transport the gas an additional 59 miles would have many implication for construction time and associated increase in impacts to the environment and costs. The LNG site characteristics are similar to those for Boulder Point except that land availability would be more of an issue and the environment in the Cape Starichkof vicinity is more sensitive with respect to fisheries, shellfish, and recreational use of the area. Marine terminal site characteristics are also similar to those for Boulder Point with the exception that navigational hazards, uncharted submerged boulders and outcrops, and potential sea-ice problems would be less of a factor at Cape Starichkof. The same permitting problems associated with Denali National Park and Preserve exist. Cape Starickof was rated as less favorable than Boulder Point and is eliminated from further consideration.

1.9.7.5.5 Harriet Point

The pipeline alignment to Harriet Point poses problems over the Boulder Point and Cape Strichkof alignments. Like Starichkof, Harriet Point would require a longer pipeline and an additional compressor station. Most of the route along the western shore of Cook Inlet is away from available infrastructure to support construction. Little data exist for environmental impact assessment and engineering design analyses. The route also passes through areas of sensitive environments for wildlife and fisheries. The LNG plant site has advantages of land availability and little potential impact to public safety from an accident or spill should one occur. One distinct disadvantage for the LNG plant site is the lack of any infrastructure. Facility construction and operation would be much more difficult and costly since there is no community or commercial base in the immediate vicinity to support the project. The potential for any secondary development would be curtailed. Along with the permitting issue associated with the crossing of Denali National Park and Preserve, Harriet Point would be rated as less favorable than Boulder Point and is eliminated from further consideration.

1.9.7.5.6 Gravina

For the pipeline from Livengood to the site, Gravina was rated as unfavorable for use of proven technology, geohazards, land-use compatability, and permitting. All of theses factors were related to the segment of the route from Keystone Canyon through the Chugach Mountains, including 15 miles of routing through the Chugach National Forest. Though operation of a marine terinal at the site had no serious drawbacks for the LNG facility, Gravina was considered to be highly unfavorable with respect to infrastructure for construction and operation of the facility and with regard to potential benefits that might be derived from secondary developments in the vicinity of the plant. The Gravina site has numerous distinct disadvantages compared to the proposed Anderson Bay site and should be eliminated from consideration.

1.9.7.5.7 Gold Creek

The Gold Creek site rated as favorable or moderately favorable for nearly all evaluation criteria considered. For the pipeline alignment the final segment passing in proximity to Robe Lake and around the outskirts of the city was not as favorable as that of the proposed project. The last 3 miles of pipeline alignment to the site along the west shore of Port Valdez would be located in an area of steep side hills which would result in difficult construction, movement of large volumes of material, and a broad visual scar along the mountainside. The LNG plant site would require extensive excavation and would pose the added problem of disposing of an extensive volume of spoil from the site. Use of the Gold Creek site would negatively affect potential expansion of the city and the recreational utilization of the Gold Creek areas and would require major site work and spoil disposal. Although the rating of the Gold Creek site was similar to the proposed Anderson Bay site, it did not appear to have any substantive advantages over the proposed TAGS project and would be eliminated from further consideration.

1.9.7.5.8 Robe Lake

Though the Robe Lake alternative would result in the shortest pipeline, consideration of the LNG site and the associated marine terminal facility immediately highlight the major concerns with this alternative. Land that would be utilized for the LNG plant is in the midst of residential and recreational use areas. Major site work would be required for the facility. Resultant impacts on aesthetics, interference with recreational use, and even removal of the parcel of land from that available for residence or recreation would be major drawbacks to the implementation of this site for the TAGS project. Though the safety record for LNG plants is excellent, should a catastrophic accident or spill occur, this site would be the worst among the TAGS alternatives in terms of potential impact to public safety. Further, the distance from the LNG plant site to the shoreline and the distance from shore to water deep enough for tanker maneuvering and berthing combine to require a 5-mile cryogenic loading pipeline from the plant to the LNG tanker loading area. The engineering and cost of such a line would make it nearly infeasible. The location of the berthing and maneuvering area within the harbor has disadvantages with respect to navigational safety, the nearby airport and the submarine soils in this region of the harbor are not favorable to development. Overall, the Robe Lake site should be eliminated from consideration.

1.9.7.6 Summary

Overall, of the three alternatives considered for the Prince William Sound region, Gold Creek is the only one that appears comparable to the proposed Anderson Bay site. However, due to the extensive earthwork required for the LNG plant site and the associated spoil disposal requirements, the difficult pipeline constructability for the last 3 miles to the site, and the greater negative impacts on city of Valdez recreational use and potential future expansion, this alternative offered no distinct advantage to the proposed project at Anderson Bay.

Neither of the Cook Inlet alternatives to Cape Starichkof nor Harriet Point offers engineering, environmental, cost, or safety advantages over location of a facility at Boulder Point. The cost, time, and additional impacted area associated with the Cape Starichkof and Harriet Point sites make them less desirable options and therefore eliminated from further consideration.

1.10 INTENDED USE AND AUTHORIZING ACTION

In accordance with NEPA guidelines the authorization to construct and operate the proposed TAGS project requires the completion of an EIS which adequately addresses the significant issues raised during the scoping process, alternative means of achieving the proposed project's objectives, and an adequate assessment of the potential effects of the proposed project. The Draft EIS (DEIS) would be circulated to the public as well as review agencies for a minimum 60 day formal review period. Comments to the DEIS would normally be submitted in writing, but public meetings would be held during the review period to solicit comments on the DEIS. All comments, both oral and written, would be evaluated and individually addressed in the FEIS. The FEIS again would be circulated to the public, review agencies, and all those who commented on the DEIS.

Once a permit decision has been determined, a formal public Record of Decision (ROD) is prepared by each federal permitting agency. The ROD identifies the permit decision made, the alternatives considered, and any mitigation, monitoring, and other means to avoid or minimize environmental impacts. A minimum of 60 days must elapse before any the BLM decision can be implemented due to the requirement for a 60-day congressional review period for major pipeline rights-of-way.

If issued, the BLM's right-of-way grant would contain general and technical stipulations. Should the right-of-way grant be signed, YPC would submit a detailed construction and use plan to the designated federal authorized officer for review by the agency. The construction and use plan would be developed for federal lands in accordance with applicable federal regulations contained in 43 CFR 2882.2-4(c), designed for the management of oil and natural gas pipelines and related facilities. At minimum the plans would include:

- Schedules for construction of the pipeline and all related facilities and estimated construction costs;

- Plans for protection of the environment during construction, operation, maintenance, and abandonment of the pipeline;

- Plans for emergency repair of any rupture during operation, containment of effluent, and restoration of damage.

Likewise, the USACE would use the FEIS to help in its decision to approve or disapprove the proposed TAGS project. USACE would first deal with the design concept and project alignment alternatives only, which preclude any construction work until such time as the second-phase review and approval takes place. This would consist of approval of specific civil engineering design for the proposed TAGS project.

The State of Alaska would act on the right-of-way grant under state regulations. A FEIS is not a prerequisite to right-of-way grants in the state.

BLM and the USACE in consultation with other state and federal agencies would also conduct an environmental and engineering review of the construction and use plan. Following this review and determination by the authorized officer that preconstruction mitigation measures have been completed, a Notice-to-Proceed (NTP) would be issued. Only then could construction begin. The federal authorized officer would inspect and monitor construction to ensure compliance with the NTP and all stipulations.

Subsequent to the requirements covered by the EIS process but prior to construction of the proposed TAGS project, YPC and TAGS would have to comply with various approval requirements. To the extent known, authorizing permit actions and responsible agencies are listed in Table 1.10-1.

1.11 PROCESSING OF DEPARTMENT OF ARMY AUTHORIZATIONS FOR TAGS PROJECT

The USACE would process the TAGS permit application in two phases. The first phase would consist of approval/disapproval of the project as described in the permit application and EIS. This approval/disapproval will deal with design concept and project alignment alternatives. Should a permit be issued it would contain stipulations which preclude any construction work until such time as the second phase approvals take place.

The second phase would consist of approval/disapproval of civil engineering design for the TAGS project. The level of detail would have to be sufficient for the USACE, in consultation with federal and state resource agencies, to identify

Table 1.10-1 Authorizing Agency

Agency	Nature of Action	Project Features
FEDERAL		
Department of Agriculture		
Forest Service	Issue special-use permit for construction	Buffer zone for LNG Terminal (These lands have been identified as suitable for selection and ownership transfer to the state of Alaska)
Department of Interior		
Bureau of Land Management	Issue federal right-of-way grant	Pipeline, access roads, material sites, compressor stations, and communication sites
	Issue temporary-use permits	Temporary construction activities; staging areas, material sites, fly-in camps and construction camps
	Special use permits	Materials sites, access roads, solid waste disposal sites, and permanent camps
	Issue cultural and paleontological resource-use permits for survey and excavation	BLM-managed federal land
	Issue competitive mineral materials sales contract	Aggregate for project construction and operation and maintenance
	Consistency with existing land use plans on federal lands managed by BLM-corridor-MRP all Federal actions	Pipeline
Fish and Wildlife Service	Issue Biological Opinion on threatened or endangered species of fish, wildlife, or plants as part of Section 7, Endangered Species Act, for all federal actions	All project features
	Implement provisions of Fish and Wildlife Coordination Act	Impacts to marine, aquatic and terrestrial resources
Department of Defense		
Army Corps of Engineers	Issue permit(s) (Section 404) for placement of dredged or fill materal in waters of the United States or adjacent wetlands	Pipelines, material sites, fly-in camps, permanent camps, access roads, lay-down areas, compressor stations, terminal, and solid waste disposal sites
	Issue permit(s) (Section 10) for structures or work in or affecting navigable waters of the United States	Water diversion facilities and construction resulting in alterations to water courses; pipeline crossings, Anderson Bay berthing facilities
Federal Communications Commission	Issue license to operate industrial radio service	Communications
Department of Transportation		
Coast Guard	Approves Operations Manual	Marine terminal and berthing facilities in Port Valdez
	Issue permit (Section 9) for bridge crossings of navigable waters	Temporary and permanent bridges over navigable waterways
Highway Administration	Issue permit(s) to cross Federal-aid highways	Pipeline and access roads
Office of Pipeline Safety	LNG siting permit, pipeline safety standards	LNG plant site at Anderson Bay, crossings of TAPS and authorized ANGTS
Environmental Protection Agency	Issue NPDES permit(s) to discharge wastewater	Any discharge of hydrostatic test water, discharge from tank storage facilities, LNG wastewater discharge, compressor station wastewater discharge, campsite wastewater discharge
	Review oil spill contingency plans and spill prevention, containment and countermeasure plans	Pipeline, terminal, and berthing facilities
Department of Commerce		
National Marine Fisheries Service	Issue Biological Opinion on threatened or endangered marine mammals as part of Section 7, Endangered Species Act, for all federal actions; implement provisions of Fish and Wildlife Coordination Act	Marine terminal at Anderson Bay
Advisory Council on Historic Preservation	Consultation on cultural sites	All project activities

Table 1.10-1 (cont.)

Agency	Nature of Action	Project Features
STATE		
STATE OF ALASKA		
Governor's Office of Management and Budget, Division of Governmental Coordination	Coastal Zone Management Consistency Determination	Pipeline and related facilities and the Anderson Bay LNG plant site
Department of Natural Resources	Grant right-of-way	Pipeline right-of-way, LNG plant site, and marine terminal at Anderson Bay
	Water rights	Pipeline right-of-way, LNG plant site, and marine terminal at Anderson Bay
	Tidelands lease and material site permits	Along pipeline on state lands and in river floodplains, at Anderson Bay
	Special use permits	Material, campsites and solid waste disposal sites
	Issue competitive mineral material sales contract	Aggregate for project construction and operation
	Consistency with state land use plans - Tanana Valley, Copper River	Pipeline
Department of Fish and Game	Title 16 fish stream crossing	Pipeline river and stream crossings
Department of Environmental Conservation	PSD air quality permits	LNG plant and marine terminal; compressor stations
Department of Environmental Conservation (continued)	Solid waste disposal permit	Solid waste disposal sites
	Wastewater disposal permit	Hydrostatic test water, test fluids, domestic waste
	Spill contingency plan	
	Certificate of Reasonable Assurance (water quality)	Placement of fill in waters and wetlands of the United States
	Hazardous waste disposal	Radiographic waste, oily water
State Historic Preservation Office	Cultural resource clearance on state lands	All project lands
	Consultation on cultural sites on federal lands	All project lands
LOCAL GOVERNMENTS		
North Slope Borough	Land-use permits	General project
Fairbanks North Star Borough	Land-use permits	General project
City of Valdez	Land-use permits	General project
	Issue Development Permit (for portions of project within coastal zone, but outside port), Federal Consistency Certification, Port Master Plan Amendment, Development Permit, and port development permit appeals	Activities within the coastal zone for development permit and/or Port Master Plan Amendment

site-specific impacts which may require mitigation that was not identified in phase one. This will likely be similar to that used for evaluating site-specific impacts for the Northwest Alaskan Pipeline project (1"=1,000' alignment sheets for the pipeline and roads).

By using this two-phase approach, USACE and the resource agencies can focus their review and evaluation first on design and major alignment alternatives. Next they can address the localized impacts at site-specific locations along the approved route. This method would allow focusing of environmental evaluations on the project as a whole before shifting the focus to much smaller site-specific environmental concerns. Site-specific mitigation requirements are generally not of sufficient magnitude to significantly alter the design or routing of a major project such as TAGS. In addition, General Permits would be developed (similar to the approach taken on ANGTS) to authorize material sites, disposal sites, and other similar project components to be identified at a future time.

1.12 LEVEL OF INFORMATION REQUIRED TO PROCESS THE ENVIRONMENTAL IMPACT STATEMENT AND, IF WARRANTED, ISSUE A GRANT OF RIGHT-OF-WAY UNDER THE DEPARTMENT OF THE INTERIOR REGULATIONS (43 CFR 2800)

The level of information required to assess reasonable options and the probable environmental consequences thereof varies according to the specific decision ripe for action.

CEQ Regulations (40 CFR 1502.20 and 1508.28) provide a mechanism to encourage federal agencies to tier their evaluations under NEPA " . . . to eliminate repetitive discussions of the same issues and to focus on the actual issues ripe for decision . . ." The NEPA evaluations and the federal decisions associated with the proposed TAGS would be tiered. The first phase, focus on environmental, social, and economic effects of construction and operating and maintaining a large-diameter, chilled, buried gas pipeline system from Prudhoe Bay to a LNG plant and marine terminal at Anderson Bay.

The second tier would focus upon whether an export license would be granted. During the export evaluation phase, issues associated with the national decision on international relations between Canada and the United States and Japan and the United States as well as the best long-term use of the natural gas resources of the Alaska North Slope would be determined. Should export as proposed in the TAGS project be determined to be in the best national interest, a final tier of NEPA compliance and federal decisions would involve site-specific evaluation and approval of the proposed and final designs for construction and operation of TAGS. If issued, the Grant of Right-of-Way would contain specific requirements for tiering action at export and for review, approval, and monitoring decisions by the federal government.

The proposed TAGS involves several distinct phases with increasing levels of detailed information. The key evaluations and decisions associated with TAGS are: preparation of the EIS, federal authorizations based upon the concepts evaluated in the EIS, state authorizations, presidential approval for export of Alaska North Slope natural gas, and then federal and state authorizations to proceed based on site-specific detailed engineering information developed by YPC.

The tiered decision process to be used in the TAGS project is not new. During the several years that the legal issues were being resolved for the Trans-Alaska Pipeline System, Alyeska Pipeline Service Company continued developing detailed engineering design information. Hence, by the time the legal issues were resolved the level of information available at the grant stage had progressed substantially.

The Alaska Natural Gas Transportation System (ANGTS) went through a series of steps similar to that proposed for the TAGS project. The EIS was completed as a supplement to the El Paso proposal to construct a buried, chilled gas pipeline from Prudhoe Bay to a tidewater LNG plant and marine terminal in Prince William Sound. The project that became ANGTS had no engineering data, environmental inventories, or related information at the EIS stage as the time between the filing of the application and the completion of the EIS was approximately six months.

A period of several years passed between completion of the EIS and the Grant of Right-of-Way while Congress decided which of the three gas pipeline proposals would be authorized. During this interval, Northwest Alaskan Pipeline Company continued to develop detailed environmental and engineering data so that it would be ready to expeditiously build ANGTS and to meet the requirements of the Federal Energy Regulatory Commission as a rate based pipeline.

The grant was issued without the answers to several critical problems associated with the new technology required to design ANGTS. Accordingly, the grant included in Stipulation 1.6.1, a requirement that certain information be developed and submitted to the federal government for review and approval. These special requirements of the grant include the so-called 1.6.1 stipulation and the following:

A. Pipeline Design Criteria Manual (approved 4/16/85)
B. Telecommunications Design Criteria Manual (approved 3/24/83)
C. Operations Control Center Supervisory Control System Design Criteria Manual (approved 1/10/83)
D. Compressor and Metering Stations Design Criteria Manual (approved 11/12/82)
E. Environmental Plans Approved and Deferred Until Remobilization (approved 4/16/85)
    1. Air quality
    2. Blasting
    3. Cultural resource preservation
    4. Environmental briefings
    5. Liquid waste management
    6. Camps
    7. Materials exploration and extraction
    8. Oil and hazardous substances control, cleanup, and disposal
    9. Pesticides, herbicides, and chemicals
    10. River training structures
    11. Solid waste management
    12. Visual resources
    13. Seismic
    14. Human/carnivore interaction
F. Plans Deferred until Remobilization (detailed outlines conditional approval)
    1. Corrosion control
    2. Erosion and sedimentation
    3. Restoration
G. Plans Deferred until Remobilization (other)
    1. Clearing
    2. Fire control
    3. Quality Assurance/Quality Control
    4. Pipeline contingency
    5. Overburden and excess material disposal
    6. Stream, river, and floodplain crossing
    7. Surveillance and maintenance
    8. Wetland construction

It should be noted that the permitting process for ANGTS has been suspended at the request of the Alaskan Northwest Pipeline Company. This includes final decisions by the Federal Energy Regulatory Commission. (see Office of the Federal Inspector Quarterly Report to the President and the Congress, 5/8/85 for specific details.)

In summary, the overall process being used for tiered federal decision-making and for NEPA compliance for the TAGS project is very comparable to those used for both TAPS and ANGTS.

SECTION 2
DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

SECTION 2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 INTRODUCTION

This section describes the proposed Trans-Alaska Gas System (TAGS) project for the transportation of natural gas from Alaska's North Slope via a 36-inch outside diameter (OD) pipeline to a tidewater facility at Anderson Bay, Port Valdez, Alaska. At Valdez, the natural gas would be converted to liquefied natural gas (LNG) for ocean transport to markets in the Asian Pacific Rim.

The following subsection details the components of the proposed TAGS project and the construction, operation, maintenance, and abandonment phases of the proposed project.

2.2 TAGS PROJECT

Yukon Pacific Corporation (YPC) proposes to construct the TAGS. The system would consist of the following major components: a 796.5-mile, 36-inch OD, buried pipeline system with a design capacity of 2.3 billion cubic feet of natural gas per day (BCF/D), compressor stations, an LNG plant, and a marine loading terminal. The lands that would be directly affected by the construction and operation of the project are primarily under the control of the federal and state governments. A federal right-of-way grant from the Bureau of Land Management (BLM) to traverse federal lands and a state right-of-way grant by the Alaska Department of Natural Resources must be approved.

Additional details on the TAGS proposal are available in the right-of-way application that has been filed with the BLM and in the permit applications to the U.S. Army Corps of Engineers (USACE). These documents are available for public review at the BLM's Alaska State Office in Anchorage; BLM's Support Center, Fairbanks; BLM headquarters; the U.S. Department of Interior's Library in Washington, D.C.; and at the USACE, Regulatory Branch, Elmendorf AFB, Anchorage.

2.2.1 Project Components

The proposed TAGS project components are discussed with reference to the system block flow diagram provided in Figure 2.2.1-1.

Natural gas would be provided to the TAGS pipeline at Prudhoe Bay via existing authorized or a newly authorized gas conditioning facility. The ownership of the gas conditioning facility would be determined by the North Slope producers and YPC. A site where such a facility could be located and air quality does not appear to be of concern is presented in Subsection 4.6. An average of 2.3 BCF/D of conditioned natural gas would be proposed for transportation through the pipeline system from Prudhoe Bay to the LNG plant and marine terminal facilities at Anderson Bay near Valdez. Approximately 0.2 BCF/D of natural gas would be utilized by the compressor stations along the pipeline and at the LNG plant facilities during the conversion of the natural gas to LNG. Thus, approximately 2.1 BCF/D of LNG would be available to load onto tankers for export to Pacific Rim markets.

In addition to these major components, other temporary and permanent project components are essential for such a major project to be constructed in Alaska. Specifically, construction workpads adjacent to the pipeline ditch, access roads, 26 construction camps at compressor stations and for pipeline construction, material storage yards, and the upgrade of five existing airfields would be required. Table 2.2.1-1 estimates the area of disturbance for construction and operation of the proposed project.

2.2.1.1 Pipeline

The proposed TAGS pipeline would extend from Prudhoe Bay to Anderson Bay near Valdez, Alaska, for a distance of 796.5 miles. A single 36-inch OD, welded steel pipeline would be constructed to transport an average of 2.3 BCF/D of conditioned

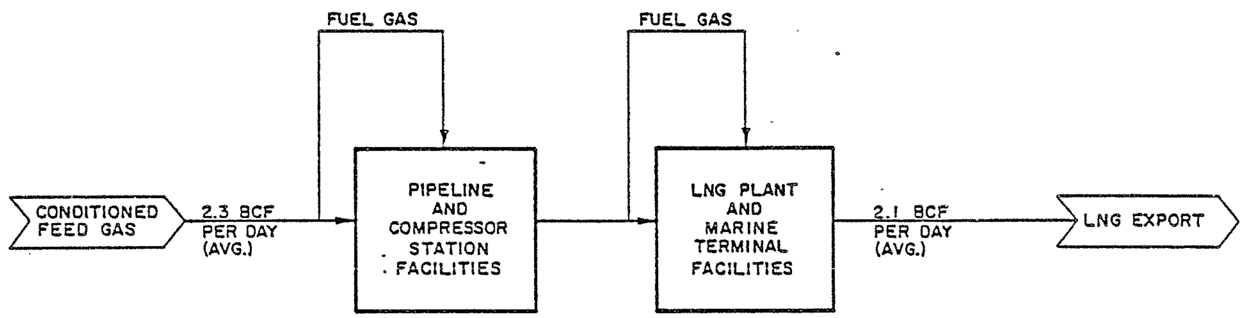


Figure 2.2.1-1 Trans-Alaska Gas System Block Flow Diagram

Table 2.2.1-1
Estimate of Disturbed Area for TAGS

	Construction	Operation
	Acres	
Pipeline	14,473	5,114
Ten Compressor Stations	278	200
Access Roads	430	430
Temporary Camps Storage Yards	730	255
Air Strips	144	0
River Crossing Extra Work Space	55	20
Spoil	700	80
Construction Material Sites and Access Roads	5,800	1,740
LNG Facility	300	280
Total Area Disturbed	22,910	8,119

natural gas at maximum operating pressures of 2220 pounds per square inch (psig). The pipeline would be installed in a buried mode with chilled operation where soil conditions are favorable for long-term operation. At certain river and fault crossings where below-ground construction would not be feasible, the pipeline would be above ground, and special design would be required. Based on preliminary evaluation without site-specific geotechnical data, refrigeration would be assumed to be required at compressor station Nos. 1 through 8. There would be a total of 10 en-route compressor stations.
Figure 2.2.1-2 provides an overview of the pipeline route and compressor station locations. (Alignment Maps 1 and 2 at end of document presents the route and major facilities.)

The proposed TAGS pipeline route alignment would begin at Prudhoe Bay, immediately downstream from the gas conditioning facilities and proceed south, generally within the utility corridor of the Trans-Alaska Pipeline System (TAPS) and the authorized Alaska Natural Gas Transportation System (ANGTS).

The proposed TAGS pipeline facilities would be designed and constructed in compliance with the Federal Pipeline Safety Regulations, 49 CFR 192, which are the prescribed minimum federal safety standards for the transportation of natural gas by pipeline. Pursuant to these standards, the proposed TAGS pipeline would be fabricated, using high-strength, steel pipe designed with sufficient wall thickness and toughness to withstand operating pressures and any

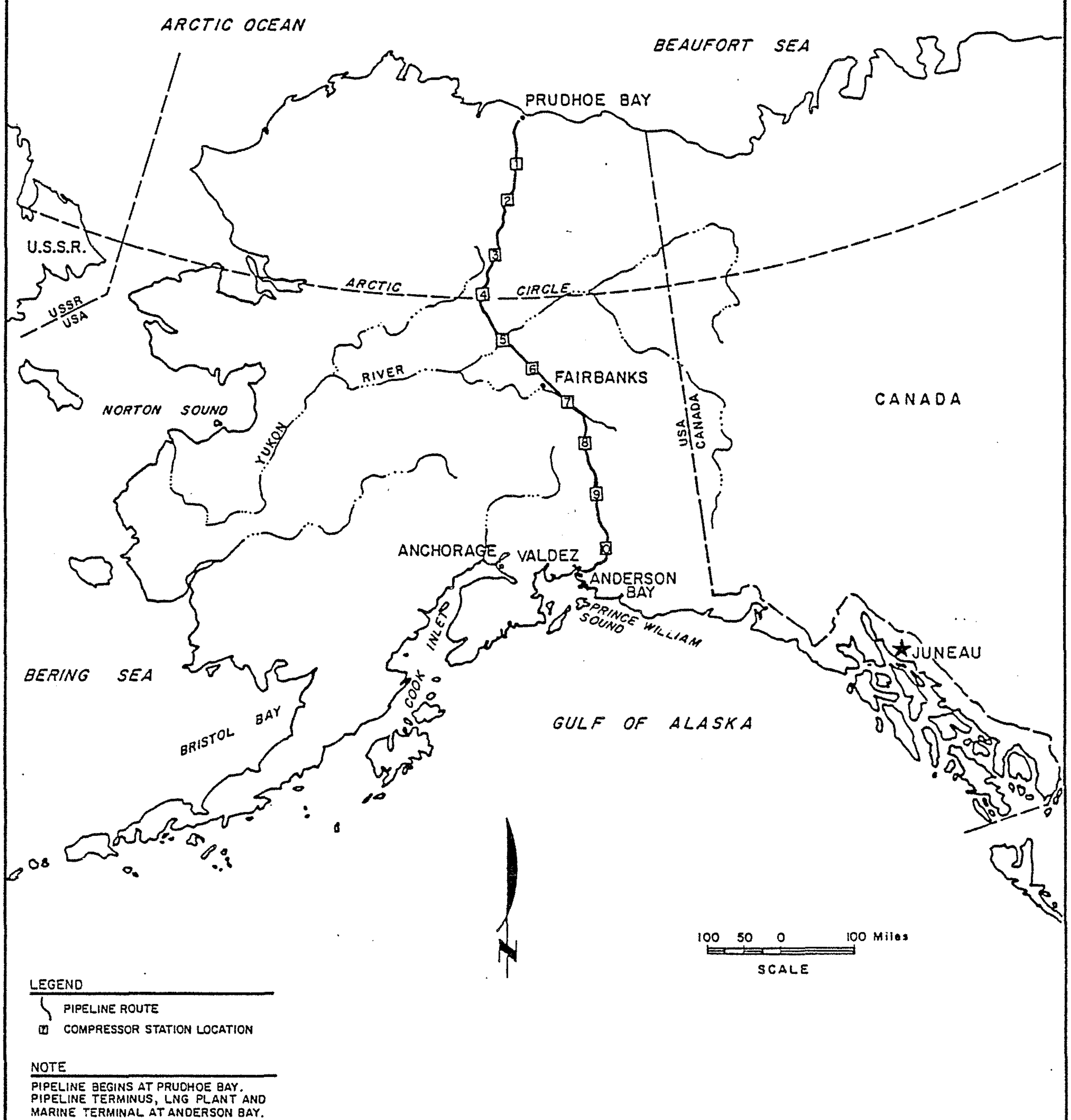


Figure 2.2.1-2 Trans-Alaska Gas System Facilities Location Overview Map

external loads that would be imposed after installation. The pipe metallurgical specifications would accommodate the range of temperature conditions that may be encountered over the life of the project. Based upon the proposed conceptual design, high-strength arctic-grade X-70 or X-80 grade pipe with yield strengths equal to or greater than 70,000 psi and 80,000 psi, respectively, and with pipe wall thickness of 0.793 to 1.430 inch or 0.694 to 1.250 inch, respectively, are under consideration. The wall thicknesses for the different pipe grades specified depend on class location and anticipated loads as identified in 49 CFR 192.5.

Using the best available arctic technology, site-specific design factors would be applied during the project design phases. For most of the proposed TAGS route, design factors for Class 1 location would apply. Corresponding pipe wall thickness would then be 0.793 inch or greater for X-70 grade pipe or 0.694 inch or greater for X-80 grade pipe. Heavier wall thickness pipe would be utilized where required for additional safety at road crossings, aerial river crossings, fabrication assemblies (block valves), or where geotechnical conditions (differential settlement, frost heave, seismic ground motion, fault displacement) or other conditions would warrant design for secondary loads.

The joining of line pipe for the proposed TAGS pipeline would be accomplished by welding methods that have been accepted for arctic use by the American Petroleum Institute and the American Society of Mechanical Engineers, as referenced by 49 CFR 192.225. Nondestructive X-ray testing of welds would be performed in accordance with 49 CFR 192.243.

Hydrostatic testing would be performed following the construction of each spread during the final summer. The pipeline would be subdivided into test sections with test manifolds located at each end of the test sections.

To meet the requirements for corrosion control prescribed in the Federal Pipeline Safety Regulations, the proposed TAGS pipeline would have cathodic protection facilities. Test stations for measuring pipeline electrical potential would be installed at 1-mile intervals along the pipeline route. Test stations would also be installed at all road, foreign pipeline, and river crossings. A test station would consist simply of a post with lead wires and terminal connections encased in a control box and conduit. The test wires would be attached to the pipeline.

In addition, the cited safety regulations also require the use of pipeline valves spaced along the route according to land use as identified in 49 CFR 192. Approximately 50 36-inch mainline block valves of the American National Standards Institute 900 ball-types, equipped with gas/hydraulic operators, would be installed. Valve operations would be designed for remote operation and site-specific arctic operating conditions. In addition to those required to comply with the regulations, block valves would be installed upstream and downstream of critical facilities such as meter stations, compressor stations, several river crossings, and fault crossings to provide isolation capability.

2.2.1.2 Compressor Stations

Ten mainline compressor stations would be located along the TAGS route to provide the pressure boosts required for the transportation of conditioned natural gas. (The proposed milepost locations and horsepower sizes are identified in Table 2.2.1-2 and located on the Alignment Maps 1 and 2 at end of document.) Between 14 and 40 acres would be required for the construction of each compressor station. Compressor station locations were selected to satisfy both engineering and environmental concerns. Extensive hydraulic studies were conducted to determine the optimal location of each station. A limited area of consideration was than selected for optimal system operating characteristics in regard to gas flow, elevations, temperature, pressure, and throughput. Consideration was also given to the rugged Alaska topography, highly variable geotechnical conditions, active hydrological conditions, and environmental sensitivities.

Table 2.2.1-2
Compressor Station Mileposts and Horsepower Requirements

Station No.	Milepost	Horsepower
1	66.5	18,400
2	125.6	20,500
3	213.7	18,700
4	280.9	16,900
5	357.0	20,500
6	421.0	18,400
7	486.4	14,700
8	562.3	20,300
9	639.2	21,100
10	720.5	16,800
		186,300

A plot plan for a typical compressor station is shown in Figure 2.2.1-3. In addition to the compression equipment (which consists of a single approximately 20,000-horsepower, turbine-driven, centrifugal compressor at each site), refrigeration equipment for cooling the gas, estimated at between 5,000- and 10,000-horsepower, turbine-driven compressors would be provided where chilled gas operations were required. Two benefits would be derived from the gas chilling operation: the ground would remain frozen and capacity of the pipeline would increase. Both the gas compressors and refrigerant equipment would be driven by turbines using pipeline gas for fuel.

A five-compressor station optional systems design would be considered during detailed design. Such a design would require more total system horsepower to compensate for the effects of pressure drop over relatively long distances between stations. If it should be determined during final design that a five-station configuration would be feasible, then alternating (even-numbered) sites only would be used for station placement, with an average spacing of approximately 130 miles. Station compression equipment for this design would consist of twin tandem (in series) turbine-driven centrifugal compressor units of an estimated 50,000 horsepower at each site. Refrigeration requirements would vary, depending upon site-specific conditions. Where refrigeration is required,a15,000- to 20,000-horsepower, turbine-driven compressor would be installed.

Refrigeration would be accomplished by compressing, condensing, and circulating an external refrigerant gas to chill mainline gas flowing through heat exchangers. Refrigerant gas, such as freon or propane, would be supplied to compressor stations in vendor storage canisters.

Compressor stations would be provided with emergency shutdown systems to allow for shutdown, isolation, and venting of all station piping and equipment. Station block valves would be provided to isolate the station and piping from mainline gas while allowing flowing gas to bypass the station.

TAGS compressor stations would include all facilities necessary for stand-alone operation, including on-site utility systems for air supply, water supply, fuel storage, effluent treatment or holding tank as appropriate, electric power, emergency power, and glycol heating; maintenance facilities; communication facilities; living quarters for operations personnel; and a heliport.

2.2.1.3 Liquefied Natural Gas Plant

The LNG plant for the proposed TAGS project would be located at Anderson Bay,

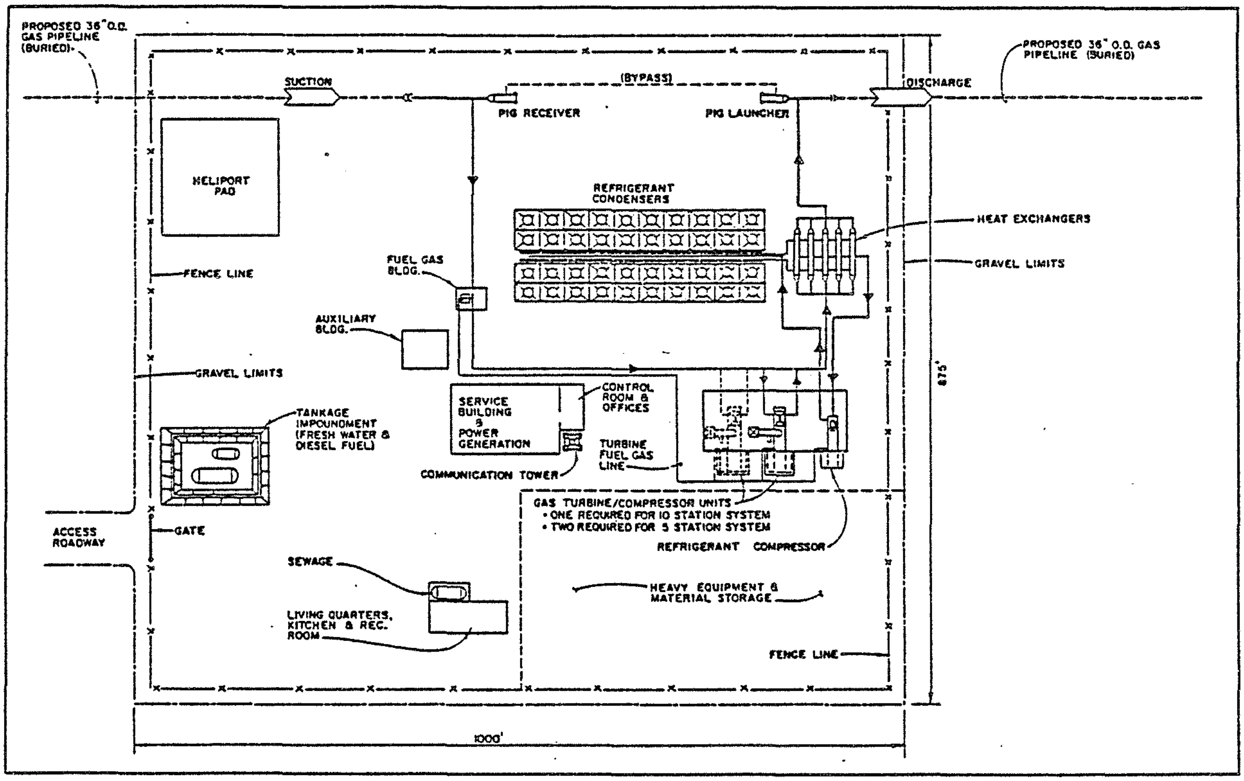


Figure 2.2.1-3 Plot Plan for Typical Compressor Stations

along the southern shoreline of Port Valdez at the terminus of the natural gas pipeline, as shown in Figure 2.2.1-4. At the proposed LNG plant, conditioned natural gas from the pipeline would be treated, liquefied, and stored in cryogenic tanks for loading on tankers at the proposed marine terminal, for export. The proposed plant site would afford approximately 300 acres of developable land directly adjacent to the proposed marine terminal site as shown in Figure 2.2.1-5. Topographic and geologic conditions at the site would allow the placement of critical facilities on bedrock foundations, well above the highest historical water level. In addition, the site would provide for safe operations due to its distance of over 5 miles to the city of Valdez and existing infrastructure.

A plot plan for the proposed LNG plant and marine terminal at Anderson Bay is shown in Figure 2.2.1-6. The major facilities at the proposed LNG plant site include metering facilities, four LNG process trains, four 800,000 barrel cryogenic storage tanks, and the LNG loading lines.

The conditioned pipeline natural gas would enter the LNG plant for initial treatment to remove moisture and impurities by passing through a series of driers and scrubbers. Once treated, the gas would proceed through the LNG process.

The proposed LNG plant would consist of several liquefaction trains operating in parallel. Each liquefaction train would produce LNG for transfer to special above-ground cryogenic storage tanks.

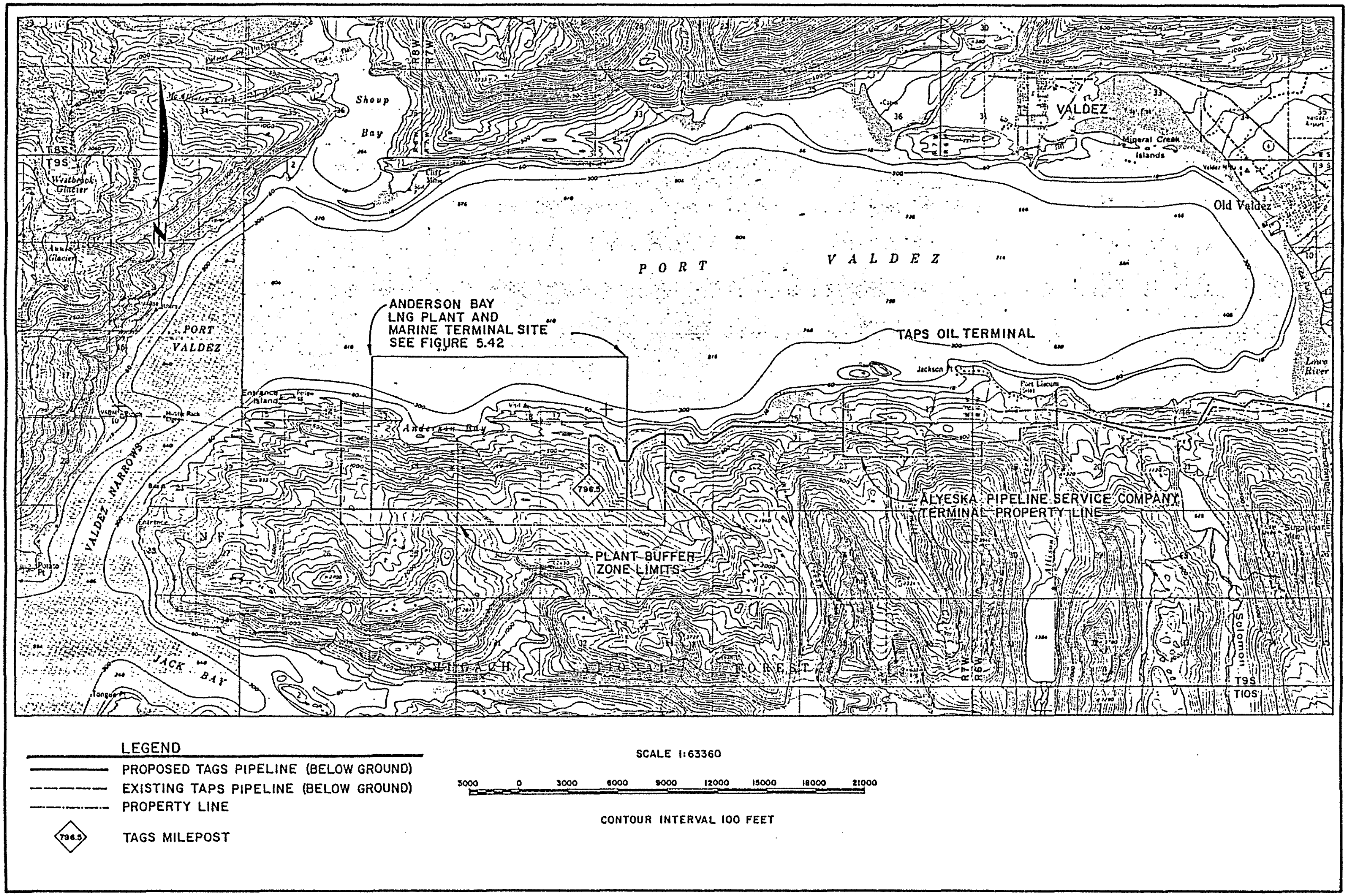


Figure 2.2.1-4 LNG Plant and Terminal Site at Anderson Bay in Port Valdez

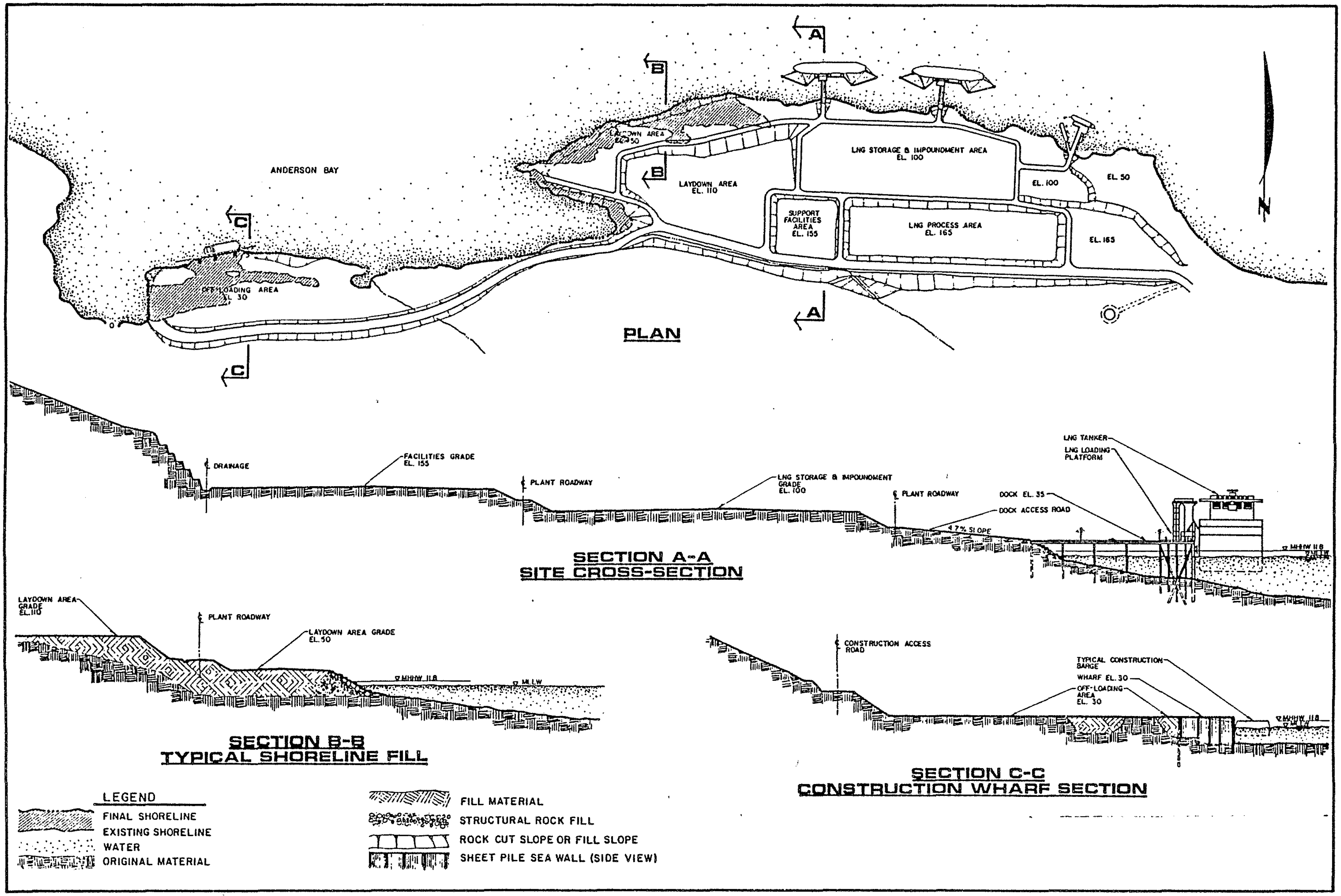


Figure 2.2.1-5. Conceptual Design for Site Development

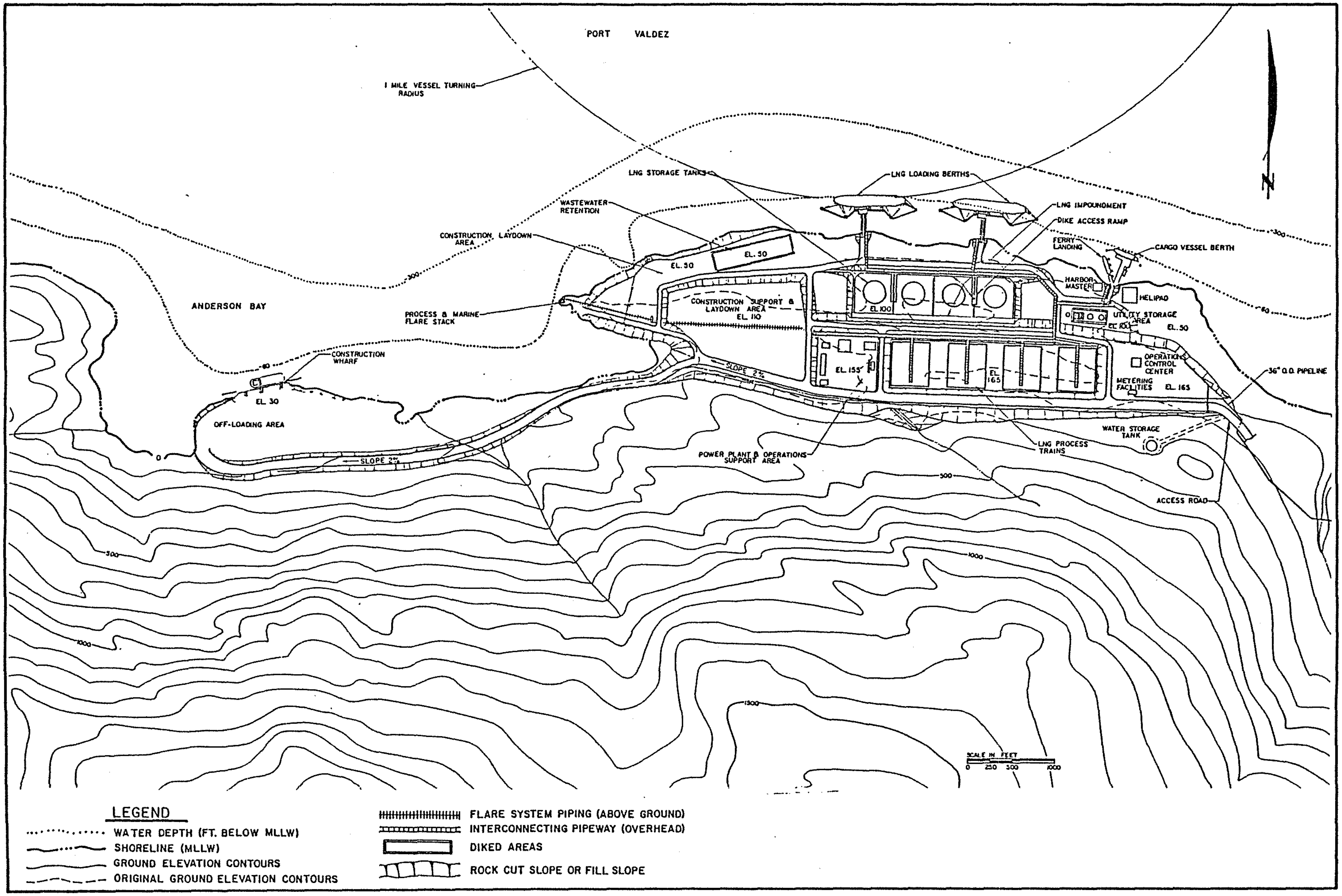


Figure 2.2.1-6. Plot Plan for LNG Plant and Marine Terminal

The proposed total tank volume of 3,200,000 barrels would provide approximately five days of LNG storage at design production rates.

Insulated, double wall, suspended roof, above-ground tanks would be used. A typical LNG storage tank is shown in Figure 2.2.1-7. To store the LNG at -259°F, metallurgy for tank construction would include a nickel alloy steel or aluminum alloy inner tank with a carbon steel outer shell. The complete tank foundation including the ring-wall base would be electrically heated to prevent frost bulb growth. The storage tank area would be surrounded by an impoundment system to contain any accidentally spilled LNG. Basically, the impoundment system would consist of reinforced concrete walls, reinforced earth walls, and excavation of bedrock (or a similar containment structure). Conceptual design has involved the consideration of a combined reinforced earth, reinforced concrete, and rock excavation system.

The LNG loading system would be designed to transfer LNG product from onshore storage tanks to LNG tanker vessels berthed at the marine terminal facility. Transfer piping would be sized for the system to load two tankers simultaneously in a 12-hour period.

Plant utility systems would include storage and distribution systems for fuel gas and diesel fuel, a generation and distribution system for electric power, storage systems for refrigerants, an air and nitrogen supply system, and a plant effluent treating system.

2.2.1.4 Marine Facilities

The proposed marine facilities would consist of two LNG tanker berths, a cargo vessel berth, a ferry landing for site

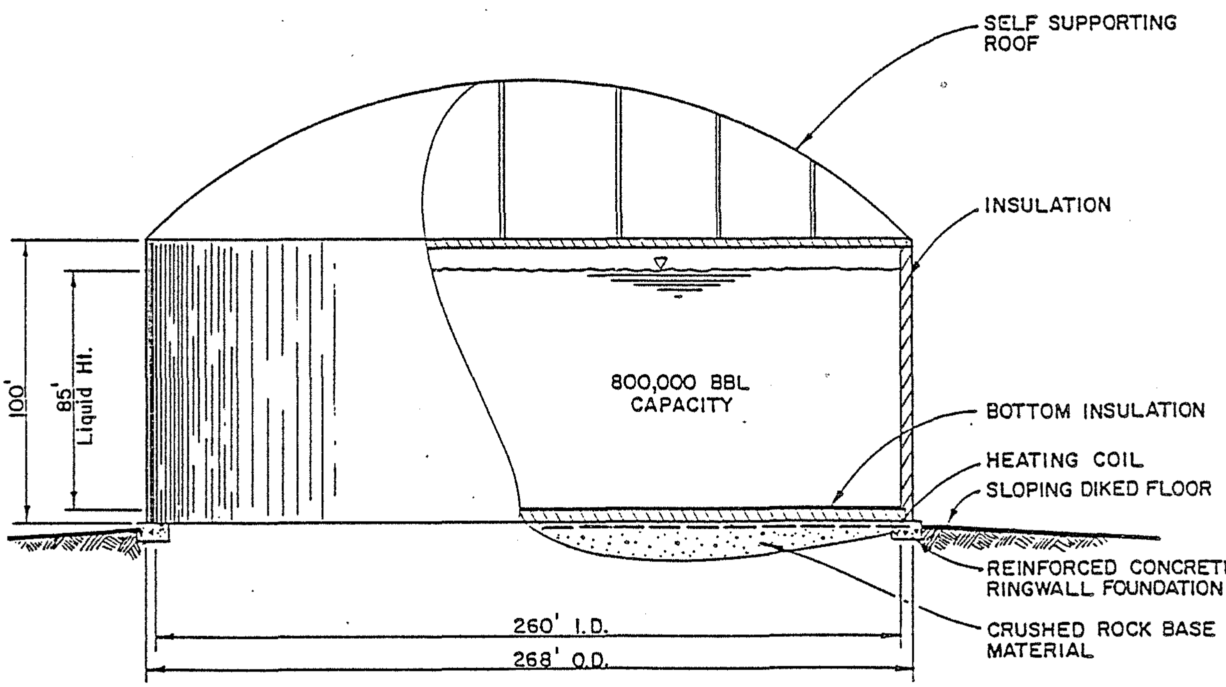


Figure 2.2.1-7. Typical LNG Storage Tank

access, a tug and work boat pier, and the temporary construction off-loading dock. Figure 2.2.1-8 presents conceptual details for each of these facilities.

Two LNG tanker berths would be provided for the mooring and loading of LNG tankers in the size range of 125,000 to 165,000 cubic meter. The tanker berths would consist of loading platforms and berthing and mooring dolphins. The LNG loading platform would be connected to the shore by a causeway, built on piles, carrying roadway and piping.

The tanker berths would be oriented approximately parallel to the shoreline in 50 feet of water (depth below MLLW) and have the capability of mooring a tanker in the aft or forward position. Figures 2.2.1-9 and 2.2.1-10 present designs of typical LNG tankers. Characteristic dimensions are given for two 125,000-cubic meter and two 165,000-cubic meter tanker designs.

During the conceptual design of loading facilities, a design loading rate of 70,000 barrels per hour per tanker was assumed. LNG transfer through the loading system would be by the use of cryogenic pumps and gravity. The loading system would be maintained in a cold condition at all times.

Loading lines supported by trestle structures would connect LNG storage tanks to the loading platform at the end of berth facilities. Special metallurgy pipe would be used for the loading lines, to accommodate the very low LNG temperatures. Loading lines would be insulated between storage tanks and loading platforms to minimize LNG boil-off.

The loading operation at each berth would involve the use of articulated loading arms between the fixed platform facility and the floating vessel. Based upon preliminary design, four loading arms would be sized at 16-inch diameters to accommodate assumed loading rates. In addition, a single vapor-return arm would serve to connect tanker boil-off with onshore vapor recovery facilities. Vapor return lines, also supported by trestle structures, would take LNG vapors back to the plant fuel gas system, or to the feed gas stream for reliquefaction. In addition to a main LNG loading line automatic shut-off valve, each loading arm would have an automatic shut-off valve to prevent LNG spillage during emergency conditions.

2.2.2 Construction Phasing and Manpower Requirements

Construction planning for the TAGS project focused on practices developed during past arctic pipeline projects, including certain innovative practices that have demonstrated that pipeline construction activities can be carried out in a manner compatible with the unique arctic and subarctic environments. Winter construction would occur during periods of short daylight, whereas summer construction would occur during periods of long daylight hours. The construction phase of the proposed TAGS project would require five years. Operation is scheduled to begin the last quarter of 1995, as depicted in the project schedule in Figure 1.6-1. The overall project construction schedule is presented in Figure 2.2.2-1. Construction of the LNG plant and marine terminal facilities would determine the overall project construction schedule. LNG plant and marine terminal construction would require five years; pipeline and compressor station construction would occur during years three, four, and five.

Manpower requirements for the proposed TAGS project would vary throughout the various project phases. During the period of design definition and permit acquisition, YPC would employ or contract with about 375 people. During the design and construction phases, YPC's staff size would average up to approximately 950 people, leveling off to about 550 people throughout operations. During the preconstruction and construction phase, the YPC work force would be based in Anchorage. Following construction, the YPC work force would be located at the Anchorage

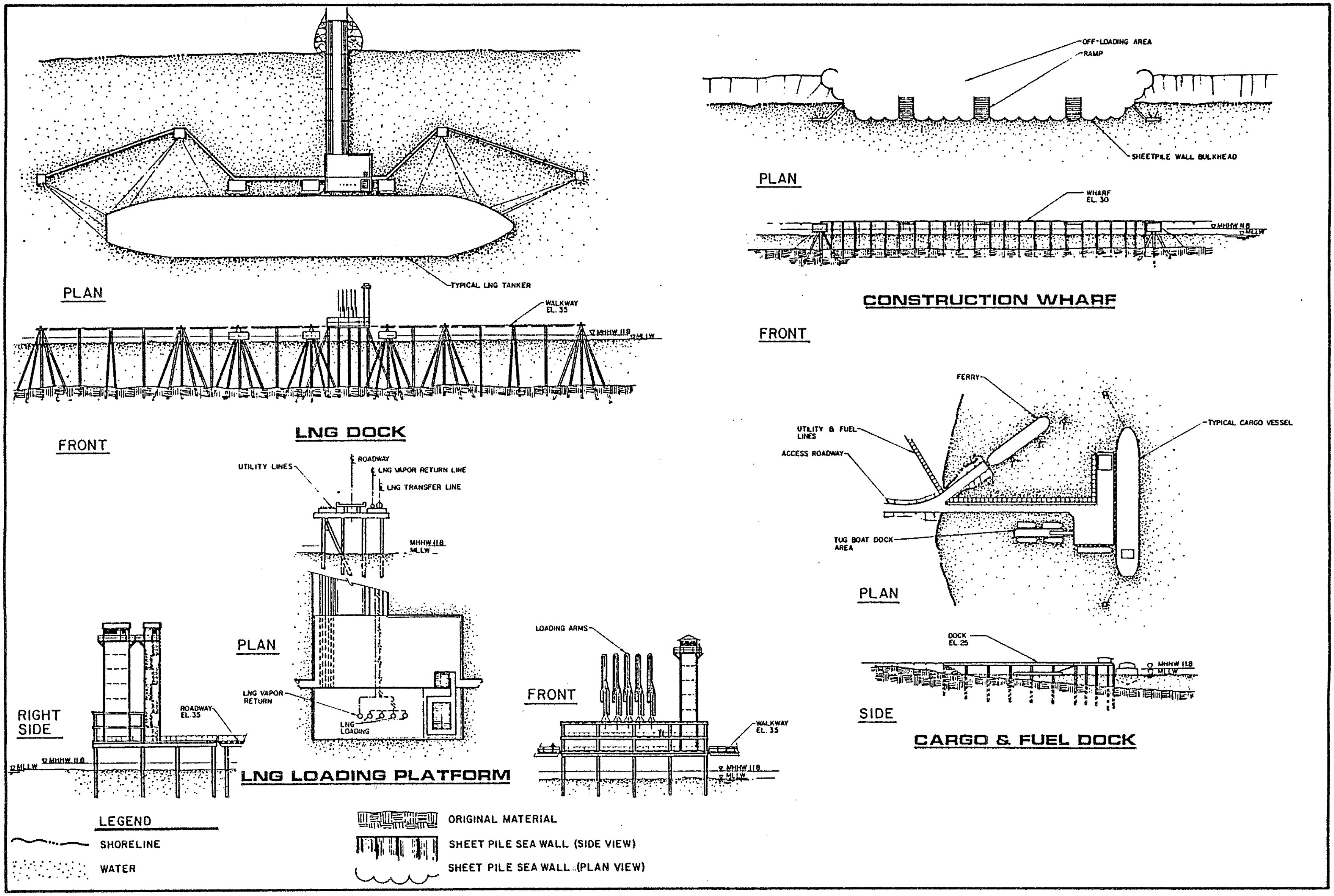
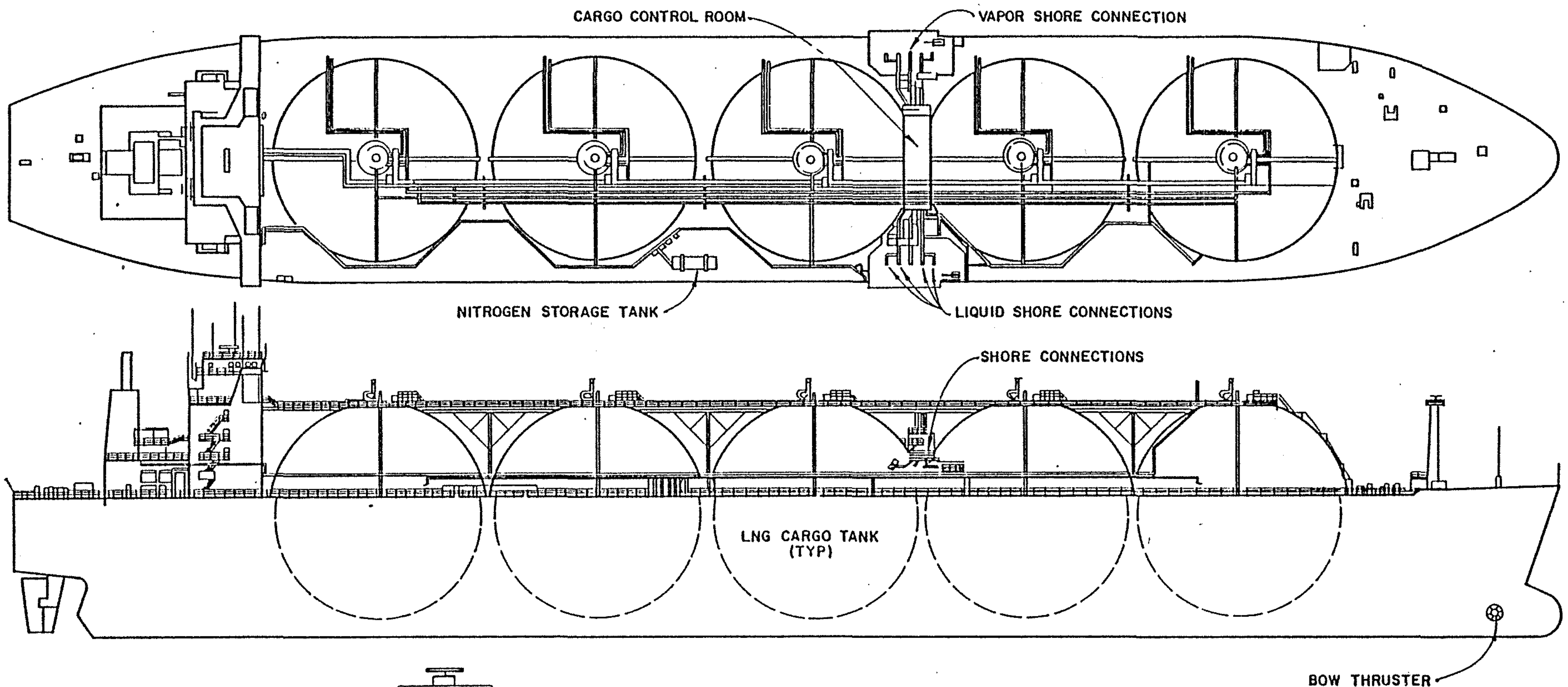
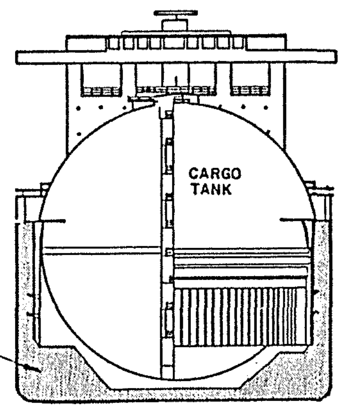


Figure 2.2.1-8. Typical for Terminal Marine Facilities



NOTE

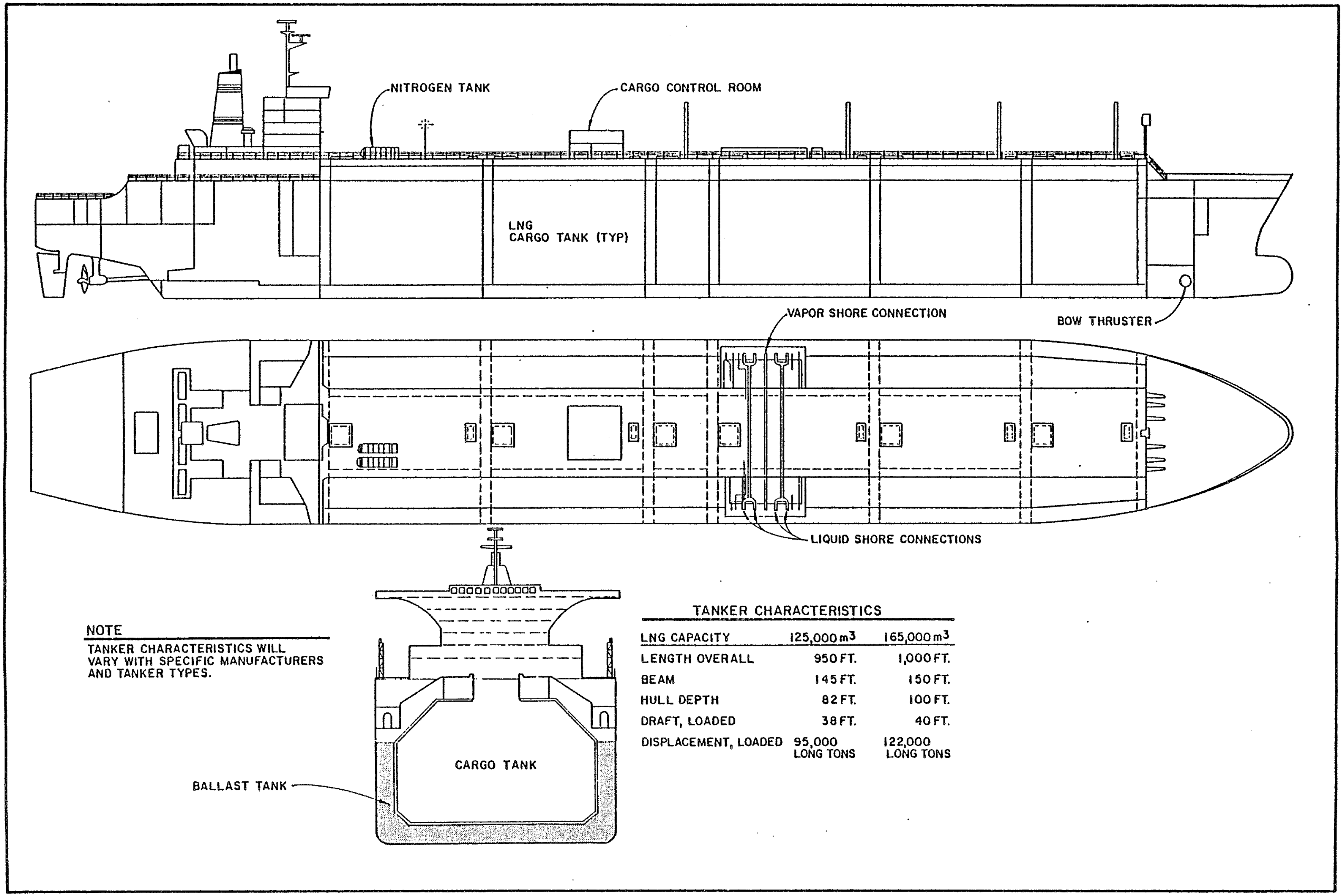
TANKER CHARACTERISTICS WILL VARY WITH SPECIFIC MANUFACTURERS AND TANKER TYPES.



TANKER CHARACTERISTICS

LNG CAPACITY	125,000 m^3	165,000 m^3
LENGTH OVERALL	950 FT.	1,000 FT.
BEAM	145 FT.	150 FT.
HULL DEPTH	82 FT.	100 FT.
DRAFT, LOADED	38 FT.	40 FT.
DISPLACEMENT, LOADED	95,000 LONG TONS	122,000 LONG TONS

Figure 2.2.1-9. Typical Spherical Design for an LNG Tanker



TANKER CHARACTERISTICS		
LNG CAPACITY	125,000 m^3	165,000 m^3
LENGTH OVERALL	950 FT.	1,000 FT.
BEAM	145 FT.	150 FT.
HULL DEPTH	82 FT.	100 FT.
DRAFT, LOADED	38 FT.	40 FT.
DISPLACEMENT, LOADED	95,000 LONG TONS	122,000 LONG TONS

Figure 2.2.1-10. Typical Membrane Design for an LNG Tanker

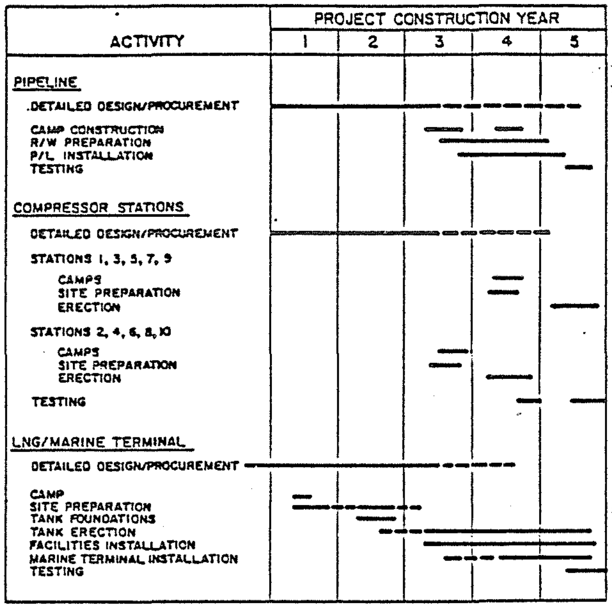


Figure 2.2.2.-1
TAGS Overall Construction Schedule

headquarters, the Fairbanks Maintenance Facility, or operations facilities.

During construction, the work force of contractors, laborers, suppliers, and support services would average 6,355 during the last three years of construction, with a peak of 10,300 during the next to the last year. These figures include all direct construction contractors plus YPC personnel.

2.3 PIPELINE CONSTRUCTION

The construction of the pipeline facilities would involve the best available arctic technology, much of which was successfully developed by Alyeska for the TAPS and further refined by other recent arctic and subarctic construction projects. Pipeline construction activities would be completed in a conventional sequence--material acquisition and stockpiling; camp construction; right-of-way preparation; ditching; pipe stringing, bending, and welding; lowering-in and tie-in; backfilling; cleanup and restoration. Construction activities would be carried out in winter and summer. Consideration would be given to such factors as subsurface conditions, length of line, need for access, type of access required, and winter snow/ice conditions. Stream crossing areas would also be evaluated for winter construction because more favorable flow conditions generally occur in the winter. Site-specific design factors would be determined during the detailed design phase.

Pipeline construction would be accomplished using the six construction segments identified in Table 2.3-1.

Table 2.3-1
TAGS Construction Spreads

Spread	Start (Milepost)	End (Milepost)	Length (Miles)
1	0	160.0	160.0
2	160	275.0	115.0
3	275	430.0	155.0
4	430	563.0	133.0
5	563	696.0	133.0
6	696	796.5	100.5

Dividing the construction project into six segments would limit segment lengths to sizes that can be handled satisfactorily by existing pipeline contractors or groups of contractors. Each spread would require approximately three years to complete. These contractors would be responsible for all construction activities within that segment except when special construction areas are designated such areas as at the aerial crossings of the Yukon, Tanana, Tazlina, and Gulkana rivers. In addition to these aerial crossings, seven other special construction areas have been identified along the pipeline route.

Each of these special construction areas was identified by YPC because it represents an area with special engineering constraints, environmental sensitivities, or land-use conflicts associated with the siting of two pipelines. Each will be discussed in Section 2.3.4.

2.3.1 Preconstruction

The preconstruction phase would include the following activities: pipeline, compressor station, communication sites, access roads would be located by survey; construction camps would be made ready for use; airfields would be upgraded; and material sources would be located.

These actions would take place from six camps north of the Yukon River and from existing facilities in communities elsewhere. Material yards would be made ready to hold construction supplies, equipment, and pipe.

Right-of-way acquisition and surveying would entail major field operations prior to construction. The location of the pipeline would be described by a surveyed centerline description of the route through Alaska.

A total of 26 construction camps would be required for the construction of the proposed TAGS project, as shown in Table 2.3.1-1. All of the dedicated pipeline construction camps except Prudhoe Bay and Sourdough Creek would utilize former TAPS construction campsites. There would be a construction camp at each of the 10 compressor stations, as well as the LNG plant/terminal camp. Total bed space for construction camps would be 11,600.

Access roads would be built to provide necessary access from existing public or private roads to construction areas such as pipeline right-of-way, material/disposal sites, compressor stations, and material storage sites. Selection of access road locations would be based largely on the location of existing public and TAPS access roads, terrain roughness, and haulage distances. Approximately 100 miles of existing access roads, permanent or abandoned, would be repaired for reuse, and approximately 34 miles of new access roads would be constructed to a specification of

Table 2.3.1-1

TAGS Temporary Construction Camps

Construction Spread	Mile-Post	Location	Bed Spaces Pipeline P/L	Bed Spaces Compressor Station
1	0	Prudhoe Bay	200	---
	43*	Franklin Bluffs	400	---
	66	Compressor Station #1	100	300
	84	Happy Valley	500	---
	125	Compressor Station #2	100	300
	140*	Galbraith Lake	500	---
			1,800	600
2	170	Chandalar	500	---
	201	Dietrich	600	---
	213	Compressor Station #3	100	300
	236*	Coldfoot	900	---
			2,100	300
3	281	Compressor Station #4	100	300
	299	Oldman	700	---
	345*	Five Mile	700	---
	358	Compressor Station #5	100	300
	394*	Livengood	700	---
	422	Compressor Station #6	100	300
			2,400	900
4	451	Fairbanks	1,000	---
	487	Compressor Station #7	100	300
	526	Delta	800	---
	563	Compressor Station #8	100	300
			2,000	600
5	600	Isabel Pass	600	---
	639	Compressor Station #9 Sourdough Creek	---	---
	682	Glennallen	700	---
			1,900	300
6	721	Compressor Station #10 Tonsina	700	300
	770	Sheep Creek	500	---
	797	LNG/Marine Terminal	200	1,500
			1,400	1,800
TOTALS			11,600	4,500

* Preconstruction camps plus one at Prospect Airport, Milepost 275.

30-feet wide at the crown with thickness determined by soil and thermal conditions. Appendix B includes a list of all major access roads required for the project by milepost and length. As an option to structural fill access roads, TAGS would consider the use of snow/ice access roads in areas where all construction activities are scheduled for winter snow/ice roads would be on a site-specific basis where conditions are determined to be advantageous.

Construction of the pipeline and ancillary facilities work pad would require natural soil or rock borrow material. This would be needed for right-of-way preparation, access roads, temporary and permanent facility foundations, and specialized ditch backfill. Borrow pit and quarry development would probably be accomplished in the first year of pipeline development. Preliminary estimates indicate that as much as 33 million cubic yards of borrow material could be required for completion of the proposed TAGS project. Reconnaissance investigations would be conducted during the detailed design phase to identify natural deposits suitable for use as borrow sources for the project. Initially, an inventory of existing sites within the corridor would be assessed. Then, a search for new, suitable borrow sources would be initiated.

Through the use of exploratory borings and geophysical evaluation, potential sites, new or existing, that best meet project needs would be examined in greater detail to establish site quality and quantity. Detailed development and mining plans would be prepared for required borrow sites. Plans would be in conformance with state and federal requirements and would contain sufficient data to permit development, mining, site protection, and borrow site reclamation.

Seven temporary storage areas for mainline pipe, equipment, and pipeline construction materials would be located along the pipeline route, as shown in Table 2.3.1-2. Initially, the double-jointed pipe sections would be delivered to main pipeline material storage yards to be located in Prudhoe, Fairbanks, and Valdez for mobilization. Distribution to the intermediate construction segment stockpile along the route would be made from these main storage yards. Pipeline construction campsites would also include sufficient area for the staging and storage of pipeline construction material.

Aircraft support services for the transportation of personnel and material during pipeline and compressor station construction would require the use of the seven existing airstrips along the corridor at Deadhorse, Prospect, Five Mile, Fairbanks, Delta, Gulkana, and Valdez as well as the upgrading of five abandoned TAPS airfields. The airfields identified for upgrade are located at Franklin Bluff, Happy Bluffs Valley, Galbraith Lake, Dietrich, and Coldfoot. The upgrade runway length would be 5,000 feet.

Table 2.3.1-2
Temporary Material Storage Area

Milepost	Storage Location	Approximate Area (Acres)
0	Prudhoe Bay	30
161	Atigun	20*
275	Prospect	20
370	Old Hess Creek	20*
674	Gulkana	30
700	Willow Lake	20
N/A	Valdez Pipe Storage Yard	30*

* Former TAPS site

2.3.2 Construction

Pipeline construction activities would be confined to a right-of-way width that would vary along the proposed route, depending primarily on topographic conditions. The typical pipeline construction zone which utilizes a gravel or rock workpad is shown in Figure 2.3.2-1. Construction zone width would vary with cross slopes and ditch types; generally, it would be confined to an approximate 100-foot right-of-way width except at temporary staging areas at river crossings and other special points requiring the temporary use of extra widths. Where feasible, the proposed TAGS project would consider the use of ice, snow, or ice and snow workpad as depicted in Figure 2.3.2-2. Preliminary estimates indicate that as much as 33 million cubic yards of borrow material could be required for completion of the proposed TAGS project. A breakdown of the total estimated borrow material by construction spread for all project construction is presented in Table 2.3.2-1.

Table 2.3.2-1
TAGS Estimated Borrow Material Requirements by Construction Spread

	Construction Section (banked cubic yards x 1000)						
	1	2	3	4	5	6	TOTAL
Workpads	4,200	4,100	3,900	3,600	3,200	2,500	21,500
Access Roads	600	900	60	600	600	300	3,600
Camp Sites/Airfields	400	200	300	100	700	200	1,900
Ditch Backfill	500	500	600	500	700	500	3,300
Compressor Stations	600	300	700	400	200	100	2,300
Other	---	400*	---	---	---	---**	400
TOTALS	6,300	6,400	6,100	5,200	5,400	3,600	33,000

* Roadway fill in Atigun Pass special construction area.
** Adequate borrow material exists on site for LNG plant site, not included in table.

Figure 2.3.2-3 represents a typical cross-country pipeline spread. Clearing would include the removal of above-ground obstacles such as trees, brush, and boulders. Grading would include the leveling of ground surface, as needed, to change the natural contours to required construction zone geometry. This would involve construction of a workpad embankment where required. Grading requirements would include the handling of temporary spoil, drainage, and erosion control. The proposed TAGS grading design would involve consideration of soils, ground slopes, construction equipment, and procedures and other parameters to ensure that localized stability conditions would not adversely affect the integrity of the pipeline or adjacent facilities and ensure that adequate working width would be provided for construction.

The TAGS criteria for grading design are to ensure:

- Stable cut and fill slopes under normal static conditions;
- Work pad stability under normal conditions;
- Stability under seismic loading, including liquefaction, where instability would affect pipeline integrity;
- Control of hydraulic and thermal erosion that could affect pipeline integrity.

Application of these criteria would ensure that no conditions are imposed on the pipe by the construction zone that would affect pipeline integrity or performance.

Temporary construction workpads would be required adjacent to the pipeline ditch to provide a working surface for construction equipment during pipeline construction only. Long-term access for monitoring and maintenance would be achieved with low ground pressure vehicles and light wheel load vehicles; maintenance activities would be scheduled for the winter season in areas sensitive to surface disturbance. The TAGS design philosophy for temporary construction workpads follows:

- Use of gravel or crushed rock workpad for temporary access to pipeline right-of-way.
- Grading and leveling of native ground surface in areas where soil conditions permit, providing adequate surface for pipeline construction.
- Use of public roadway as construction surface only in areas where pipeline is buried in road shoulder.

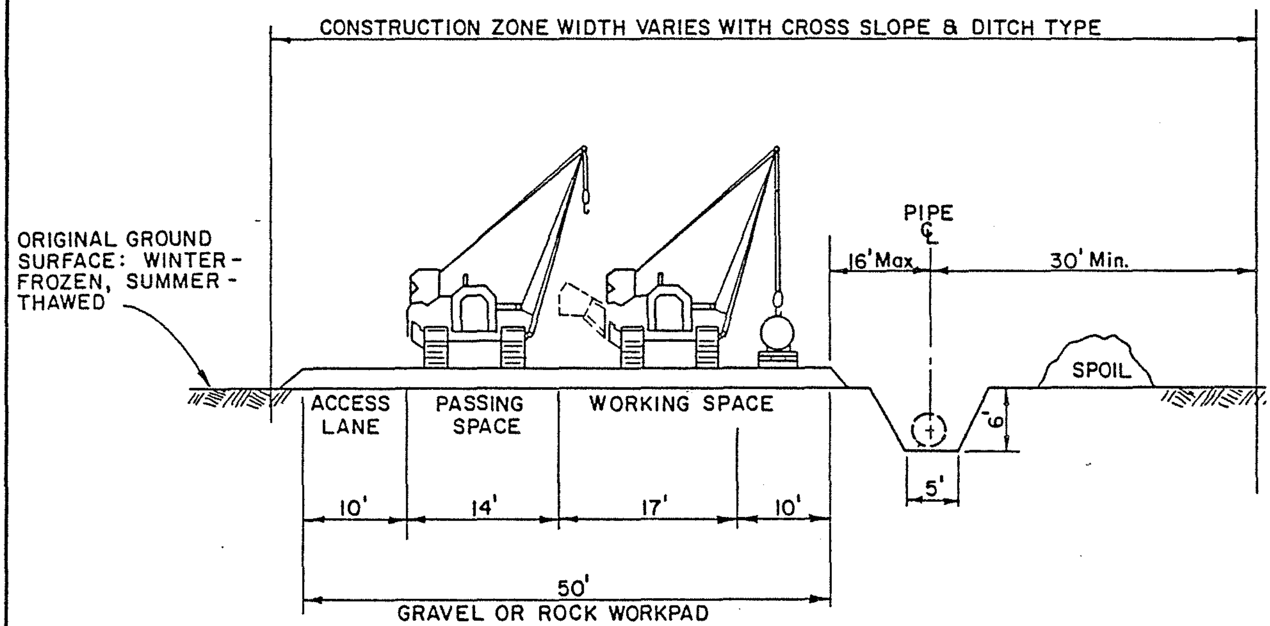


Figure 2.3.2-1. Typical Construction Cross-Section with Gravel or Rock Workpad

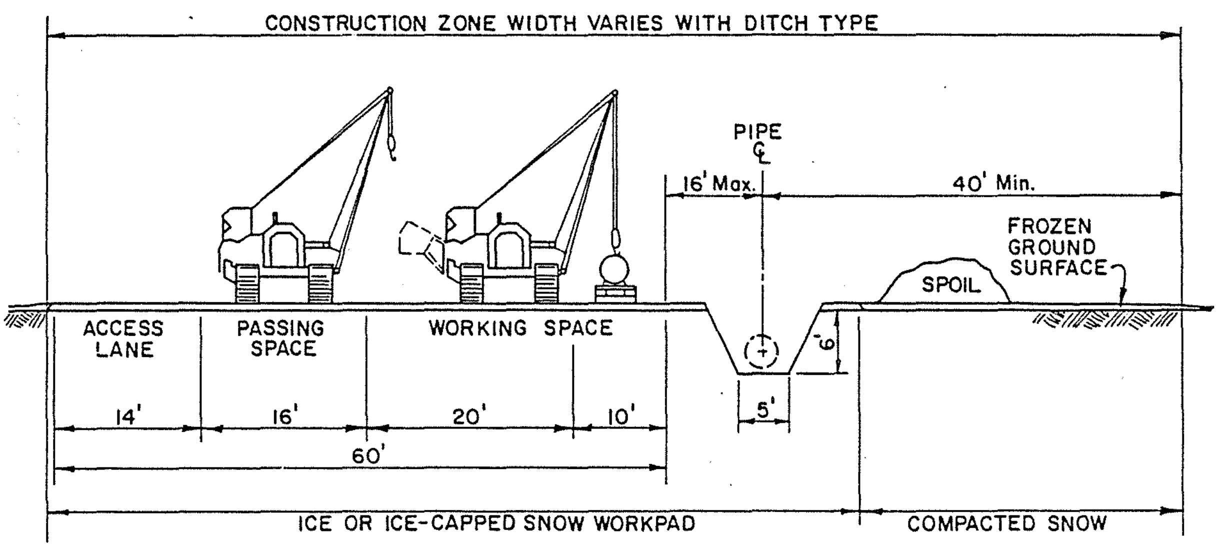


Figure 2.3.2-2. Typical Construction Cross-Section with Ice and Snow Workpad

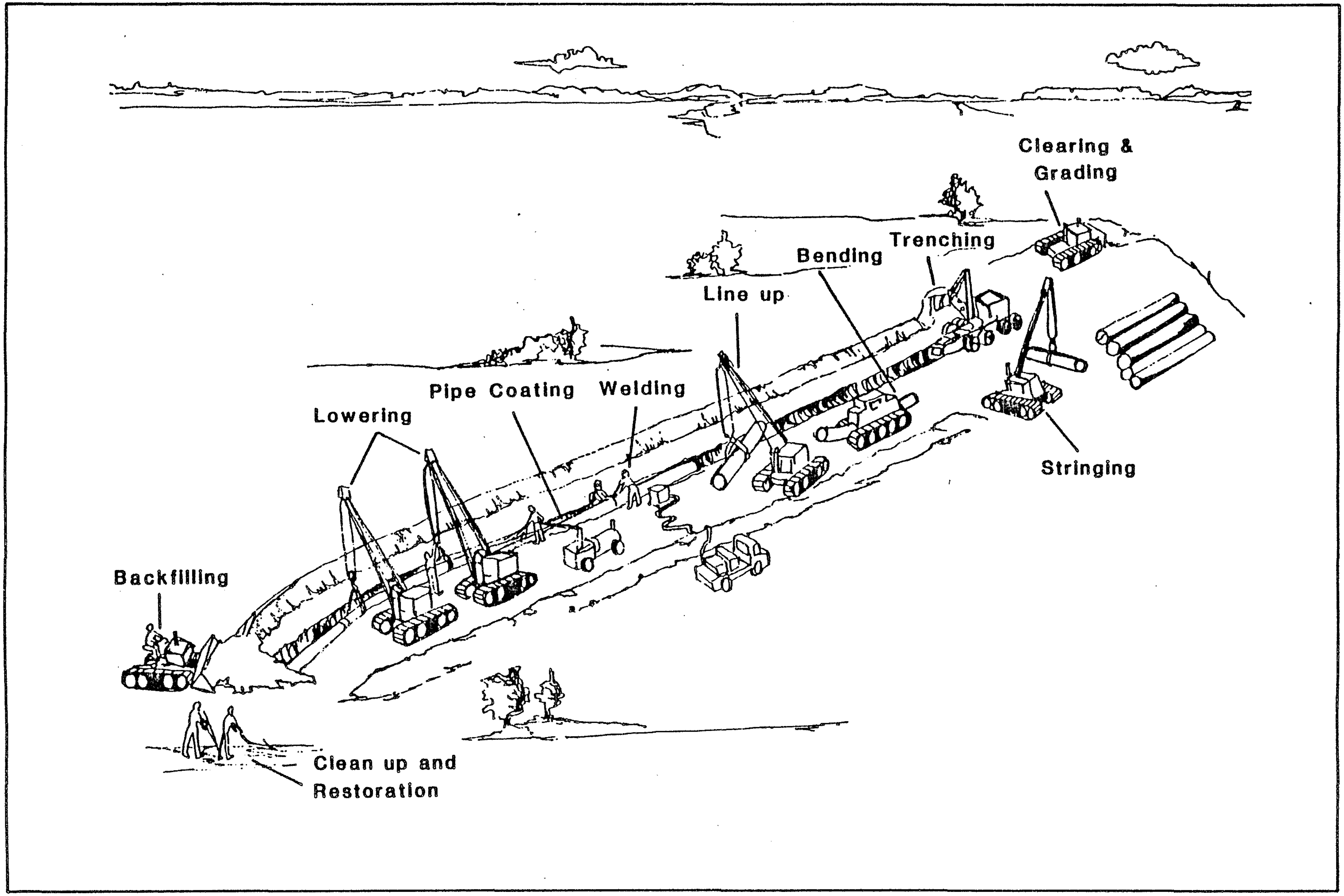


Figure 2.3.2-3. Typical Cross-Country Construction Pipeline Spread (typical, not to scale)
(BLM, 1984)

- Consideration of optional work pad designs to reduce surface disturbance or costs. Optional geofabric, snow/ice, ice-capped snow, ice, and aggregate ice.

The pipeline ditch would be excavated using a combination of conventional excavation techniques to achieve a ditch of specified dimensions and required depth of cover for the pipeline. Pipeline minimum depth of cover would be in accordance with the 49 CFR 192. In normal soils, cover would vary from 30 to 36 inches; in rock conditions, it would vary from 18 to 24 inches. A typical ditch cross section is shown in Figure 2.3.2-4.

TAGS proposed excavation techniques have been used successfully in arctic and subarctic environments. The selected excavation technique would be matched to the soil type, thermal condition, and ground-water conditions.

Ditch excavation techniques for the TAGS project include ditching machines, backhoe, backhoe with blasting, and dragline. Ditching machines would be best suited to the excavation of frozen fine-grained soils, frozen coarse-grained (sandy) soils without significant cobbles or boulders, and thawed, dense, fine-grained soils without ground-water flow. Backhoes, though well-suited for excavating these soil conditions, would have slower advance rate for such conditions than a ditching machine. Therefore, a backhoe would be used primarily in conditions not amenable to the use of ditching machines: to excavate coarse materials with cobbles and boulders and in areas of moderate ground-water flow and high water tables. In addition, backhoes would be used in conjunction with line blasting techniques in frozen soils and bedrock. Spoil piles of backhoes would not be as neat as those produced by ditching machines. Draglines would be used primarily for river crossings and floodplain excavation.

The double-jointed precoated line pipe would be hauled from the temporary material

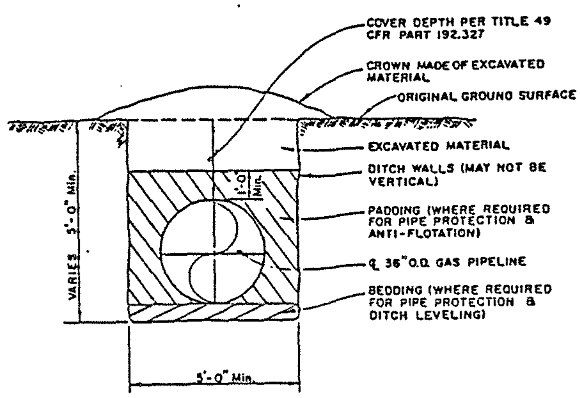


Figure 2.3.2-4
Typical Ditch Cross Section

storage yards to stockpile points along the route. The spacing of the stockpiles would be selected to optimize the hauling of pipe along the pipeline right-of-way and to minimize backhaul.

The line pipe would be bent by special bending crews to conform to the terrain and fit the vertical and horizontal contours of the ditch. Pipe bending would be performed on the right-of-way using a 36-inch bending machine that would be moved along the right-of-way by tractor. Side-boom tractors would be used to handle the pipe in the bending operation. Following bending, the pipe would be placed on skids for welding. Coating repairs would be completed using patch sticks or shrink sleeves if coating damage due to bending is identified.

The line pipe would be elevated on skids to provide lineup clearance for welding and holding the pipe in alignment during the first welding pass. Mainline welding would be performed manually or by using a mechanical welding system that permits consistent, high-quality welding and produces a desired production rate. Field crews would bevel each joint of pipe to the profile required for automatic welding. Pipe ends would be preheated prior to welding.

Each step of the welding process would be visually inspected by qualified welding inspectors. Alignment and spacing would be inspected for conformance to specifications. Visual inspection of the root pass, filler passes, and cap would be made, and any defects would be removed by grinding. Following welding, radiographic crews would make X-rays of completed welds as required by 49 CFR 192. Welding would conform strictly to the specifications of codes (API 1104). Rejected welds would either be repaired or cut out, depending upon the severity of the defects. Field weld joints would be coated, utilizing thin-film, tape, shrink sleeves or similar type coating. Pipe coating would be inspected with a "jeep" to detect holidays or other damage to the coating. Repairs would be made using patch sticks.

The welded pipe would then be lifted and lowered into the ditch by a series of side-boom tractors with slings acting in unison and spaced so that the weight of supported pipe would not cause buckling or other damage. Wherever there is a break in the continuous welded pipe, separate tie-in crew would be required to manually weld together the lowered-in pipe strings to complete the pipeline section. Other locations requiring tie-in welds include valves, road crossings, river crossings, compressor stations, and other special crossing areas.

Backfilling procedures would comply with specifications regarding protection of the pipe and coating. Selected granular material would be placed around and under the pipe to protect the pipeline whenever the ditch passes through material that could damage the coating, to mitigate buoyancy problems (outside of floodplain areas), and to protect against excessive loss of pipe cover due to erosion. In all areas where these potential problems do not exist, ditch spoils would be used as backfill and placed in direct contact with the pipe. In active floodplains and at stream crossings where buoyancy control is required, concrete bolt-on weights or continuously concrete coated pipe would be installed. Ditch plugs would be used in areas where potential excessive erosion along the ditch line could affect pipeline integrity. After the completion of the various backfill procedures, the backfill crews would complete the filling of the trench to about 1 foot over the top of the pipe using either ditch spoil or select backfill material. The remaining ditch spoil material would be used to complete ditch backfill and crown the ditch. In sensitive stream and wetland areas, excess ditch backfill could be removed to designated spoil-disposal areas.

Clean-up procedures would be performed following pipe laying and backfilling and would include the final grading of the pipeline right-of-way and the shaping of a crown over the pipeline ditch, as required. Restoration procedures, such as seeding and fertilizing, would be performed as required to mitigate erosion, minimize siltation, and encourage the natural revegetation of disturbed areas. In addition to right-of-way restoration, other disturbed construction areas such as material sites, camps, and temporary access roads would be restored to an acceptable condition and revegetated as required. The planned long-term approach to stabilizing disturbed areas involves natural revegetation and reinvasion by native species.

Hydrostatic testing of the pipeline would be conducted during the final summer of construction in each spread. Hydrostatic testing would be performed using water from local sources. Water would be withdrawn from designated surface water sources with the capacity to supply the desired volumes without adversely affecting aquatic habitats and associated biota. It has been assumed that hydrostatic testing could be accomplished using untreated water without the aid of freeze depressant additives. Following testing, water releases would be confined to designated areas and diverted to settling basins or to energy dissipators where needed to avoid induced erosion.

2.3.3 Special Pipeline Design

Certain areas along the pipeline construction route such as river and stream crossings, road crossings, foreign pipeline crossings, and active fault crossings, would require the use of special equipment, materials, and procedures. These requirements would be given special design consideration on a site-specific basis.

2.3.3.1 Buried River and Stream Crossings

The proposed pipeline design has buried crossings at rivers and streams, except at four special river crossings where aerial designs would be used due to site-specific geotechnical, environmental, and/or difficult construction conditions.

The objective of buried pipeline crossing design would be to ensure that the pipe is not exposed to the hydraulic and abrasive forces of water flow and sediment movement. Detailed design would evaluate the potential for pipe exposure to degradation and local scour of the river or in the streambed. In addition, an evaluation would be made of the potential for pipe exposure to bank erosion. Degradation, scour, or erosion would be heavily dependent on the flow regime and morphologic character of the stream or river at the particular location and would be mitigated by site-specific design.

Wherever possible, river or floodplain crossings would be aligned, as near as practical, at right angles to the direction of flow. This orientation would be to prevent channelization along the right-of-way and to minimize the length of the crossing. Where a river or floodplain must be crossed at an angle to the flow, the need for structures to control the river or stream and prevent channelization would be evaluated and designed and utilized where appropriate. In assessing the potential for riverbed scour, floodplain erosion, and the need for pipe buoyancy control, design discharges, and corresponding water levels would be evaluated. Such design would be based on:

- Statistical flood frequencies obtained from analyses of local or regional flood data;

- Regional relationships between maximum recorded discharge and drainage area, where regional streamflow records are of sufficient quality and duration; and

- Regional relationships between drainage area and extreme discharges obtained by unit hydrograph techniques.

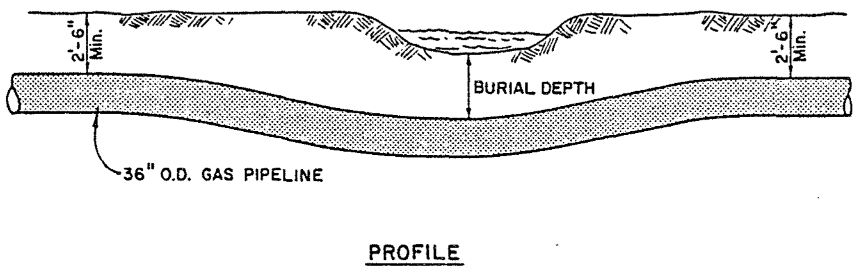
Erosion and scour estimates are generally based on hydraulic parameters corresponding to design discharge unless other discharge is considered to be critical.

Figure 2.3.3-1 presents three typical configurations for three types of buried river and stream crossings. The unweighted crossing would be used where crossings of minor streams and drainages require only minimum cover depths and where pipe buoyancy would not be a problem. Weighted river crossing designs would be utilized to allow pipeline construction in wet ditch areas or for long-term pipe buoyancy control. Selection of bolt-on weights or continuous concrete coating would be based on site-specific conditions.

Following pipe laying, trenches would be backfilled with materials equal to or better than the materials excavated. This would minimize changes in channel characteristics with respect to scour and erosive forces. Use of rip-rap or other bank protection techniques would be required in some locations.

2.3.3.2 Aerial River Crossing

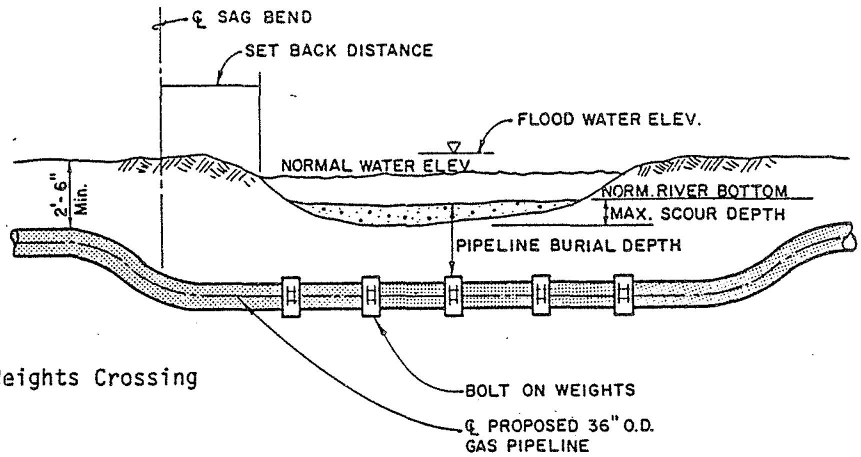
The proposed TAGS conceptual design identified four major river crossings that would require independent aerial suspension bridges due to known environmental and difficult construction conditions. Aerial



NOTE

PIPELINE BURIAL DEPTH AT STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.

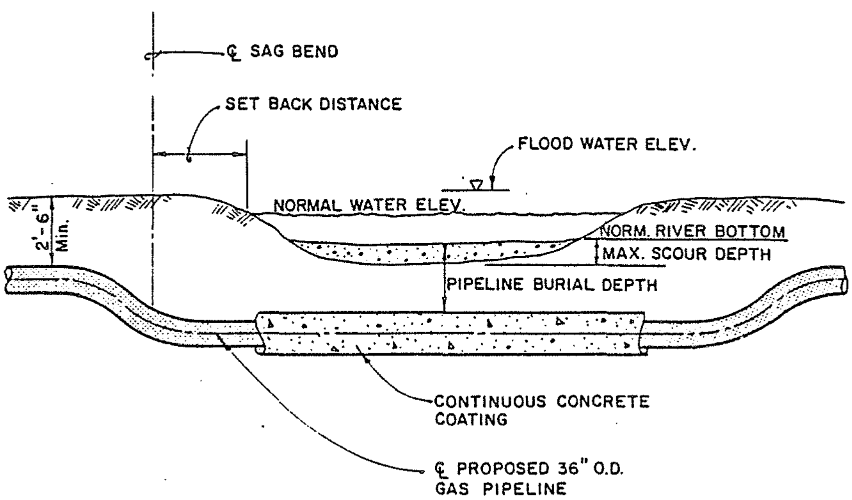
a. Unweighted Stream Crossing



b. Bolt-on Weights Crossing

NOTE

1. PIPELINE BURIAL DEPTH AT RIVER AND STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.
2. BOLT-ON WEIGHTS WILL BE SIZED AND SPACED TO SUFFICIENTLY COUNTER-ACT BUOYANCY FORCES.



c. Concrete Coastal Crossing

NOTE

1. PIPELINE BURIAL AT RIVER AND STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.
2. CONCRETE COATING WILL BE OF SUFFICIENT THICKNESS TO COUNTER-ACT BUOYANCY FORCES.

Figure 2.3.3-1
Typical River or Stream Crossing

rather than buried crossings would be used for the Yukon, Tanana, Gulkana, and Tazlina rivers.

Figure 2.3.3-2 is a conceptual sketch of the single-span bridge proposed for the crossing of the Tanana, Gulkana, and Tazlina rivers. Span lengths for the three crossings are estimated to be 1,200 feet, 380 feet, and 700 feet, respectively. The Yukon River crossing would be an independent, twin-span suspension bridge.

2.3.3.3 Road Crossings

The proposed TAGS pipeline road crossings would be designed and installed with or without casings in accordance with 49 CFR 192. Access roads into material sites, camps, foreign pipelines, service facilities, and private property would be traversed uncased, as shown in Figure 2.3.3-3. The 67 major highway and road crossings would be evaluated on a site-specific basis to determine if an uncased crossing can be used. Where excessive wheel loads are anticipated or concerns for pipeline integrity are identified at road crossings, the advantages and disadvantages of cased crossing will be evaluated during the design phase.

Design and construction would be coordinated with the Alaska Department of Transportation and Public Facilities (DOT/PF) for highway crossings, proper authorizing agents for other public roads, and private owners for access roads as appropriate. Activities would be coordinated with Alyeska Pipeline Service Company where highway crossings are proximate to its fuel gas line or where its access roads are crossed by TAGS.

2.3.3.4 Foreign Pipeline Crossings

The design and construction of crossings of foreign pipelines would require consideration of site-specific conditions and operational characteristics at each crossing. The proposed TAGS route crosses TAPS (above-ground and below-ground sections), the TAPS fuel gas line, the Kuparuk oil line (above-ground section), producer gathering lines, the Haines products pipeline, and the right-of-way for the proposed ANGTS.

Crossings of above-ground foreign pipelines would be designed for minimal impact to the foreign pipeline or respective right-of-way. Although precise angles of crossing would vary based upon site-specific conditions at each crossing location, the angle between the two pipelines at the crossing point would tend toward a right angle (80° to 100°). The TAGS pipeline would be buried a minimum of 2.5 feet below the original ground surface. A crossing point at the midpoint between support bents of an above-ground foreign pipeline would minimize the impacts of construction. Crossings would not be near anchors at valve support locations. For additional safety, TAGS would utilize heavy pipe-wall thicknesses through crossing areas. Figure 2.3.3-4(a) shows a typical crossing scheme for existing above-ground TAPS or Kuparuk oil pipelines. Above-ground producer gathering lines would be crossed by TAGS using a similar scheme.

Crossings of below-ground foreign pipelines would also be designed to minimize impact to the foreign pipeline and respective right-of-way. Crossing angles for large-diameter, buried, foreign pipelines would also tend toward a right angle. The TAGS pipeline would be buried in an above-ground berm where it crosses large-diameter buried foreign pipelines. Berms would be constructed to allow temporary construction and long-term permanent through-access for TAGS and respective foreign pipeline activites. The height of the berms would be such that the TAGS pipeline, elevated a minimum of 6 inches above the existing ground surface. would attain a cover depth of at least 2.5 feet. The TAGS pipeline would be insulated throughout bermed sections and would be

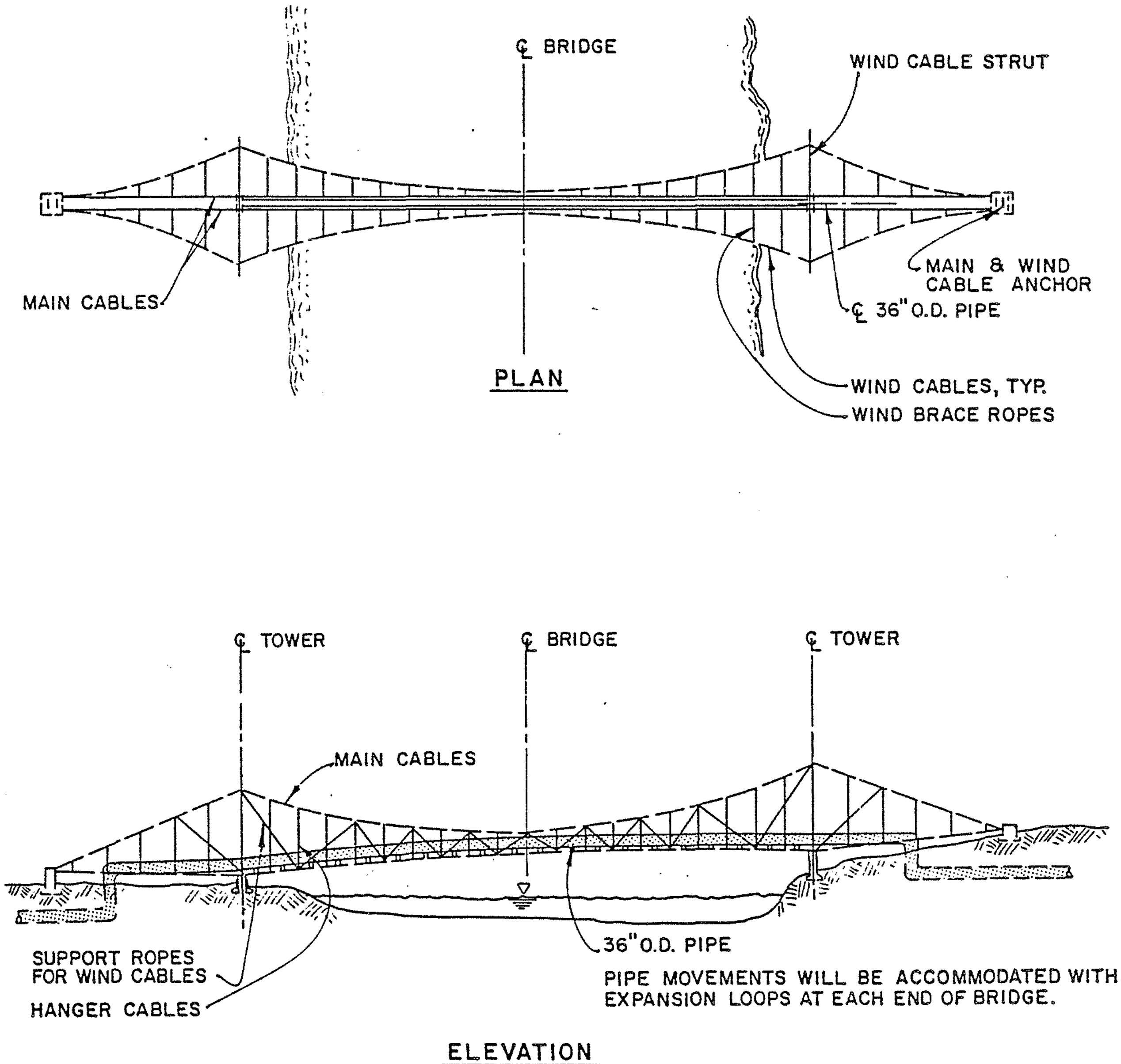
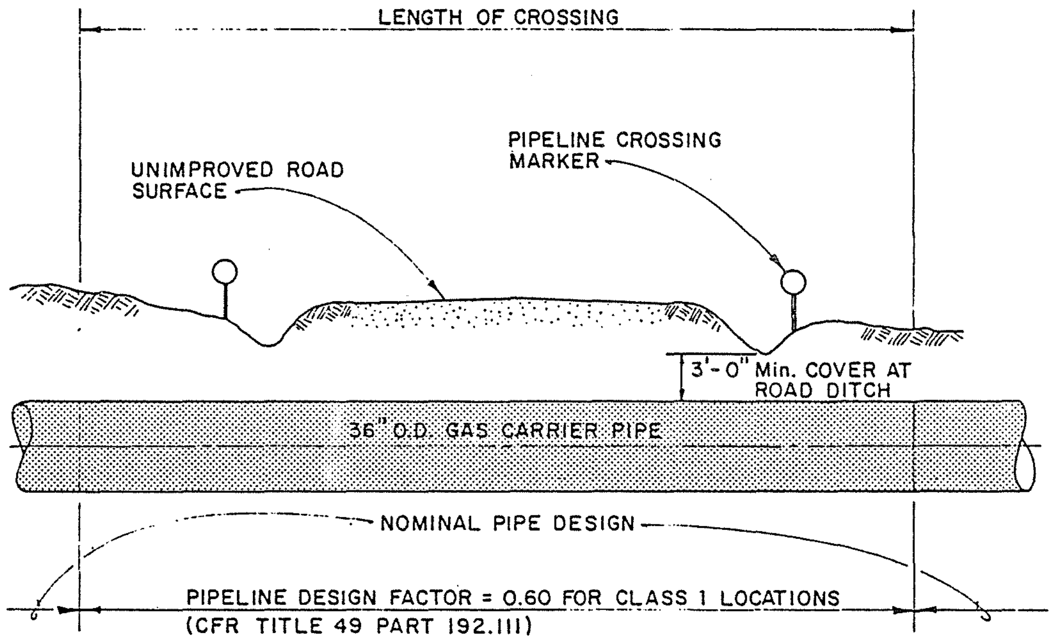
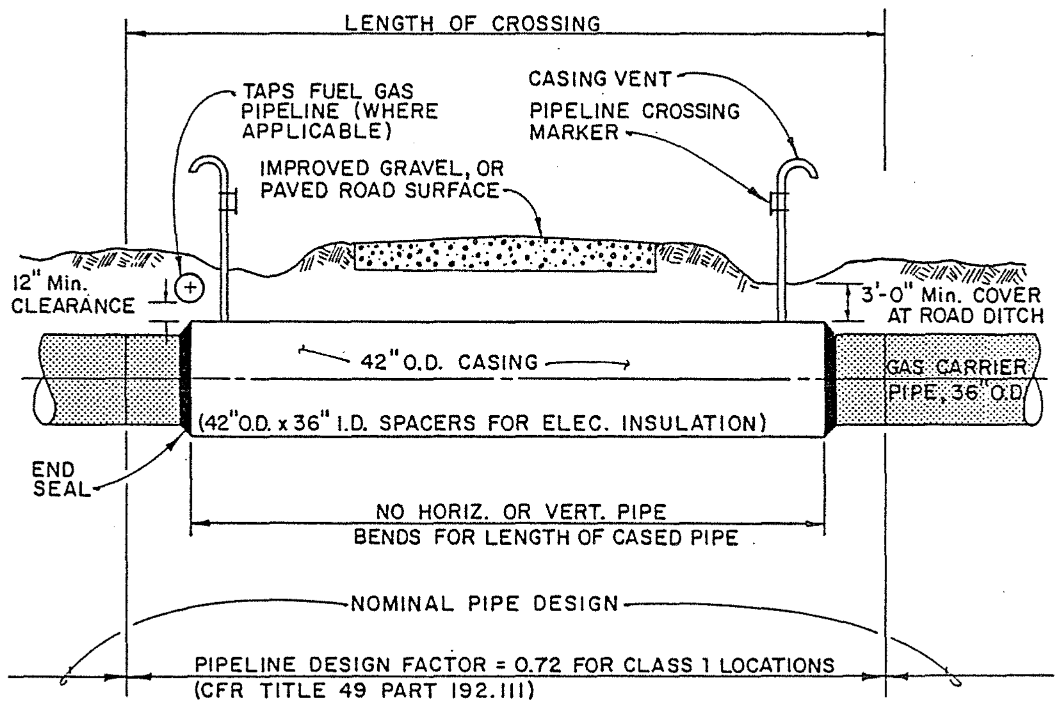


Figure 2.3.3-2. Typical Aerial River Crossing



a. Uncased Road Crossing

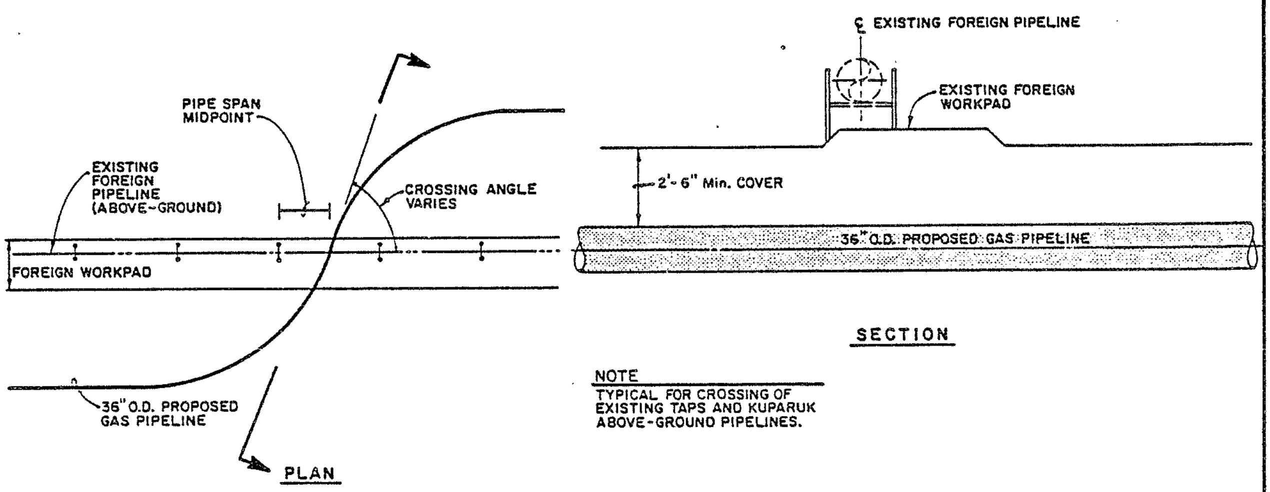


b. Cased Road Crossing

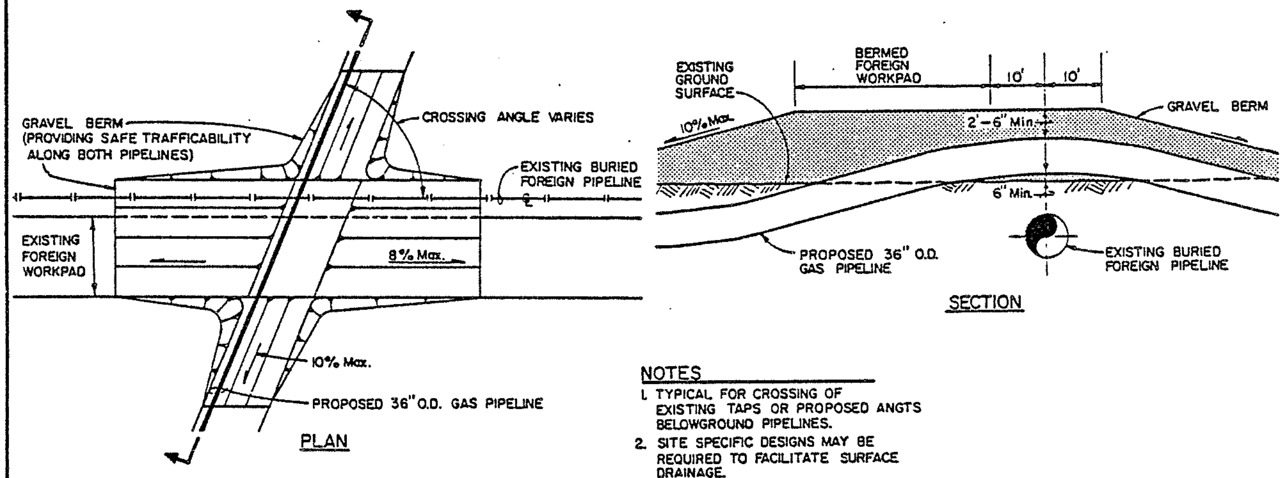
NOTES

1. CASING WILL BE EXTENDED 5' BEYOND ALYESKA FUEL GAS LINE WHERE PRESENT.
2. INSULATED OR OTHER THERMAL DESIGNS WILL BE UTILIZED WHERE REQUIRED.

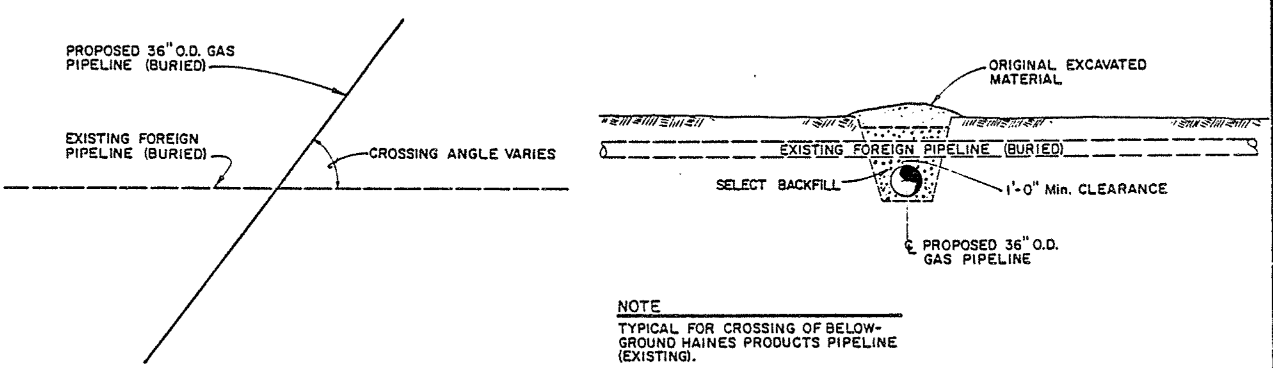
Figure 2.3.3-3. Typical Road Crossing



a. Crossing of Existing Above-Ground Pipelines



b. Crossing of Existing Below-Ground Pipelines



c. Crossing of Existing Below-Ground Haines Product Pipelines

Figure 2.3.3-4. Typical Foreign Pipeline Crossings constructed with heavy pipe-wall thicknesses. Figure 2.3.3-4(b) shows a typical crossing section for existing below-ground TAPS pipeline sections or proposed below-ground ANGTS pipeline sections should the ANGTS pipeline be constructed prior to TAGS.

Crossings of the below-ground Haines products pipeline would involve burial of the TAGS pipeline beneath the Haines line. A minimum of 1 foot of clearance would be maintained between the TAGS and the Haines pipeline. Select granular backfill would be utilized to replace the original material excavated from the TAGS ditch. Crossing angles would vary, based upon site-specific conditions. Figure 2.3.3-4(c) shows a typical crossing of a below-ground foreign pipeline, where the TAGS pipeline is buried beneath the foreign pipeline.

Crossings of the TAPS fuel gas line would be made along with cased Dalton Highway crossings. Road crossing construction would be of the open-trench type with necessary support and protection provided for the fuel gas line during construction. Select backfill material would be utilized throughout the road crossing length, including that area where the fuel gas line would be crossed. Crossings would tend toward right angles to minimize construction impacts. Figure 2.3.3-3(b) shows a typical cased road-crossing scheme, including the fuel gas line.

2.3.3.5 Active Fault Crossings

Three major active fault zones would be traversed by the TAGS pipeline--the Donnelly Dome, Denali, and McGinnis faults between Delta and Summit Lake. Crossings over active faults would be elevated on steel beams at grade or elevated on vertical support members (VSM) as shown on Figure 2.3.3-5.

The major hazards affecting pipeline operations in these areas are: 1) differential movement along the fault zone; 2) soil liquefaction; and 3) ground motions. The Denali Fault represents the greatest hazard from differential movement. The McGinnis fault crossing, in the vicinity of the Denali Fault would cross the active floodplain of both Miller and Castner creeks and would be underlain by extensive deposits of thawed floodplain soils.

In the Donnelly Dome and Denali fault areas, the pipeline would be elevated on steel cross-beams supported by precast concrete ties at grade, as shown in Figure 2.3.3-5(a). Since the McGinnis fault area falls within an active floodplain, the horizontal support beams would be raised above the highest expected water elevation on steel vertical support members, as depicted in Figure 2.3.3-5(b). In all above-ground areas, the pipeline would be installed with foamglass insulation protected by a metal jacket. Typically, supports would be spaced 60 feet apart and anchors would be provided about every 1,200 feet.

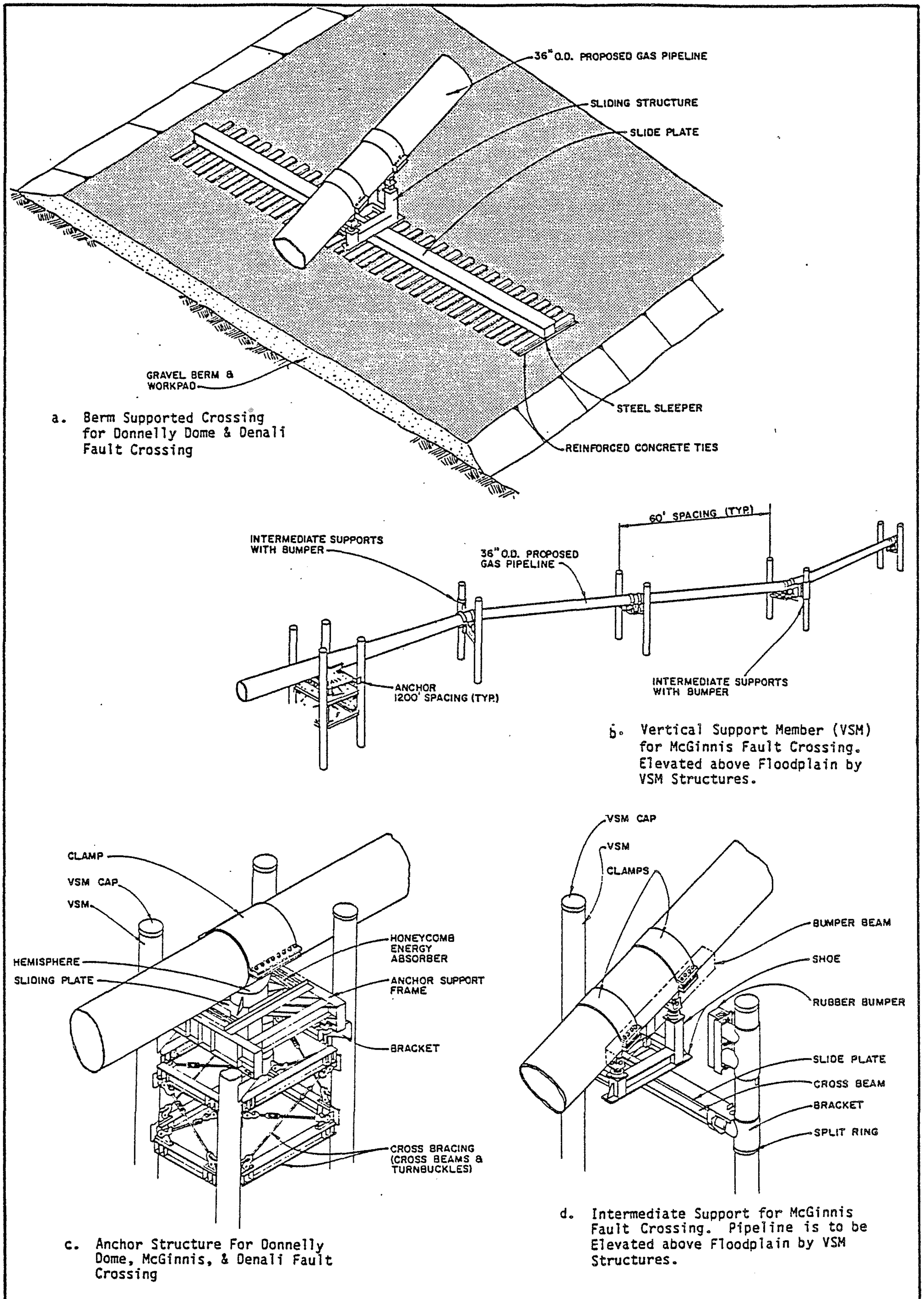
2.3.4 Special Construction Areas

Seven special construction areas have been identified by YPC along the proposed TAGS alignment. Those areas are: Atigun Pass, the Sukakpak Mountain area, Yukon River, Moose Creek Dam, Phelan Creek, Keystone Canyon, and the TAPS terminal construction area. Each of these locations involves special engineering constraints, environmental sensitivities, or land-use conflicts associated with the siting of two or more pipelines.

2.3.4.1 Atigun Pass

The proposed TAGS pipeline route over Atigun Pass is a narrow "pinch point" intended to accommodate road transportation and pipelines from the North Slope. See Figure 2.3.4-1 for a map of the Atigun Pass construction area.

Atigun Pass is the highest point to be crossed by the TAGS pipeline in the Brooks



a. Berm Supported Crossing for Donnelly Dome & Denali Fault Crossing

b. Vertical Support Member (VSM) for McGinnis Fault Crossing. Elevated above Floodplain by VSM Structures.

c. Anchor Structure For Donnelly Dome, McGinnis, & Denali Fault Crossing

d. Intermediate Support for McGinnis Fault Crossing. Pipeline is to be Elevated above Floodplain by VSM Structures.

Note: Passive Heat Removal Devices (Thermosyphons) would be Installed in VSM, as Required in Permafrost Areas.

Figure 2.3.3-5. Typical Fault Crossing

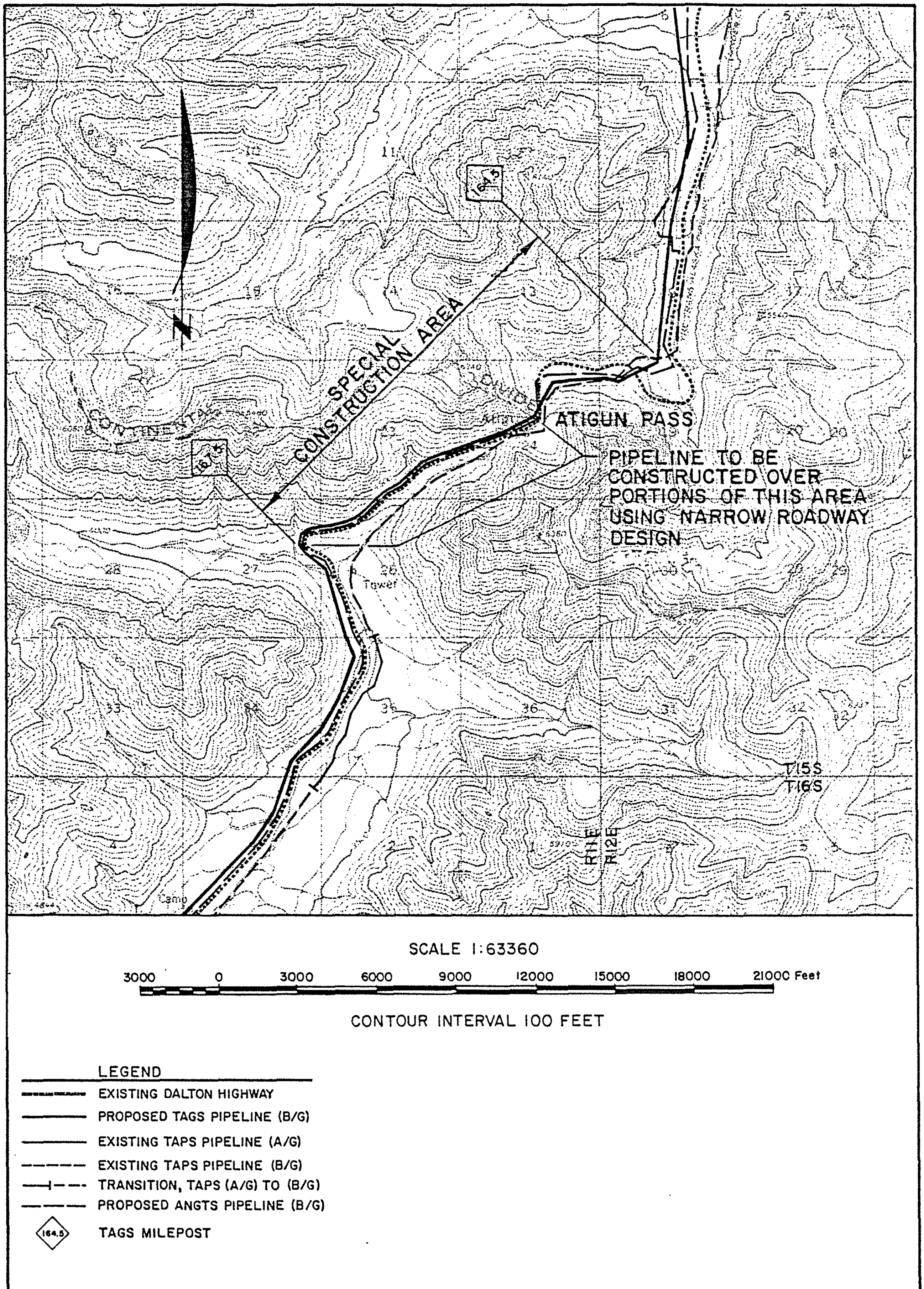


Figure 2.3.4-1. Atigun Pass Construction Area

Range. It is the only feasible route over this section of the Brooks Range. A route through the pass was therefore selected for the state highway and the TAPS project and has also been selected for the authorized ANGTS pipeline and TAGS pipeline.

The TAGS pipeline route would ascend the upper Atigun River valley on the west side of the Dalton Highway and crosses TAPS at the base of Atigun Pass. The route would ascend the north side of Atigun Pass, crossing the state highway, TAPS, and the authorized ANGTS pipeline right-of-way. The TAGS route then ascends roughly parallel to the TAPS route to the continental divide, where a second crossing of the highway and the authorized ANGTS route would be made. The TAGS route would then descend the south side of the pass, proximate to the west side of the authorized ANGTS route and highway, to the base of the pass. At the base of the south side of Atigun Pass, the route crosses the upper Chandalar River and parallels the west side of the highway to the Chandalar shelf. The closest proximity to TAPS would be at the top of Atigun Pass, where TAGS encroaches to within approximately 120 feet of the oil pipeline.

An optional route through an alternative pass 4.5 miles to the west was evaluated but eliminated from further consideration because the approach to the pass was blocked by extensive talus slopes and rock glacier in a steep narrow valley; was remote from existing infrastructure; increased length by 3.5 miles, required 21.5 miles of all-weather road and would require an additional work camp. This option was removed from further consideration.

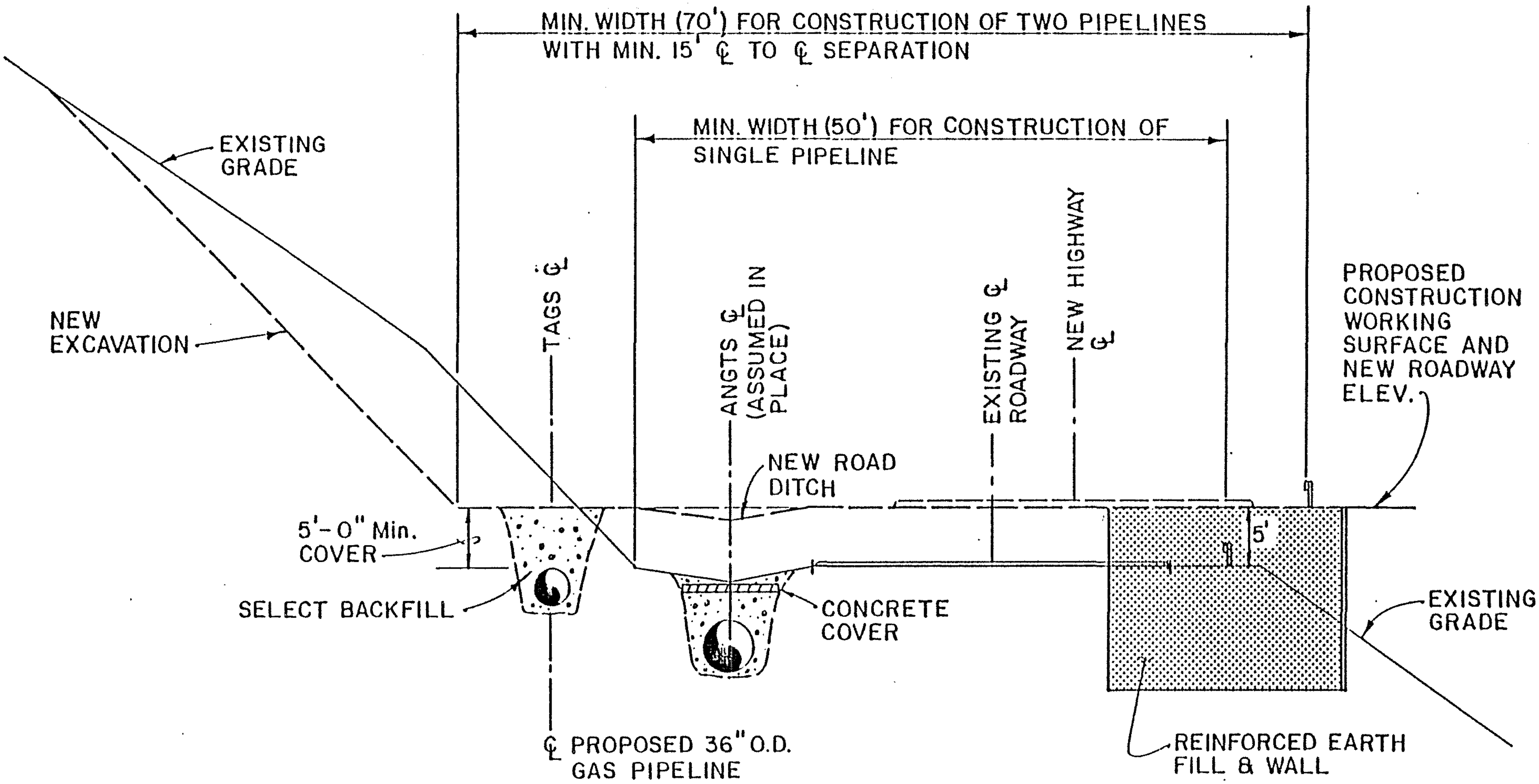
Construction of the TAGS pipeline is estimated to require two summers of work in the pass area. Civil work to widen the highway would be completed during the first summer and pipeline installation during the second summer. Summer highway traffic would be carefully controlled on a 24-hour basis by radio-equipped flagmen. Travel interruption would be kept to a minimum. Larger vehicles and oversized loads might experience some delay in order to pass the construction area safely.

The second summer construction season would be used entirely for pipeline installation through the pass. Construction would be performed 24 hours per day. The total length of the construction would be limited to approximately 1,700 feet at any one time. Excavated ditch material would be hauled off site to provide sufficient room for pipe-laying operations. Roadway widening would provide sufficient room for pipe stringing (limited to 800-foot sections) and welding operations. The pipe would be laid in 800-foot sections with backfill accomplished as soon as all work is completed on each 800-foot section as shown in Figure 2.3.4-2. Upon completion of pipe-laying operations, the roadway ditch and surface would be restored.

2.3.4.2 Sukakpak Mountain Area

Within the Sukakpak Mountain area, the alignments from Dietrich Camp into the Koyukuk River valley would include routing options that consider the least effects on the existing highway, TAPS, the authorized ANGTS right-of-way, scenic landscapes, and a confluence of the Dietrich and Bettles rivers with the Middle Fork of the Koyukuk River. Routing considerations would be to avoid geotechnical, thermal, and hydrologic conditions that are incompatible with, or detrimental to, construction and operation of a high-pressure, chilled gas pipeline.

Alignment through this approximately 10-mile area would be given further evaluation. The intent of design and routing efforts would be to provide an environmentally and visually acceptable route through this area which also has suitable geotechnical, thermal, and hydrologic characteristics for location of a high-pressure, chilled gas pipeline yet does not affect existing facilities.



NOTE
ANGTS REPRESENTS 48" O.D. GAS PIPELINE PROPOSED BY NORTHWEST ALASKA PIPELINE COMPANY AND ASSUMES CURRENT ROADWAY DITCH IS ANGTS CENTERLINE.

TYPICAL NARROW ROADWAY CONSTRUCTION
DALTON HIGHWAY-SOUTH APPROACH TO ATIGUN PASS
Section View Looking North

Figure 2.3.4-2. Atigun Pass Construction Area Narrow Roadway Cross Section

2.3.4.3 Yukon River

The proposed TAGS pipeline would cross the Yukon River approximately 1,000 feet upstream from the existing Dalton Highway Bridge by way of an independent suspension bridge, as shown in Figure 2.3.4-3. Several criteria limit the number of feasible crossing points for the new bridge: relatively narrow straight river section would be needed for bridge piers; suitable foundation conditions should exist for the support of bridge piers and anchor structures; suitable geotechnical conditions should exist in the surrounding area for the construction of pipeline approach segments; access from existing infrastructures should be reasonable; and the location should not affect existing river structures.

Conceptual design of a suspension structure for the TAGS project is shown in Figure 2.3.4-4. A twin-span bridge would be designed for pipeline loading only. Each span would be approximately 1,000 feet long. Of the three piers required for this structure, the central pier would be constructed near the middle of the river on a bedrock anchor. Three 120-foot-high steel towers would support the main cables and pipeline load. Wind struts, 120 feet wide, would provide support for laterally strung wind cables and wind loads.

Design of the proposed bridge would involve consideration of river flood levels, ice scour conditions, high wind loads characteristic of the Yukon Valley, atmospheric icing loads, a wide range of temperature variation, navigation, and seismic loading. A site-specific geotechnical investigation would be necessary to determine the actual pier location.

The TAGS above-ground pipeline crossing of the Yukon River would be located approximately 800 feet upstream of the existing Yukon River bridge. Access to this existing boat ramp area would be restricted by the security zone for the bridge abutments and for the above-ground pipeline on both bridge approaches. Due to the need to secure the above-ground portion of the pipeline from transition to transition, the security zone for the TAGS Yukon River crossing would be of greater size than the TAPS security zone.

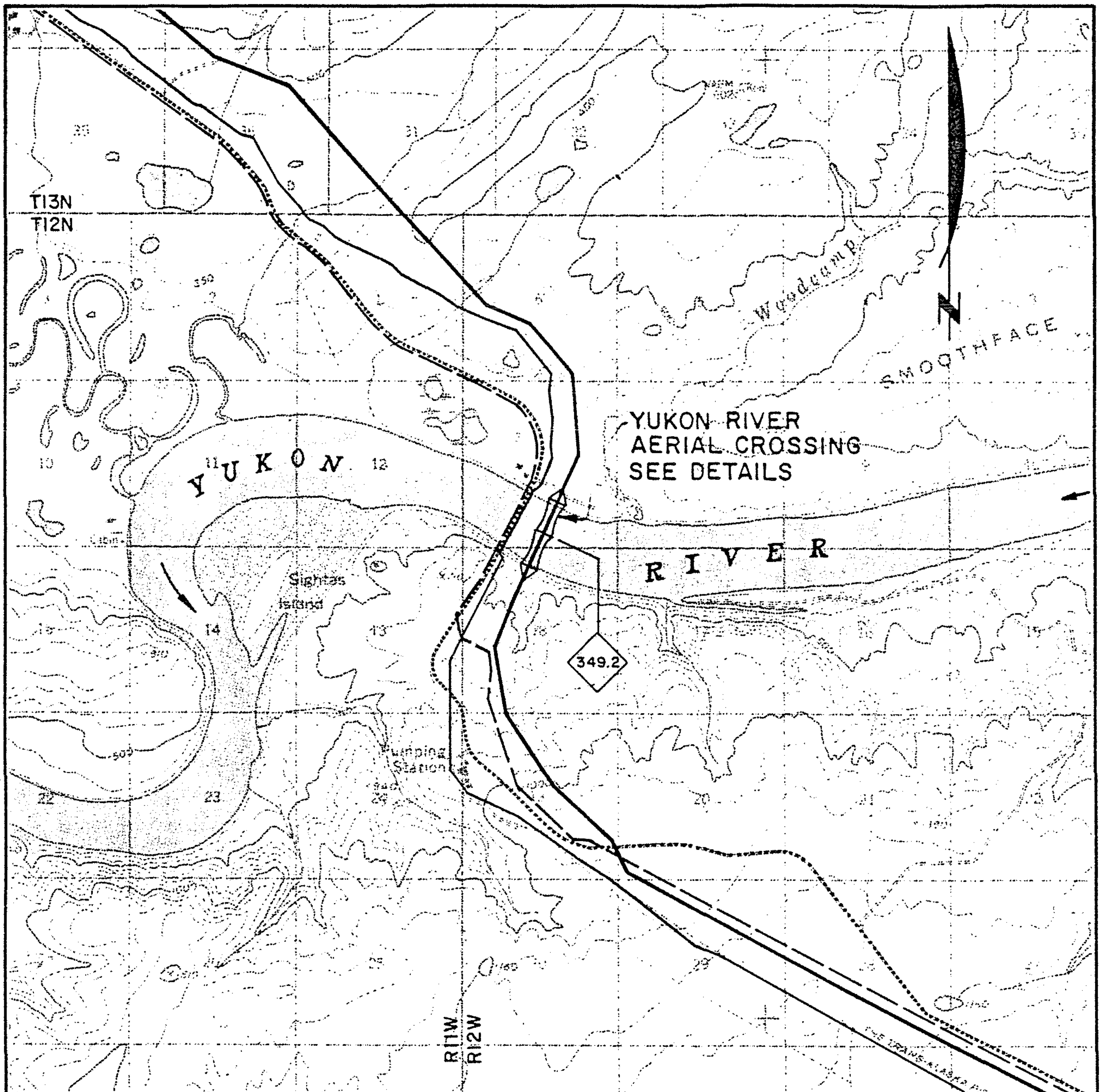
2.3.4.4 Moose Creek Dam

The TAGS pipeline crosses the Chena River Flood Control Project (Moose Creek Dam) southeast of the Fairbanks area. Moose Creek Dam is approximately 6.5 miles long and is oriented perpendicular to the TAGS route. The TAGS route would cross the dam on a flat floodplain 1.8 miles south of the main channel of the Chena River. At the point of pipeline crossing the dam height is approximately 40 feet, with 2.5:1 dam slopes. A special crossing over the top of the dam would be planned to prevent disturbance to the earthen structure of the dam.

Construction of the Moose Creek Dam crossing would occur in two phases during the first year of pipeline construction. The first phase, which would involve civil work only, would be conducted during the summer to ensure proper compaction of fill. Rip-rap protection would be placed on the upstream side of the structure except at the 80-foot-wide construction zone needed for pipeline installation. The second phase would involve the installation of the pipeline, which would commence in the fall. After completion of backfill, required rip-rap protection would be placed on the pipeline right-of-way.

2.3.4.5 Phelan Creek

The proposed TAGS alignment between the mouth of Phelan Creek and the subsequent crossing of Phelan Creek would include co-use of the Richardson Highway areas. Figure 2.3.4-5 is an area map of Phelan Creek. The total length of special construction would be approximately 10,500 feet, with three co-use areas totalling



SCALE 1:63360

3000 0 3000 6000 9000 12000 15000 18000 21000 Feet

CONTOUR INTERVAL 100 FEET

LEGEND

- EXISTING DALTON HIGHWAY
- PROPOSED TAGS PIPELINE (B/G)
- EXISTING TAPS PIPELINE (A/G)
- PROPOSED ANGTS PIPELINE (B/G)
- 349.2 TAGS MILEPOST

Figure 2.3.4-3. Yukon River Construction Area

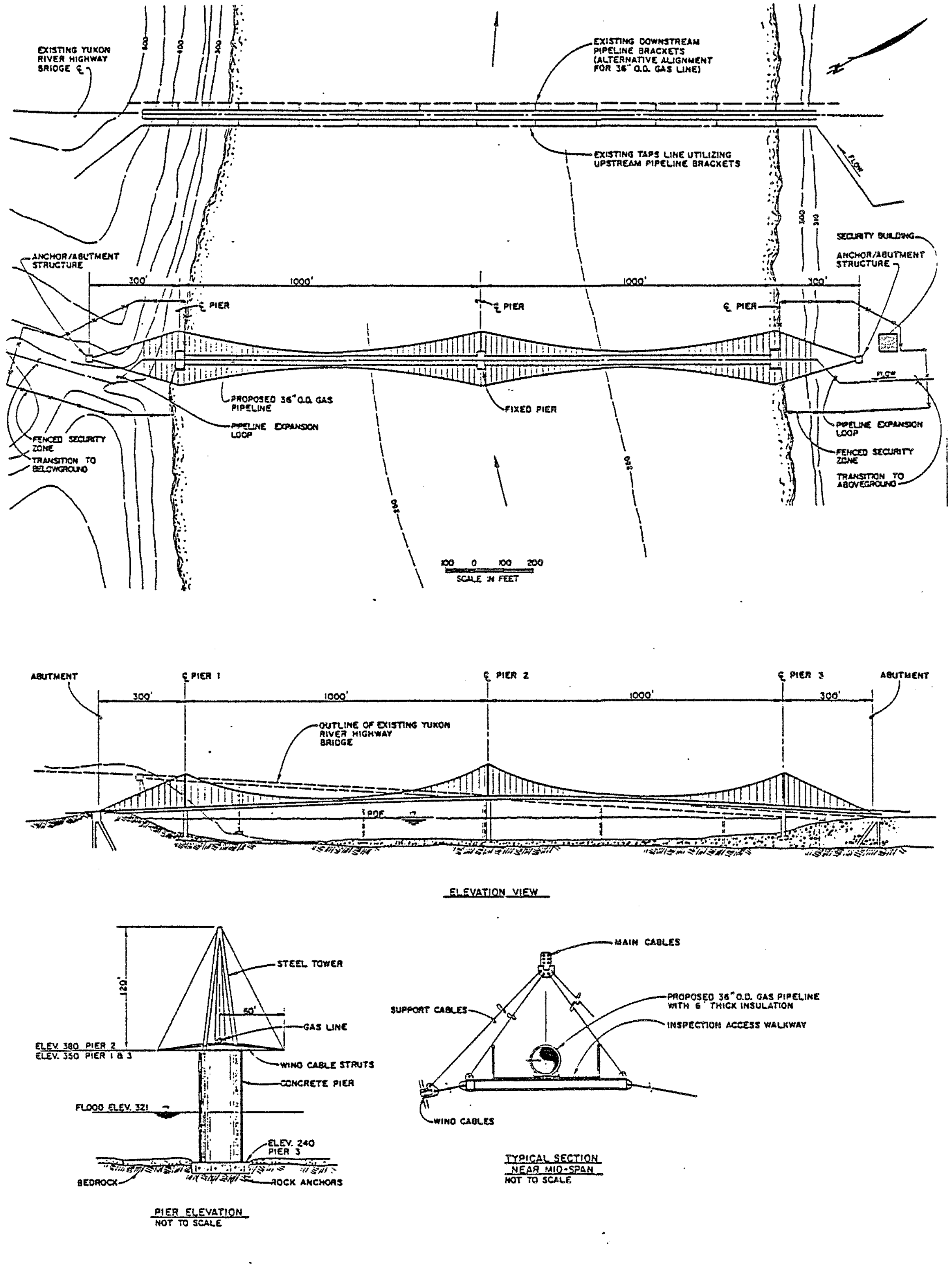


Figure 2.3.4-4. Yukon River Aerial Crossing

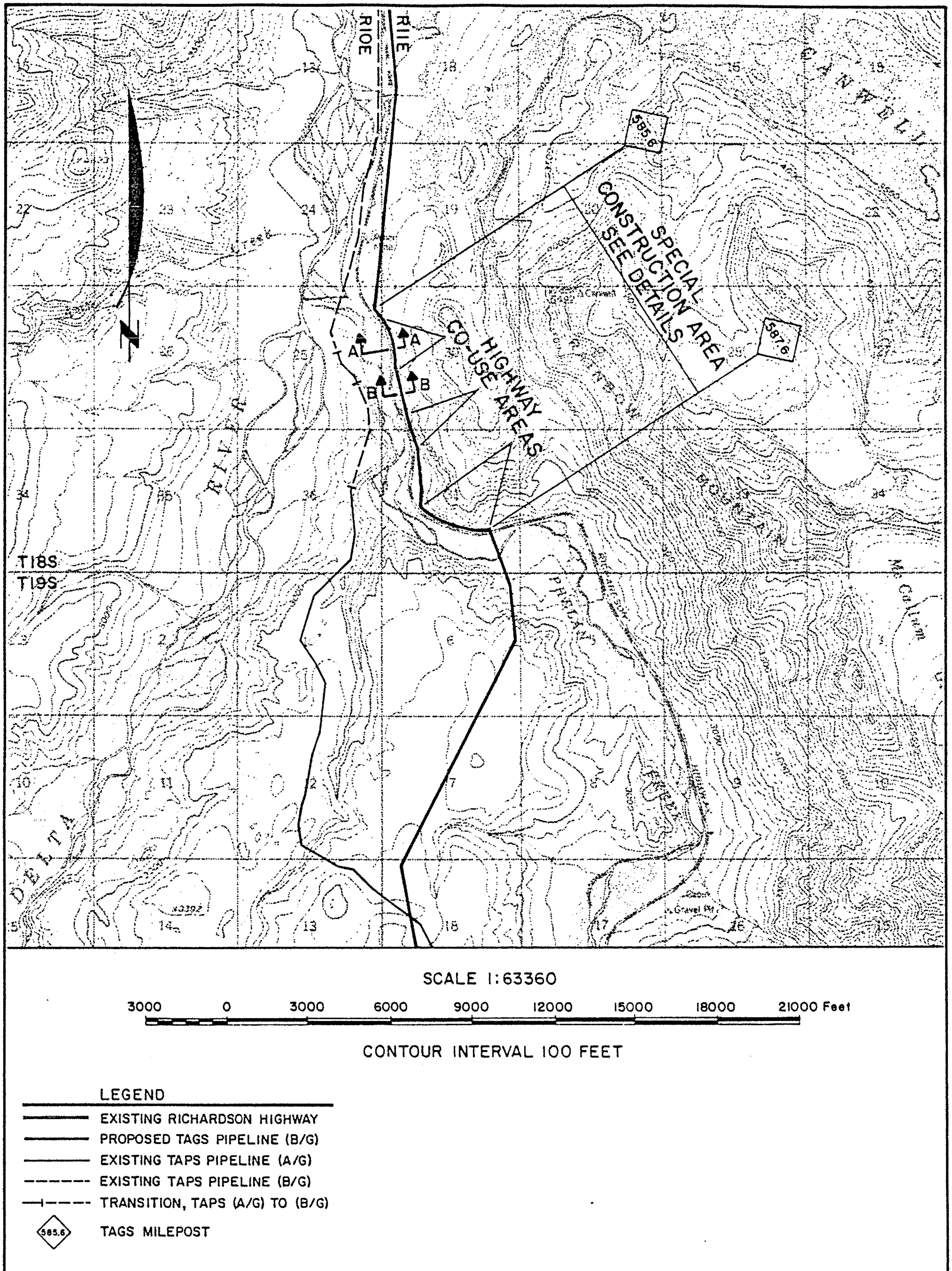


Figure 2.3.4-5. Phelan Creek Construction Area.

7,800 feet. The Richardson Highway throughout this area follows the break in slope between the steep valley wall and the wide braided floodplain of Phelan Creek. In two areas, totalling approximately 2,700 feet in length, the highway has been relocated farther from the valley wall to straighten alignment. The TAGS pipeline would be routed along the toe of the slope of the valley wall, encroaching on the highway ditch only where the highway is located close to the valley wall. Pipeline construction for these areas of encroachment is depicted in Figure 2.3.4-6.

A site-specific investigation and an evaluation of the potential for the creation of aufeis and heave in the paved highway surface would be conducted during final design. Where applicable, insulation would be utilized to limit frost-bulb growth and the blockage of ground-water flow.

2.3.4.6 Keystone Canyon

The proposed TAGS route through Keystone Canyon would involve Richardson Highway co-use for most of its 19,500-foot length, as shown in Figure 2.3.4-7. The special construction area starts near the south end of the Richardson Highway bridge crossing of the Lowe River, near Bear Creek, and ends at the TAGS pipeline crossing of the highway at the mouth of Keystone Canyon.

Through this section the Richardson Highway is routed near the Lowe River in Keystone Canyon. The Lowe River is severely constricted in the canyon, and the Richardson Highway is closely flanked by the steep canyon walls and the river. In the upper canyon area the highway is located on the east side of the river. In the lower canyon area, the highway is located on the west side, Richardson Highway crosses three bridges within the canyon.

The proposed TAGS pipeline would be routed primarily in the highway ditch next to the canyon wall and would deviate only to avoid conflicts with highway bridges and to cross the Lowe River. To avoid conflict with the two highway bridges in the upper canyon area (near Snowslide Gulch), the TAGS pipeline would use the old Richardson Highway tunnel.

Installation of TAGS in this area would be completed in a single summer season during the second year of pipeline construction. Typical construction sections for the area are shown in Figure 2.3.4-8. Except for construction through the old highway tunnel and in the limited areas where sufficient space exists for pipeline construction from a separate work surface, construction would take place off of the highway with the pipeline near the roadway ditch. A protective cover would be utilized over the pipeline where it is located immediately adjacent to the roadway.

Pipeline installation would be conducted on a 24-hour-per-day basis to reduce construction time through this section, thus allowing a return to natural traffic flow as soon as possible. Ditch spoil would not be stored on-site since no area exists next to the ditch for stockpile.

A temporary bypass would be constructed in the Lowe River floodplain for the section north and east of the old Richardson Highway tunnel. Traffic through this section would be allowed to pass without delay except during blasting and material handling, minor delays could be required for public safety.

Construction activity would be limited to approximately 1,200 feet in length. The critical point in the Keystone Canyon construction section would be the roadway crossing required at Ruddleston Falls. This crossing and the Lowe River crossing immediately to the north would be installed concurrently. Since no room exists for a bypass, the highway crossing would be cut and temporarily bridged to maintain trafficability. The river crossing would be excavated, then the road crossing and river crossing would be installed. After completing pipe installation, the temporary bypass on the north end of the section would be removed and the roadway through the section would be restored.

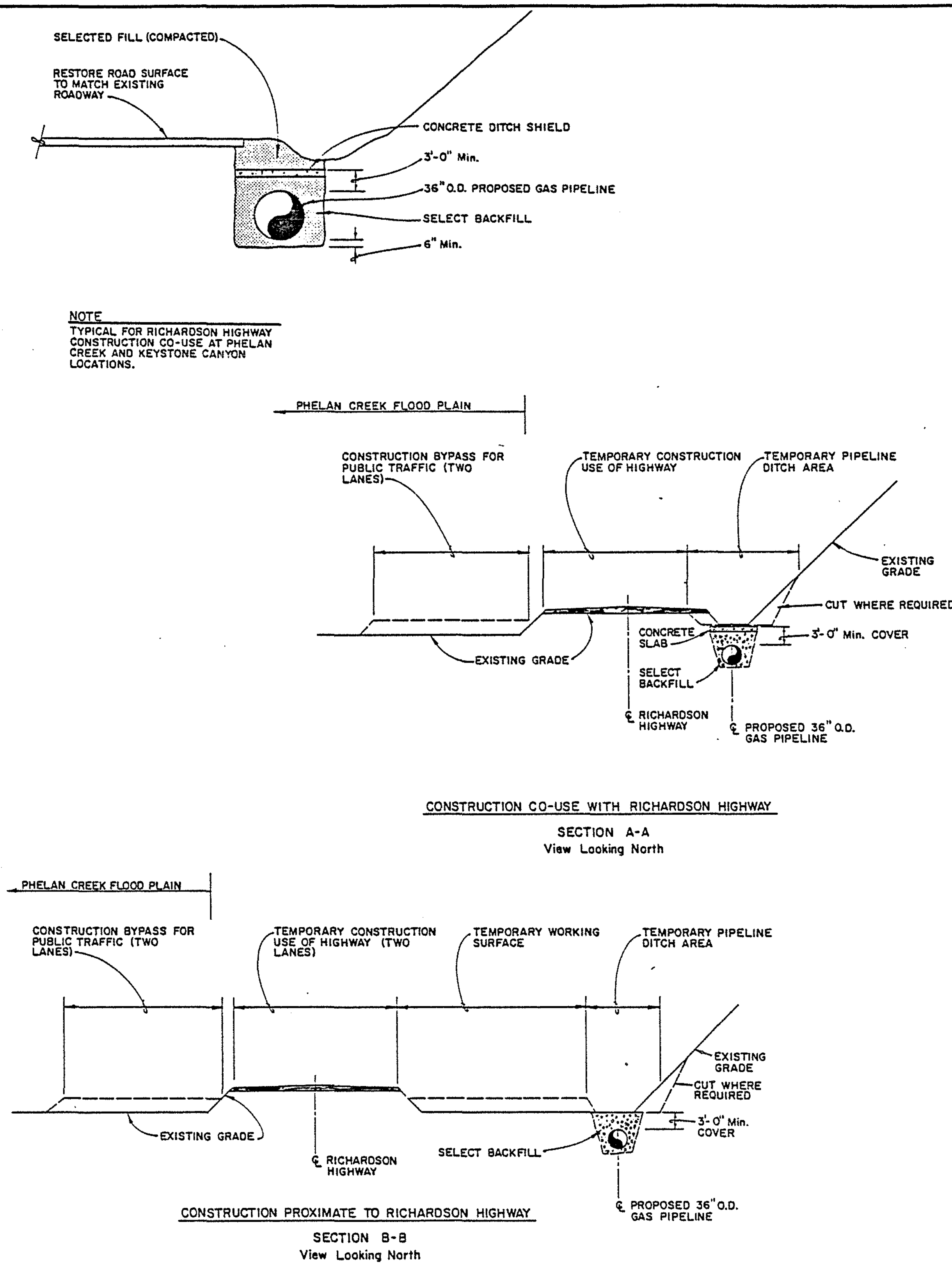


Figure 2.3.4-6. Phelan Creek Construction Area Cross Section

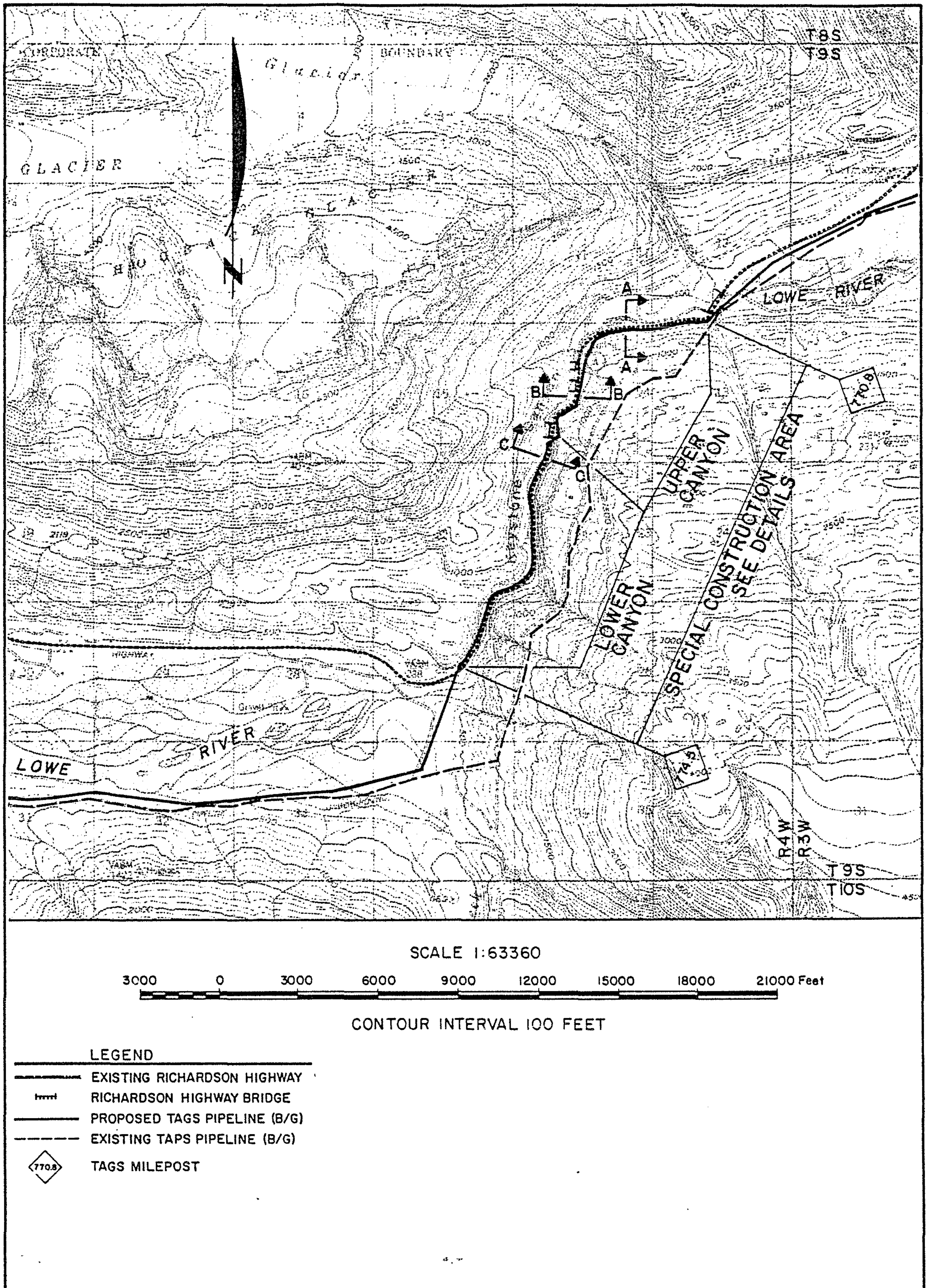
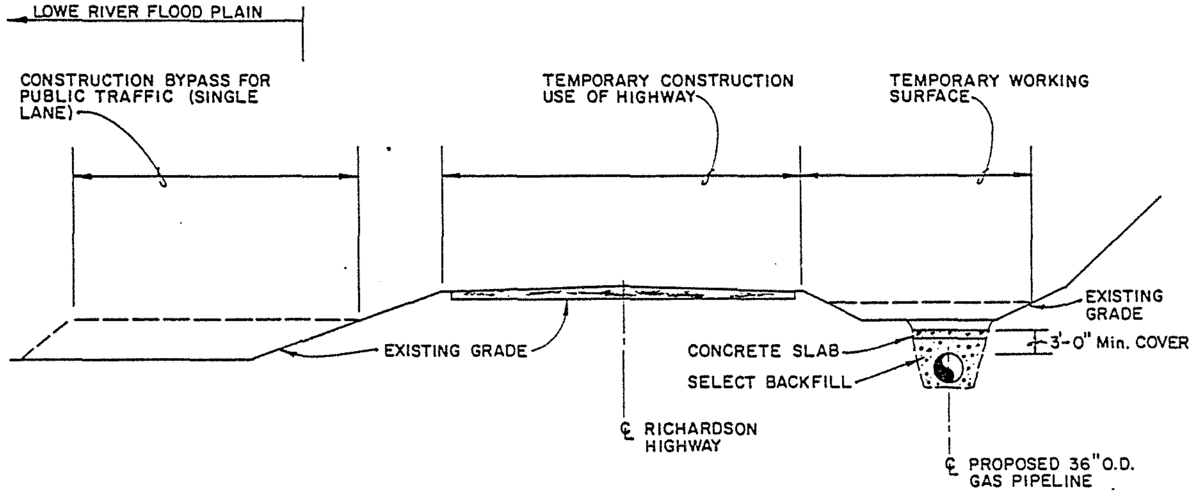
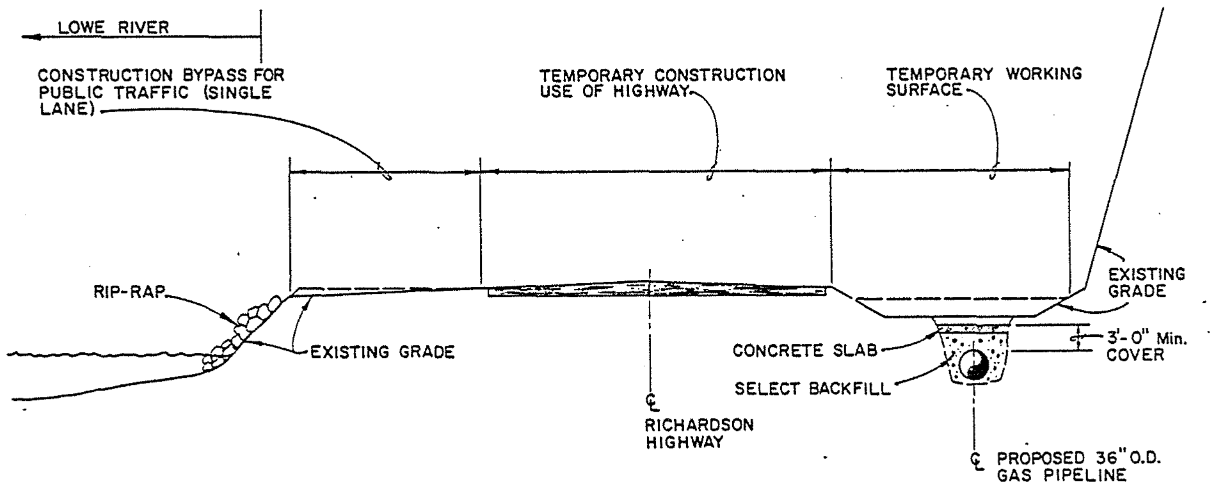


Figure 2.3.4-7. Keystone Canyon Construction Area



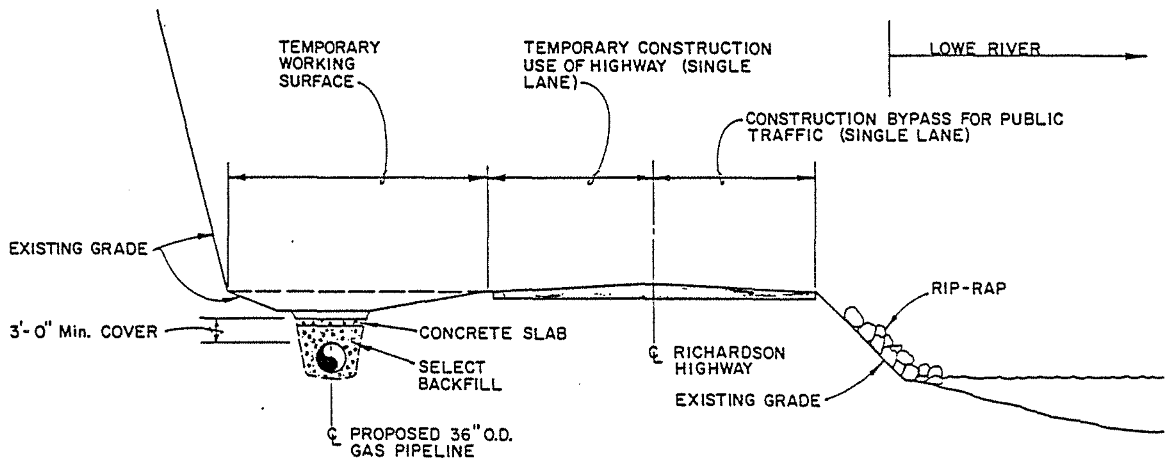
CONSTRUCTION CO-USE WITH RICHARDSON HIGHWAY

SECTION A-A
View Looking North



CONSTRUCTION CO-USE WITH RICHARDSON HIGHWAY

SECTION B-B
View Looking North



CONSTRUCTION CO-USE WITH RICHARDSON HIGHWAY

SECTION C-C
View Looking North

Figure 2.3.4-8. Keystone Canyon Construction Area Cross Sections

2.3.4.7 TAPS Terminal Construction Area

The proposed TAGS alignment between the Fort Liscum slide area and the mouth of Sawmill Creek requires routing in the area of the TAPS oil terminal site owned by the Alyeska Pipeline Service Company. This special construction section would be approximately 18,500 feet and routed south of the TAPS oil terminal site. Two construction seasons would be required, the first would be for work pad and site preparation and the second for pipeline installation, as shown in Figure 2.3.4-9.

The feasibility of this route and alignment design in this area would involve coordination with Alyeska Pipeline Service Company. Selection of a specific route in the area of the terminal would be the result of detailed evaluation of available alternatives, design requirements, and construction procedures. Proposed TAGS operating and maintenance requirements would also affect specific route selection.

2.4 COMPRESSOR STATION CONSTRUCTION

The optimal conceptual system design would result in selection of 10 compressor stations to provide the necessary pressure boosts to efficiently transport 2.3 BCF/D of natural gas from Prudhoe Bay to Anderson Bay. These stations would be located along the pipeline by the mileposts identified in Table 2.4-1 and shown on the pipeline route map in Alignment Maps 1 and 2.

Location of proposed TAGS compressor stations is based upon consideration of system operating requirements and physical siting constraints. Ideally, station locations would allow equal horsepower to be installed and operated at all compressor stations. Siting constraints include the rugged Alaska topography, highly variable geotechnical and highly active hydrological conditions, environmental sensitivities, and restricted access. The compressor station locations selected would provide acceptable system operating characteristics while satisfying environmental and engineering concerns.

Construction of each compressor station would require two construction seasons. The first season would be used for site preparation, camp and temporary facility installation, and foundation construction. The second season would be used for equipment and material receipt, installation, erection, and start-up.

The compressor stations would be constructed in two groups. The first group (stations 2, 4, 6, 8, and 10) would be built in construction years three and four. The second group (stations 1, 3, 5, 7, and 9) would be built in construction years 4 and 5. An overall schedule for compressor station construction is shown on Figure 2.2.2-1.

Conventional techniques and procedures would generally be used to construct the compressor stations. All construction activities would be carried out on the station gravel pad and would not affect the surrounding environment.

Compressor station sites first would be cleared of brush and timber. Where appropriate, pads would be installed at each site over a geofabric to reduce gravel volume and to ensure the long-term performance of the pad. The pads at compressor stations 1 and 2 would be located in cold permafrost areas: they would consist of gravel placed over high-density polystyrene insulation. Compressor Station 10, to be located on the existing Tonsina Camp pad, would require the addition of 1 foot of gravel only to level the pad for construction.

Based on the conceptual design, it is estimated that 2,300,000 BCY of borrow material would be required for the construction of 10 compressor stations and related temporary camp and storage yard areas. The following Table 2.4-1 provides estimates of borrow requirements for each site:

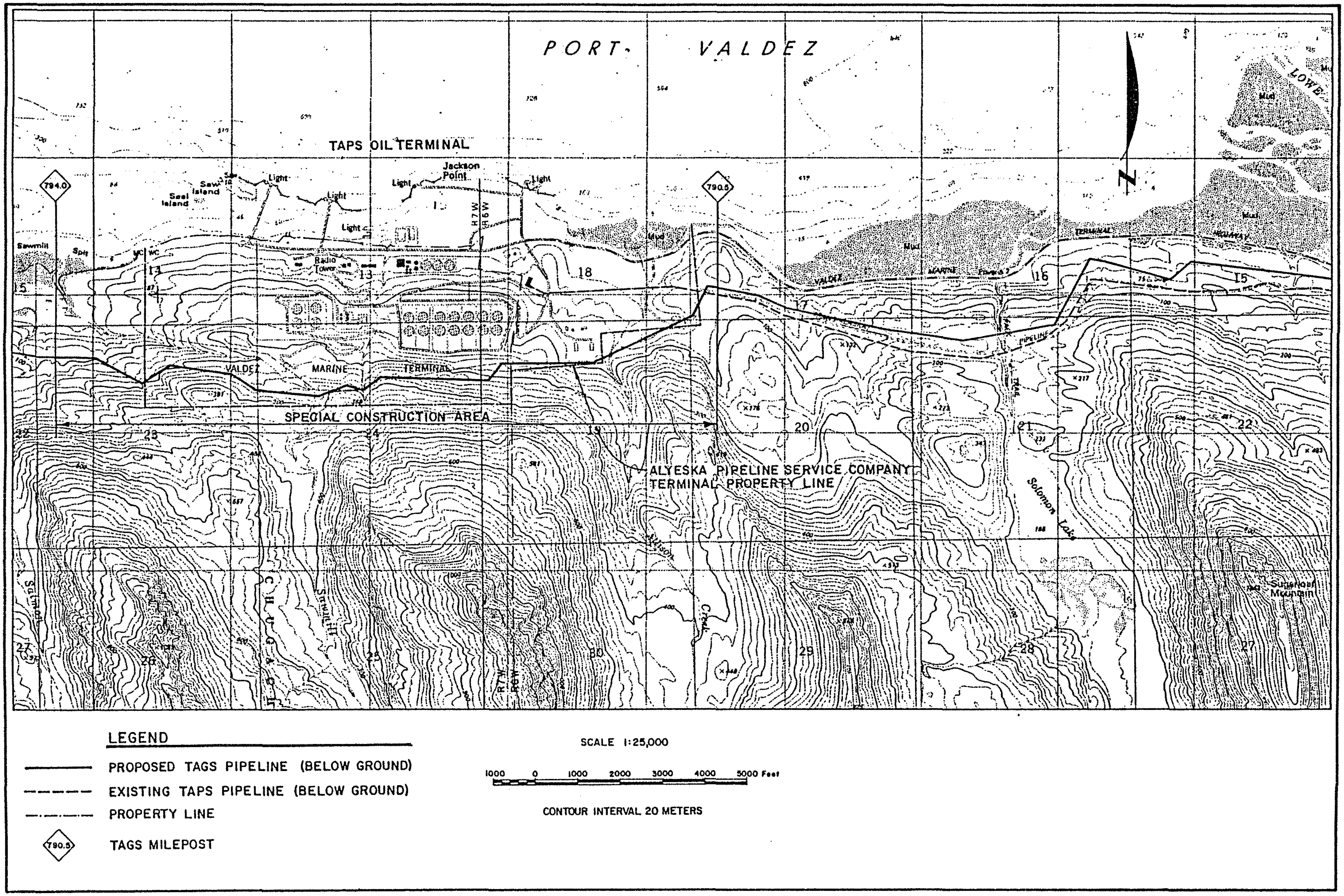


Figure 2.3.4-9. TAGS Pipeline Route through Alyeska Terminal Areas

Table 2.4-1
Compressor Station Sites
Borrow Requirements

Compressor Station	Milepost	Acreage Required	(BCY)
1	66.5	40	340,000
2	125.6	30	260,000
3	213.7	30	300,000
4	280.9	30	175,000
5	357.0	30	350,000
6	421.0	30	175,000
7	486.4	30	150,000
8	562.3	30	250,000
9	639.2	14	200,000
10	720.5	14	100,000

Buildings and structures at compressor station sites in permafrost areas would be supported on artificially refrigerated or steel pipe foundations. In nonpermafrost areas, conventional concrete foundations would be used.

The compressor station installation plan would maximize the use of off-site fabrication and assembly in order to minimize field installation man-hours, reduce overall cost, and improve completion schedules. However, because of size restrictions on key Alaska highways leading to the compressor station sites, prefabrication would be limited to equipment assemblies rather than complete facility modules. The packaged equipment to be shipped to each site would include the main gas compressors, the refrigeration compressors, the fired heater packages, the gas turbine-driven generator packages, and the air compressor packages.

All compressor station piping would be prefabricated to the maximum extent practical in spools and pieces marked for installation at each site. Preassembly of piping, such as valve assemblies and launcher and receiver assemblies, would be performed in the manufacturer's shop. These preassembled units would be insulated in the shop to minimize field construction work.

The majority of the gas and refrigeration piping would require field welding. Long straight runs of exterior piping would be preinsulated to the extent practical.

2.5 LNG PLANT AND MARINE TERMINAL CONSTRUCTION

The proposed TAGS LNG plant and marine terminal would be located at Anderson Bay, along the southern shoreline of Port Valdez. Anderson Bay is approximately 3 miles inside the Valdez Narrows, 3.5 miles west of the existing TAPS oil terminal, and 5.5 miles west-southwest of the city of Valdez, as shown in Figure 2.2.1-4.

Construction of the LNG plant and marine terminal at Anderson Bay would require conventional construction procedures and techniques. Detailed design and construction activities would be completed over a 5-year period. A general schedule outlining the overall construction program is provided in Figure 2.5-1. The critical path schedule consists of site preparation, LNG tank foundation installation, and tank erection. Detailed engineering for the site layout and the site preparation design and contract packages would have to be completed during the last six months of the project development activities prior to the initiation of construction in order to complete the LNG plant and marine terminal at the end of year 5.

Development of the LNG plant and marine terminal site would be completed by subcontractors. Scope of work would include completion of all earthwork, foundations (except LNG tank foundations), retaining structures, subsurface lines, rock reinforcement and rock drainage, site drainage, and roadways. Site development activities would begin as early as possible in the first construction year to ensure completion of the LNG tank areas early in the second construction season. Site development activities mostly would be carried out in three consecutive summer seasons.

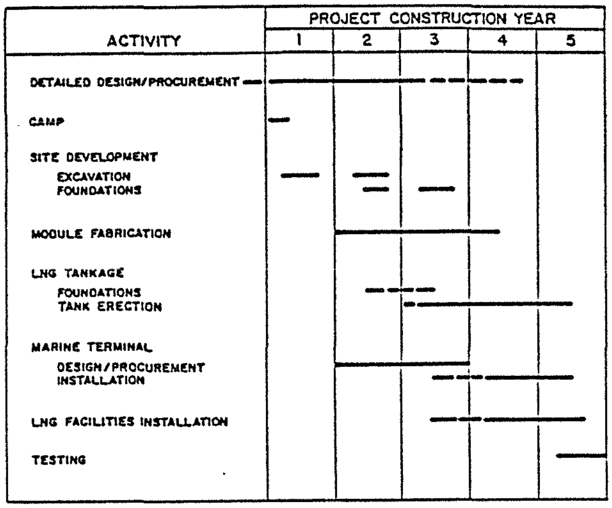


Figure 2.5-1
LNG Plant and Marine Terminal
Construction Schedule

Site excavation would involve removal of overburden soils, within design limits, down to bedrock and placement of these soils in planned disposal areas; the removal of rock down to design grade elevations; and the placement of compacted rock fill in low areas up to design grade elevations. Overburden removal would be done using conventional shovels, loaders, and haul trucks. Rock excavation would be done using conventional drilling and blasting techniques. Rock would be moved and placed by dozers, loaders, haul trucks, and compactors.

Based on the layout developed during conceptual design, bedrock foundations for all critical facilities would be provided using the following site grades:

Facility	Elevation
LNG process trains	165'
Metering facilities, feed gas preparation and control area	165'
Power plant and operations support area	155'
LNG storage tank area	100'
Utility storage area	100'
Harbormaster and helipad area	50'
Wastewater retention area	50'
Construction wharf and off-loading area	30'

Site excavation quantities would be approximately 12 million cubic yards, of which 75 percent is expected to be rock. After bulking, this volume would be approximately 10 million cubic yards of the excavation quantity which would be used for on-site fill, including earthwork for the construction wharf and off-loading area in Anderson Bay. Approximately 5 million cubic yards of excavated material would not be needed and would require disposal.

Conventional concrete foundations would be used almost exclusively. Major foundations would be located on bedrock, and minor foundations would be located on bedrock or engineered rock fill.

Trenches for subsurface lines (electrical, instrument, water, and sewer) and drainage facilities would be excavated using drilling and blasting in bedrock areas and backhoes in rock-fill areas. Rock cut-slope reinforcement and drainage would be installed as required using conventional drilling and anchoring techniques and standard casing material. Site roadways would be constructed from blasted rock material generated during site excavation activities.

A construction off-loading dock area would be located in Anderson Bay. Constructed of rock fill from site excavation, the off-loading area would be designed to stage maximum 1,200-ton module loads. Steel sheet-pile cells would be utilized to construct the pier front. The dock would be designed for loaded-barge drafts.

Upon completion of site development for the LNG tank area, the LNG tanks subcontractor would mobilize and begin construction of the ring foundations for the first two LNG tanks as early as possible in the second construction season, continuing until all four tank foundations are complete. Tank materials would be received on-site early in the second construction season. LNG tank erection would begin in late summer of the second construction season and would continue until all four tanks are constructed. Expected completion would be in midsummer of the fifth construction year. The tanks constructed would be using a nickel alloy steel or aluminum alloy inner tank and a carbon steel outer shell. The complete tank foundation including ring-wall base would be electrically heated to prevent frost-bulb growth.

The storage tank area would be surrounded by an impoundment system constructed to contain any accidentally spilled LNG. The impoundment system would be formed with reinforced concrete walls, reinforced earth walls, by excavating bedrock, or by using a combination of these structures. During conceptual design a combined reinforced earth, reinforced concrete, and rock excavation system was considered. Individual cells 450' x 450' x 35' high were evaluated during the conceptual phase of impoundment design as being adequate for safety standards.

The installation of the remaining LNG shoreside facilities would be handled by an erection subcontractor. The erection subcontractor would mobilize to the site in the third quarter of the third construction year. Completed modules would be shipped via barge to Alaska, unloaded at the construction dock facility in Anderson Bay, and moved to the site by way of the dock access roadway. LNG process trains would be delivered and installed in sequence until all four process trains were completed.

The remaining yard pipe would be installed, tested, and tied in. All systems would go through a transfer of care, custody, and control procedure prior to final commissioning and operations.

The design and construction of all marine terminal facilities would be handled by a specialty subcontractor. A contract for this work would be awarded in the fourth quarter of the first construction year. Marine terminal design and procurement activities would begin at the start of the second construction year and continue for about two years.

The marine terminal subcontractor would begin construction of the two LNG mooring and loading berths late in the third construction year and continue until all marine terminal facilities were completed in midsummer of the fifth construction year.

The two fixed berths would be constructed approximately parallel to the shoreline in 50 feet of water. Each would be capable of mooring a 125,000- to 165,000-cubic meter LNG tanker. Mooring and breasting dolphins would be driven into the harbor bed. Fenders would absorb tanker movement impacts at the berths. A platform to support the marine cryogenic loading arms would be set back from the breasting line. Cryogenic loading lines supported by trestle structures on piles would connect the LNG storage tanks to the loading platform at the end of the berth facilities.

The conceptual design for each berthing facility would consist of three breasting dolphins, a transfer platform for the four marine loading arms and a vapor return arm, and four mooring dolphins located outboard of the vessel. Both the mooring and breasting dolphins would be accessible by catwalks.

A cargo vessel berth and dock would be constructed to handle general cargo shipments to the site and for refrigerant and liquid-fuel loading. The berth would be located in water deep enough for a vessel with 20 feet of draft. Conceptually this facility would be designed for a 5,000-deadweight-ton vessel. A ferry landing would be constructed to allow marine access to the site from the city of Valdez and would be the primary means for site access during operations. A front-loading ferry capable of transporting cars and light trucks (5 tons per vehicle) would be constructed. The landing would consist of either a fixed ramp structure, a floating dock, or a combination of both. Conceptual design locates the tug and work boat pier adjacent to the cargo berth causeway. Space would be provided for three tugs and a pilot launch. This facility would be a floating dock with swing-type access ramps.

Other facilities to be constructed at the LNG plant and marine terminal site would include meter stations, communications systems, operations support facilities, and maintenance facilities.

The proposed TAGS LNG plant facility would be developed in accordance with the Pipeline Safety Regulations of the U.S. Department of Transportation. The Code of Federal Regulations Title 49, Subchapter D, Part 193 (49 CFR 193) prescribes Federal Pipeline Safety Standards for liquefied natural gas facilities. Analysis conducted by YPC indicates that the Anderson Bay site could be developed in compliance with 49 CFR 193. Recognizing the commitment to safety embodied in this code, it has been used as the basis for evaluation of the proposed LNG plant site, for development of a conceptual definition of the LNG plant, and for LNG plant safety planning. These regulations would be used as the primary standard for specific siting requirements, design, construction, equipment, operations, maintenance, personnel qualifications and training, fire protection, and security of the proposed LNG facilities.

2.6 OPERATIONS AND MAINTENANCE

Operation of the proposed TAGS pipeline, LNG plant, and marine terminal facilities would be in compliance with all applicable federal, state, and local regulations and standards. In addition, optimal system operating characteristics would be a goal in the design phases of the project as related to pipe structural requirements, geotechnical requirements, and thermal requirements and in site-specific evaluations.

The proposed TAGS pipeline system would be designed to transport 2.3 BCF/D of conditioned natural gas from Prudhoe Bay. Beginning at a Prudhoe Bay gas measurement facility, the pipeline would extend 796.5 miles south to the proposed Anderson Bay LNG plant and marine terminal facility. Maximum operating pressures would be 2220 psig to a low of 1100 psig. YPC would consider gas takeoffs along the route on a business basis.

At the terminus of the pipeline, LNG plant facilities would receive gas throughput at a pressure of approximately 1300 psig. Operating temperatures below 32°F would be maintained through northern and interior permafrost areas. Conventional warm gas operation would be utilized in southern areas where essentially permafrost-free soil conditions exist. The single transition point from chilled to warm gas flow would be determined based on geotechnical and pipe constraints during later detailed design.

Gas entering the TAGS pipeline at Prudhoe Bay and gas delivered by the pipeline for liquefaction at Anderson Bay would be measured for flow volumes, composition, and BTU content. Table 2.6-1 identifies the feed gas composition used for conceptual design for the proposed TAGS project.

An integrated communication system would provide for the exchange of voice and data information along the entire pipeline route. A Private Automatic Branch Exchange (PABX) key system and public telephone network would be located at the Anchorage headquarters, the Fairbanks maintenance facility (FMF), all compressor stations, the LNG plant/marine terminal, and the operations control center (OCC). A mobile radio system would link the entire pipeline, the OCC, the FMF, and the headquarters. A supervisory control and data acquisition communication (SCADA) system at the OCC would monitor metering stations, valves, and compressor stations. A microwave radio system would link all telephone system locations, PABX, SCADA, Telex, and mobile radio repeater equipment.

Table 2.6-1
Anticipated Feed Gas Composition

Constituent	Molecular Percent
N_2 Nitrogen	0.75
CO_2 Carbon Dioxide	0.00
C_1 Methane	91.60
C_2 Ethane	2.67
C_3 Propane	3.40
iC_4 Iso-Butane	0.35
nC_4 Normal Butane	1.12
iC_5 Iso-Pentane	0.06
nC_5 Normal Pentane	0.04
C_6+ Hexanes and heavier	0.01
	100.00%

Sites for communication facilities would be selected during the detailed design phase. These would be located on ridges or mountaintops in a manner similar to communication facilities developed for TAPS. Figure 2.6-1 shows a conceptual layout of a typical communication facility.

At each compressor station, a remote terminal unit would coordinate the control functions, activities, and communication of signals and data to the SCADA system at the OCC. In addition to instrumentation at each compressor station, meter station, and mainline valve station, other remote monitoring units would also transmit data to the SCADA computer at Anderson Bay. These units may include earthquake detection accelerometers, ground displacement sensors for sensitive slopes, or discrete pipeline monitoring devices for localized areas

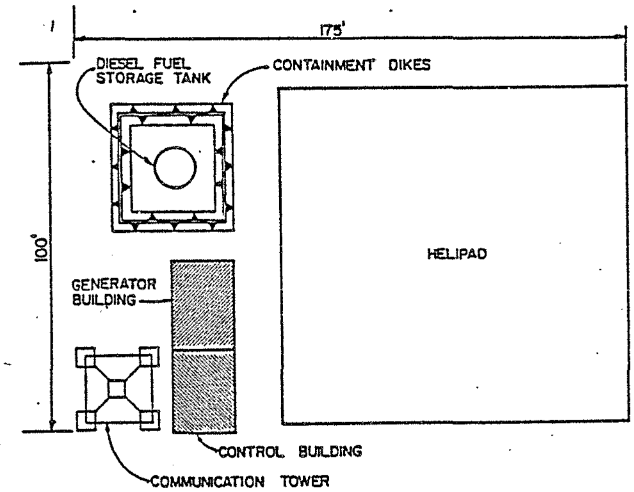


Figure 2.6-1
Anticipated Feed Gas Composition

affected by frost heave, should they become necessary during pipeline operations. Remote monitoring units would be connected to microprocessors that would collect and transmit the data to the OCC.

Auxiliary facilities along the pipeline system would be required to support operation and maintenance efforts. Block valves spaced regularly along the pipeline route would provide for sectional system isolation. Corrosion control facilities would be spaced regularly along the pipeline route to provide system cathodic protection and measurement capabilities. Gas metering facilities would be required at each end of the pipeline system in order to account for gas deliveries at Prudhoe Bay, gas deliveries to the liquefaction plant, and pipeline/compressor station fuel and to account for any system losses. A major maintenance facility would be located near Fairbanks. Material and equipment storage areas would be maintained along the pipeline to allow for responsive pipeline maintenance.

The proposed TAGS LNG plant and marine terminal would provide treatment, liquefaction, storage, and loading capabilities for natural gas to be liquefied and exported by tanker. Of the initial 2.3 BCF/D (average stream) of pipeline gas received at Prudhoe Bay, the equivalent natural gas product would be approximately 2.1 BCF/D for export at Anderson Bay.

The proposed LNG plant would liquefy natural gas utilizing cryogenic processes. Pipeline gas would first be prepared for liquefaction by passing through a series of driers and scrubbers to remove any moisture and impurities. After preparation, gas fed to liquefaction trains would be dry and clean.

Liquefaction of the natural gas would be accomplished by refrigerating the feed gas to a temperature of approximately -259°F. The refrigeration plant would consist of four liquefaction trains (units) operating in parallel. Each liquefaction train would produce LNG for transfer to a common storage facility.

The refrigeration requirements for liquefaction would be supplied by a series of closed-loop systems in each train. Each closed-loop system circulates refrigerant through a heat exchanger. Feed gas, also flowing through the exchanger, though confined to through-flow piping, would be chilled by the refrigerant. Resulting chilled natural gas would become LNG product. Refrigerant that became warm in the thermal exchange would be returned to the beginning of its closed-loop for recompression and cooling. Process designs that use various refrigerant gases and closed-loop refrigerant schemes are available. Designs for using a mixed gas refrigerant system or single gas refrigerant systems in series are available. Either system would provide the desired LNG product.

Refrigerants for the closed-loop systems would consist of propane, ethylene, methane, and possibly some nitrogen. Propane and ethylene would be from off-site sources; methane would come from the feed-gas stream. Nitrogen from the air separation unit would provide purge and utility nitrogen for the LNG plant. Storage for liquid nitrogen from the air separation plant would also be provided.

After feed gas is chilled and condensed into liquid by exchangers, it would flow into an LNG flash drum where LNG could be pumped to storage and vapor could be recovered for use as fuel gas. All refrigeration and power generation gas turbines would be fueled by feed gas, boil-off gas, and flash gas. During LNG tanker loading, feed gas make-up to fuel would be reduced to compensate for the vent gas from the tanker, which would be collected, compressed, and sent to the fuel system. A block flow diagram of LNG plant facilities is presented in Figure 2.6-2.

During conceptual design, liquefaction facility would be sized for pipeline throughput to the LNG plant at 2.3 BCF/D (average stream). At this rate, 2.1 BCF/D, or approximately 100,000 cubic meters of LNG, could be produced. An estimated 680,000 horsepower of refrigerant gas compression would be required to meet these preliminary design figure. According to preliminary design, an estimated total cooling load released to the atmosphere would be about 2.6 billion BTU per hour.

LNG product would be pumped from the final flash drum in each liquefaction train through a common header to the LNG tankage area. Storage would be provided by four tanks with 800,000-barrel capacity, which would operate at near or slightly above atmospheric pressure. The proposed total tank volume of 3,200,000 barrels would provide approximately five days of LNG storage at design production rates.

The tanks would be individually pressure controlled to avoid boil-off fluctuations with changing atmospheric conditions. Safety pressure and vacuum valves, sized for emergency conditions, would protect the tanks. Boil-off from LNG storage tanks would be compressed and returned to the process trains for reliquefaction or for fuel gas. The storage tank area would be surrounded by an impoundment system to contain any accidentally spilled LNG.

The LNG product from onshore storage tanks would be transferred through the LNG

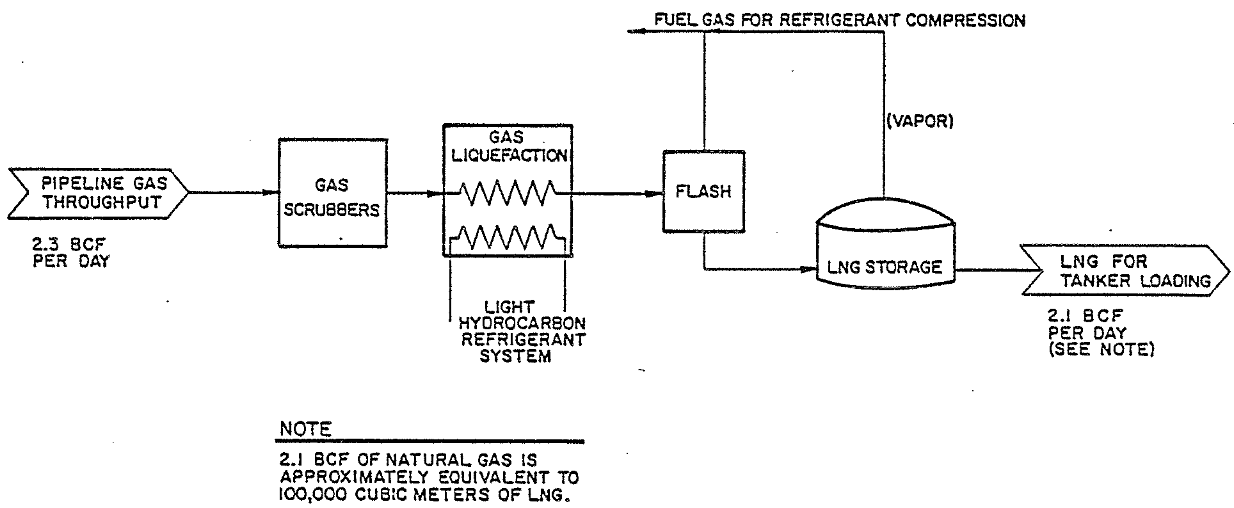


Figure 2.6-2
LNG Block Flow Diagram

loading system. LNG tanker vessels would be berthed at the marine terminal facility to receive LNG for export to the Asian Pacific Rim. Transfer piping would be sized that the system would be capable of loading two tankers simultaneously in a 12-hour period.

Conceptual design of loading facilities would involve a design loading rate of 70,000 barrels per hour (bph) per tanker. LNG would be transferred through the loading system by cryogenic pumps and gravity. The loading system would be maintained in a cold condition at all times.

Loading lines supported by trestle structures connect LNG storage tanks to the loading platform at the end of berth facilities. Special metallurgy pipe would be used for loading lines, to accommodate the very low LNG temperatures. Loading lines would be insulated between storage tanks and loading platforms to minimize LNG boil-off.

The two LNG tankers would be oriented approximately parallel to the shoreline in 50 feet of water (depth below MLLW) and have the capability of mooring in either the forward or aft position. Figures 2.2.1-8 and 2.2.1-9 present sketches for typical spherial and membrane LNG tankers with dimensions for both 125,000 and 165,000 cubic meter tanker designs.

A typical 125,000-cubic meter tanker would require approximately 66,000 ton of ballast under normal operating conditions. Sea water would be used for ballast should ballast water be taken on in any port areas, it would be exchanged for sea water on the open ocean. Polluted ballast water would not be disposed of in Prince William Sound. There would be no oily ballast water from LNG tankers due to the nature of the LNG containment vessels.

The loading operation at each berth would involve using articulated loading arms to span between the fixed platform facility and the floating vessel. Based on preliminary design, four loading arms would be sized at a 16-inch diameter for assumed loading rates of 70,000 bph. In addition, a single vapor return arm would serve to connect tanker boil-off with onshore vapor recovery facilities. Vapor return lines, also supported by trestle structures, would take LNG vapors back to the plant fuel-gas system or to the feed-gas stream for reliquefaction. In addition to a main LNG loading line automatic shut-off valve, each loading arm would have an automatic shut-off valve to prevent LNG spillage during emergency conditions.

The proposed TAGS LNG plant facility would be developed in accordance with the Pipeline Safety Regulations of the U.S. Department of Transportation. The Code of Federal Regulations Title 49, Subchapter D, Part 193 (49 CFR 193) prescribes Federal Pipeline Safety Standards for liquefied natural gas facilities. Analysis conducted by YPC indicates that the Anderson Bay site could be developed in compliance with 49 CFR 193. Recognizing the commitment to safety embodied in this code, it has been used as the basis for evaluation of the proposed LNG plant site, for development of a conceptual definition of the LNG plant, and for LNG plant safety planning. These regulations would be used as the primary standard for specific siting requirements, design, construction, equipment, operations, maintenance, personnel qualifications and training, fire protection, and security of the proposed LNG facilities.

2.7 TERMINATION

The project life of TAGS would depend on the availability of natural gas. If additional supplies should become available, the life of the facilities could be extended beyond the projected 30-year life of the project. The termination procedures to be implemented would be subject to appropriate existing federal, state, and local regulations in effect at that time. A full review of these procedures would be submitted by YPC during the "Authorization to Proceed With Construction" phase of the project.

2.8 PROPOSED MITIGATION MEASURES

2.8.1 Introduction

The following mitigation measures were developed by YPC to prevent and/or mitigate major adverse impacts. Where impacts were considered minor or of an extremely short duration, no mitigation measure was developed.

In addition to the mitigation measures contained in this EIS, the BLM and USACE would attach standard and special right-of-way stipulations to its right-of-ways grant. These stipulations would contain generic measures applied to all right-of-ways as well as site-specific measures which could be evaluated at the time the pipeline centerline is surveyed. For example, required surveys for cultural resources and protected animals could identify the need for site-specific stipulations.

Federal and state agencies can enforce mitigation measures and stipulations on federal, state, and private lands that are affected as a federal action.

Mitigation measures presented in this section are those that are anticipated to be implemented. These measures have been committed to by YPC; others are reasonably expected to be permit requirements of at least one or more permitting agencies.

The mitigation measures proposed by YPC were designed to accomplish the following purposes.

- Assure that the pipeline is structurally sound to minimize the potential for damaging accidents or leaks.

- Minimize the potential impacts to soils integrity and permafrost including considerations of hydrology and vegetation.

- Conserve limited resources, including water and gravel, along the entire route.

- Minimize impacts to wildlife, marine and aquatic habitat.

- Minimize environmental impacts due to spills, discharges and waste disposal.

- Minimize potential for damage to other structures, facilities and operations.

These purposes, if accomplished by the mitigation activities and techniques, described in 2.8.2 below, would fulfill YPC's stated purpose of constructing the pipeline in a cost-effective yet environmentally acceptable manner.

Mitigation measures proposed by the applicant are listed below under the categories of route selection, construction, and operations.

2.8.2 Pipeline Route and Compressor Station Selection

- Minimize the number of river and stream crossings.
- Avoid areas where icing occurs regularly.
- Provide adequate separation between the pipeline and other facilities in areas with high potential for subsurface flow to prevent impacts by frost bulbs on existing facilities.
- Reuse former TAPS facilities, borrow pits and sites as much possible.
- Select slopes that meet the required stability criteria.
- Identify cultural and historic resource sites and either avoid those sites if possible or excavate, if necessary.

2.8.3 Construction

- Design and implement a testing and monitoring program to ensure structural integrity of the pipeline.
- Design river and floodplain crossings at right angles to the direction of flow, if possible.
- Place the top of the pipe below the lowest bed profile that might develop as a result of scour in erosion prone areas.
- Limit construction and vegetation removal to rights-of-way to minimize impacts to vegetation.
- Backfill trenches with material equal to or better than that removed to minimize changes in channel characteristics with respect to scour and erosive forces.
- Use rip-rap or other bank protection techniques where needed.
- Schedule construction activities to minimize impacts to construction areas near critical water crossings and to prevent downstream impacts.
- Coordinate design and construction for highway, private roadways, access roads or highways with the adjacent fuel/gas with DOT/PF, Alyeska Pipeline Service Company or private landowner.
- For highways and major road crossings, utilize bypass roads around the crossing area, where feasible, to maintain traffic flow.
- Design crossings of below-ground foreign pipelines to minimize impacts to the foreign pipeline or respective rights-of-way.
- Along active faults elevate crossings on steel beams at grade or on vertical support members.
- Minimize the amount of disturbance due to ditching activities.
- Plan the ditching operation to minimize disturbance to right-of-way soils.
- Spread excess ditch spoil uniformly over workpad area or dispose of excess material in an authorized disposal site.

- Perform light grading of the right-of-way the year after construction of each segment of pipeline where localized settlement, erosion, or drainage problems occur.

- Use concrete coating, bolt or weights, or granular backfill material to avoid pipeline buoyancy problems.

- Incorporate erosion control practices with all elements of pipeline construction to provide for control of erosion, sedimentation production, and transport and deposition to allowable limits.

- Minimize gravel usage as much as possible through use of workpad designs utilizing thinner gravel overlay and winter construction.

- Where feasible, consider use of ice, snow, or ice and snow workpad to minimize potential disturbance and reduce use of mineral material volumes.

- Repair and reuse TAPS access roads where available.

- Implement techniques for mitigation of liquefaction-related problems where alignment changes are not feasible.

- After detailed evaluations and analysis of expected conditions, pipe stress evaluations, soil/pipe thermal evaluations, and constructability assessments, develop necessary frost heave mitigation measures. The primary mitigative measure would be use of increased pipe thickness. Other measures that might be utilized include such things as insulated pipe walls, insulated ditch, above-ground berms, or remove and replace frost-susceptible or thaw unstable material.

- Design measures to mitigate the impact of frost bulb growth on subsurface flow, including placement of insulation on the pipe and deep burial of the pipe.

- Where significant uplifts may occur over long pipeline lengths, establishment of cross drainage may be accomplished by a reduction of pipe cover for very short lengths or by initial burial of the pipeline deeper than normal and subsequently removing some or all of the uplifted soil.

- Evaluate winter construction as a possibility for redundant stream crossings because of more favorable flow conditions and minimum fishery resource impacts (except in areas upstream of fish overwintering).

- For sensitive slopes identified along the right-of-way, hand clear and stabilize by methods best suited to the particular area.

- Minimize environmental impacts during gravel extraction through:

  - Use of existing mineral material sites;

  - Selecting new sites that minimize the biological significance of habitat alteration;

  - Designing and developing upland sites to maximize potential for revegetation and minimize potential for erosion and adverse visual impact;

  - In floodplain sites, adherence to biologically accepted practices including those summarized in the FWS, 1980 guidelines manual.

- Utilize blasting control measures when blasting were proximate to existing facilities to avoid damage to those facilities.

- Schedule ditching operations to minimize periods during which ditches are open.

- Use ditch plugs wherever slope and soil conditions indicate the probability of excessive erosion along the ditch line.

- In sensitive stream areas, remove excess ditch backfill to designated spoil disposal areas.

- Draw water for hydrostatic testing and for snowpads only from designated surface water sources with the capacity to supply required volumes without adverse affects in the aquatic environment.

- In general, for water taken from fish streams and lakes, follow accepted ADF&G practices.

- Confine test water releases to designated areas and divert to settling basins as necessary to comply with discharge permit limitations.

- Utilize energy dissipaters where needed to avoid inducing erosion of the ground surface.

- Conduct clean-up of right-of-way in a manner to minimize disturbance to surface vegetation.

- Seed and fertilize disturbed areas as required, after cleanup is completed.

- Construct permanent erosion control facilities such as culverts, berms, and dikes to maintain long-term right-of-way stability.

- Emplace rip-rap on slope and stream embankments, as required, to mitigate erosion and minimize siltation of sensitive streams.

- In addition to right-of-way restoration, restore material sites, campsites, and temporary access roads to an acceptable condition and revegetate, as required. Generally, natural revegetation of disturbed areas is planned for long-term stabilization.

- Coordinate activities in the vicinity of all TAPS facilities with Alyeska Pipeline Service Company.

- Prepare detailed plan for reclamation of project construction areas. The plan will be submitted to appropriate federal and state agencies for approval prior to construction.

- Incorporate special features, as required, at pipeline crossings to ameliorate potential impacts.

- Develop mitigative measures where possible to address the potential impacts on surface and subsurface drainages.

- Provide for the uninterrupted movement and safe passage of anadromous fish during the construction and operation of the pipeline.

- Revegetate disturbed lands as soon as practical in accordance with schedules developed by the land management agencies and YPC.

- Construct and maintain containment dikes and other suitable structures around all temporary and permanent storage facilities for fuel and other hazardous substances. Further, a specific plan for the prevention of spills and the storage of such substances would be submitted to the appropriate agencies before construction disturbance of the pipeline corridor begins.

2.8.4 Operations Mitigation

- Utilize chilled gas operation for northern Interior permafrost areas and warm gas operation in southern areas where essentially permafrost-free conditions exist.

- Incorporate remotely controlled block valves for section system isolation. In addition to block valves required by regulations, block valves would be installed immediately upstream and downstream of meter stations, compressor stations, aerial river crossings, and fault crossings.

- Maintain and monitor erosion control practices and procedures during operations to provide for occurrences not anticipated during construction.

- Develop and incorporate into design stress analysis criteria to protect installed pipeline.

- Develop, implement and conduct a pipeline structural monitoring program.

- Decommission abandoned access roads by blocking access, removing culverts, or through surface reclamation.

- Incorporate an automatic shut-off valve at each loading area to prevent LNG spillage during emergency conditions.

- Develop design contingency earthquake and design operating earthquake plans and procedures.

- Discharge open ocean seawater ballast in U.S. waters from tankers.

- Incinerate sludges and skimmings from the oil/water separator in an approved incinerator.

- Use secondary treatment of combined wastewater from LNG plant and marine terminal before discharge into the receiving waters of Port Valdez, as per State and EPA requirements.

- Develop site drainage and erosion control designs to minimize sediment transport from facility sites.

- Use medium energy outfall diffuser to mix the freshwater effluent with sea water in a very short distance.

- Develop and implement a project control system and procedures to provide for detection of leaks and rapid system shutdown to minimize the release of gas in the event of a leak.

- As needed, incorporate design measures to mitigate any potential for thermal interaction between pipelines where adverse thermal impacts are likely to occur.

- Incorporate policies and procedures to ensure that the integrity of the TAPS pipeline will be protected during the construction, operation, and maintenance of the TAGS project.

- By appropriate policies and procedures, protect existing telephone and electric transmission lines, roads and other pipelines during construction, operation, and maintenance of the TAGS system.

- Design culverts so that velocity of streams through culverts does not exceed the rate where outflow erosion occurs or fish movement is impeded.

- Design intake structures to prevent impingement or entrainment of fish.

2.9 ALTERNATIVES

2.9.1 Introduction

An evaluation of criteria developed to identify and appraise environmentally acceptable and environmentally feasible routes to transport Prudhoe Bay natural gas to tidewater for liquefaction and transportation to Asian Pacific Rim markets is presented in Subsection 1.9.6. The results of this evaluation identified that none of the three Prince William Sound alternatives was ranked as superior to the YPC proposed TAGS project to Anderson Bay. This evaluation also identified that the Cook Inlet-Boulder Point alternative appears to be the best of the Cook Inlet alternatives evaluated. The no-project alternative is also discussed in this subsection.

2.9.2 Cook Inlet-Boulder Point Alternative

The Cook Inlet alternative pipeline route would originate in the vicinity of Livengood (Milepost 395 of the proposed TAGS pipeline alignment) and proceed in a southerly direction to Cook Inlet as shown in Alignment Map 3 at end of document. At Cook Inlet, the alternative pipeline route could proceed to one of three alternative sites evaluated in Subsection 1.9.7.5. These sites are at Harriet Point, Boulder Point, and Cape Starichkof. The results of the evaluation of criteria indicated that of the three alternative terminus locations and pipeline routes to reach the terminus locations, Boulder Point appears to be the most desirable of the Cook Inlet alternatives.

The Boulder Point alternative resulted in a pipeline length similar to that of the proposed TAGS project with the same number of compressor stations, whereas both Harriet Point and Cape Starichkof required a significantly more pipeline mileage and an additional compressor station. Both the pipeline route to Boulder Point as well as the site for the LNG would be located in less sensitive environments than either Harriet Point or Cape Starickof (see Subsection 1.9.7.5.

The project description presented in Subsections 2.2 through 2.7 would be the same for a project to the Cook Inlet-Boulder Point alternative. As identified in Table 1.9.5-5, , this alternative would require a 15-mile subsea pipeline across Cook Inlet from near Figure Eight Lake on the north side of Cook Inlet across to Point Possession and two additional elevated river crossings.

To reach Boulder Point on the Kenai Peninsula, a 15-mile subsea pipeline, as depicted in Figure 2.9.2-1, would be required to cross beneath Cook Inlet. Construction of the Cook Inlet subsea pipeline crossing would require the use of a large-pipeline lay barge capable of handling the concrete coated 36-inch diameter pipe. Welding of pipe joints and completion of the coating process at the joints would be accomplished on the lay barge, and the completed section would then be lowered to the sea floor. The pipe would then be buried using a jet sled equipped with high-capacity airlift pumps. Provisions for excavating and removing occasional boulder size material from the pipe alignment and trench would be incorporated in the construction plan.

Due to the extreme tidal fluctuations and currents found in Cook Inlet, a multipoint anchoring system would be required to hold the lay barge in position. The presence of the lay barge and its multipoint anchor system would result in the need for a traffic control system for vessels bound to and from the Port of Anchorage during the construction phase. Additionally, pipe burial depth should be sufficiently deep to provide adequate protection from anchor dragging or protection from scour.

Along the Cook Inlet-Boulder Point alternative, aerial crossings of the Tanana River, two crossings of the Nenana River,

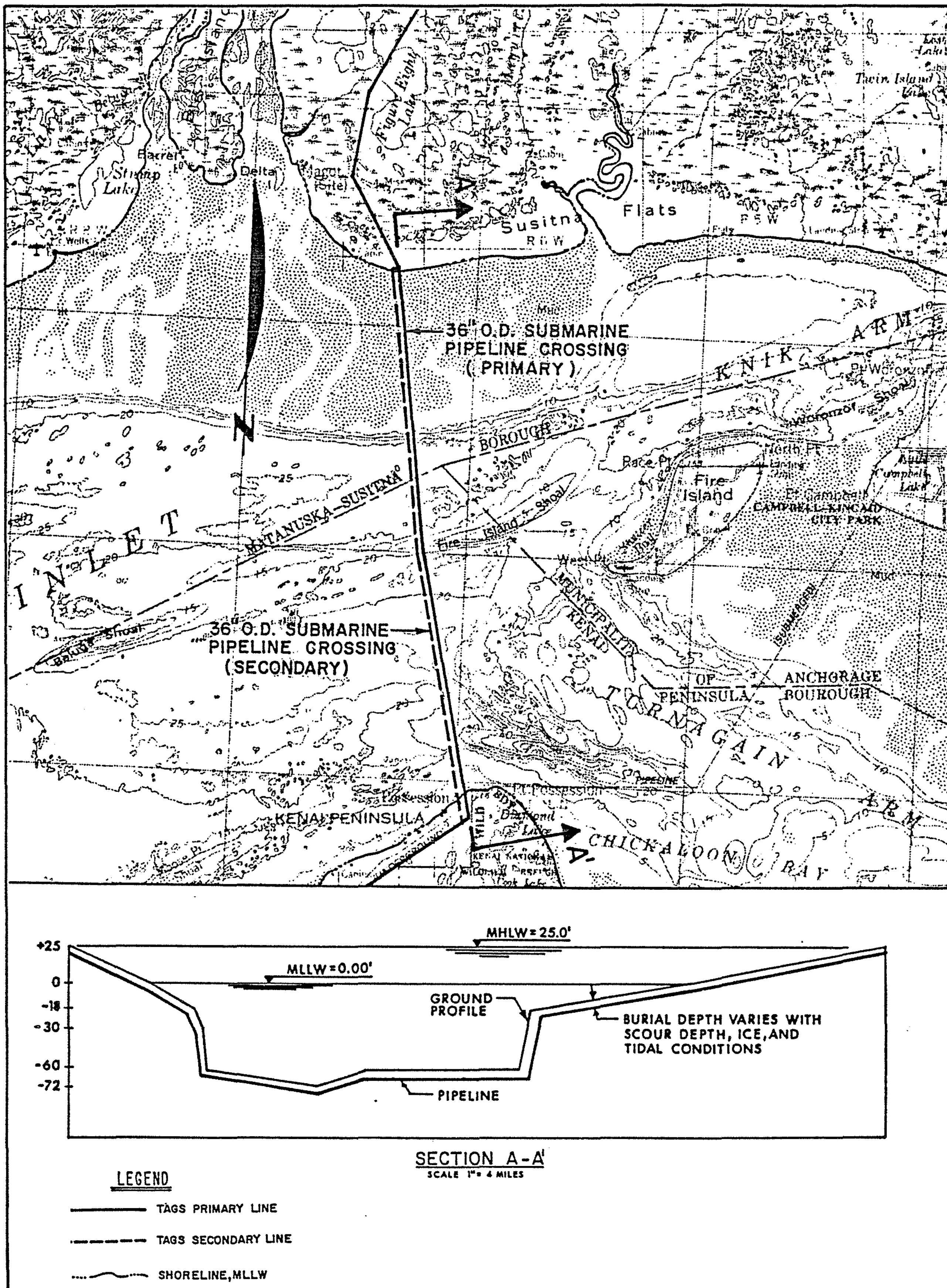


Figure 2.9.2-1 Cook Inlet Crossing for the Cook Inlet-Boulder Point Alternative

Hurricane Gulch, and Montana Creek would be required. These aerial crossings would be similar to those discussed in Subsection 2.3.3 and depicted in Figure 2.3.3-2. The exception would probably be the Tanana River crossing which, because of the width at the crossing point, would either require a fixed pier in the center of the river similar to that which would be used for the Yukon River (see Figure 2.3.4-4) or a span with pier abutments on an island in the river.

The alternative LNG site located at Boulder Point would be along the eastern shoreline of Cook Inlet just north of the constriction known as the East Foreland as shown in Figure 2.9.2-2. The LNG plant site and marine terminal configuration for this alternative site are shown in Figure 2.9.2-3. The facilities depicted for this site are described in Subsection 2.5.

2.9.3 No-Action Alternative

Under a no-action alternative the construction of facilities to transport natural gas to tidewater for conversion into LNG for export to the Pacific Rim markets would not occur, and producers would continue to reinject the excess natural gas not used for field or pump station fuel into the fields unless the authorized ANGTS were built. This alternative avoids all adverse effects associated with project implementation.

The no-action alternative would forego the economic benefits the proposed TAGS project would create, not only from direct and indirect employment during construction and operation, but also from the benefits of taxes and State of Alaska sale of its royalty gas. Estimates of the projects economic impacts from both a statewide and regional basis is presented in Environmental Consequences, Section 4.0. In addition to the loss of state revenue, the benefit of offsetting some of the unfavorable trade imbalance which presently exists with Japan, the Republic of Korea, and Taiwan would be lost to the United States.

Inherent in the initial decision to produce oil at Prudhoe Bay was the realization that natural gas would also be produced. At present there are more than 27 trillion cubic feet of proven reserves of natural gas in the field, with significant estimates for additional probable and possible reserves (most of the data concerning these reserves is confidential, [FPC 1975]). Due to the lack of an existing system to market these natural gas reserves, there is no incentive for producers to explore or to further develop existing or potential natural gas reserves.

2.9.4 Summary

The applicant's proposed project involves the transport and sale of natural gas from Alaska's North Slope to the Asian Pacific Rim markets. The potentially feasible alternatives for the project include construction and operation of a natural gas pipeline to a tidewater port in either the Prince William Sound or Cook Inlet regions of Alaska and shipment of LNG by tanker. Evaluation criteria were developed to consider the feasibility and preferability of various alternative ports in both the Prince William Sound and Cook Inlet regions and then applying these criteria to the alternative projects. The applicant's proposed Anderson Bay project was confirmed as the preferred site in Prince William Sound, and Boulder Point was determined to be the best Cook Inlet alternative.

The potential environmental consequences of constructing and operating a pipeline from Livengood to the Cook Inlet-Boulder Point were analyzed and compared with the consequences on the various disciplines for the proposed project.

The Cook Inlet-Boulder Point alternative pipeline alignment with an LNG plant and marine terminal at the Boulder Point site represents an alternative to the proposed project that is feasible and would be environmentally acceptable, though not

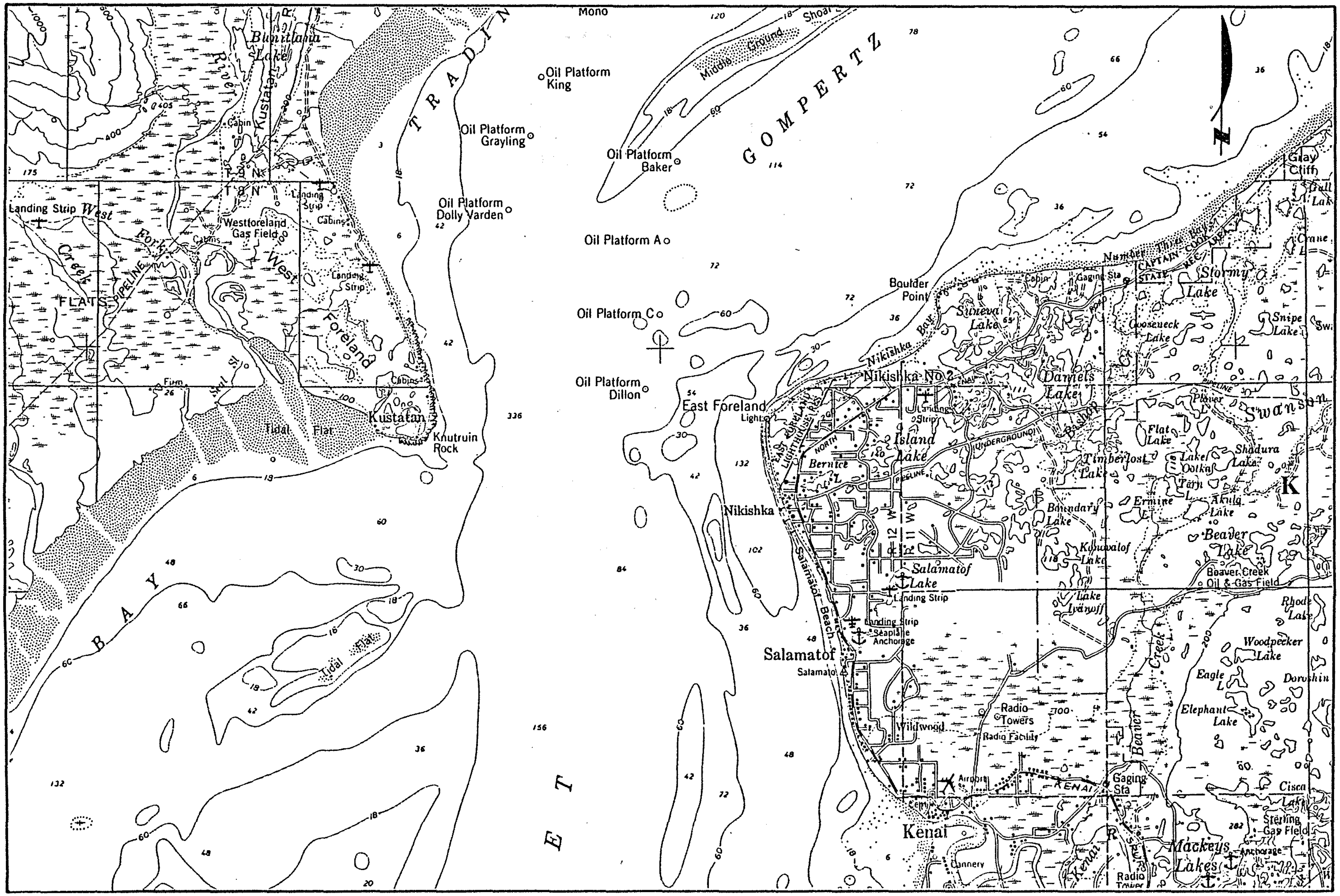


Figure 2.9.2-2 Boulder Point Location Adjacent to the East Foreland Area of Cook Inlet.

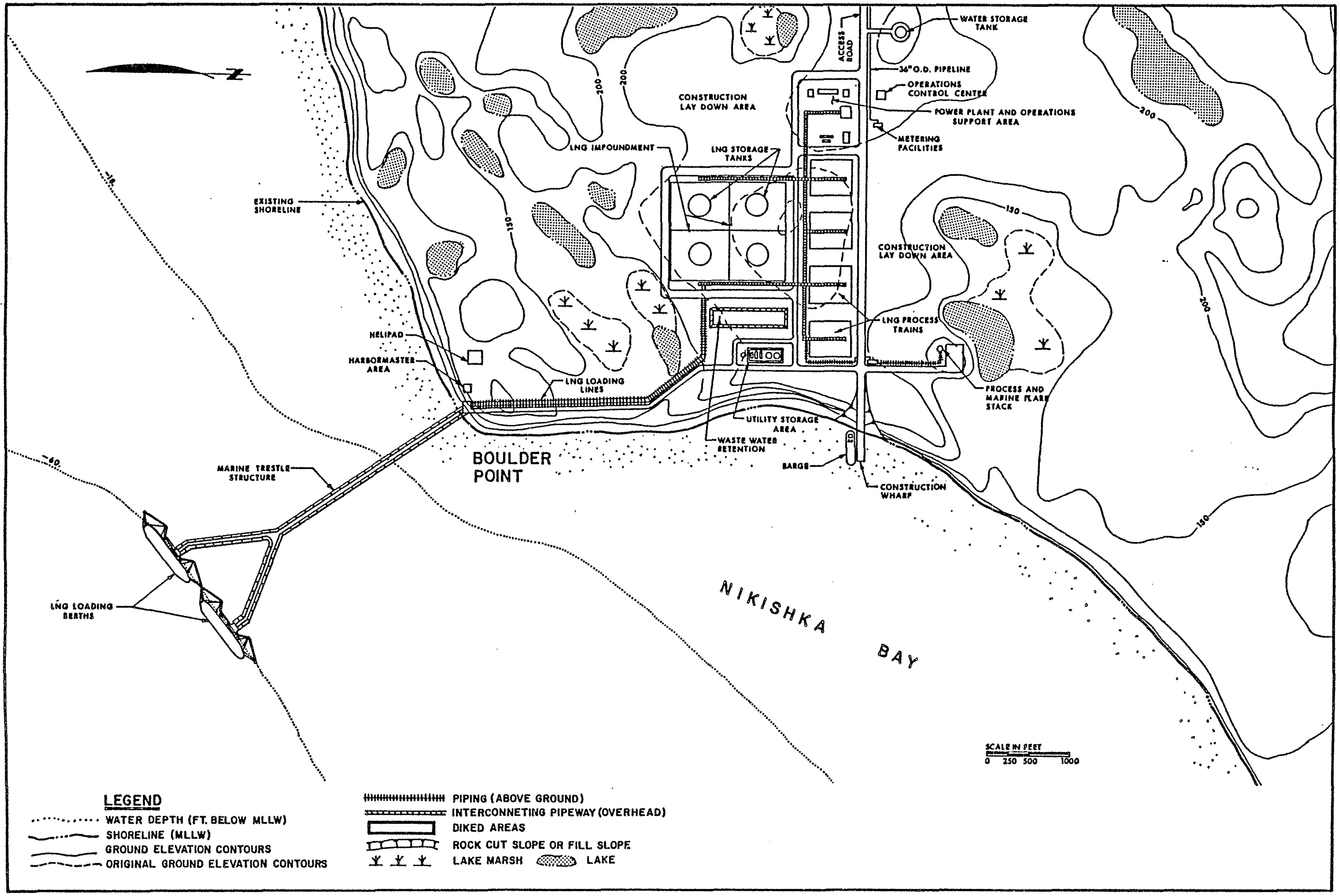


Figure 2.9.2-3 LNG Plant Site and Marine Termal Layout for the Boulder Point Alternative Site

environmentally preferred over the applicant's proposed project.

The no-action alternative was considered. The national, international, and statewide impacts of this alternative mainly include the lack of development of North Slope natural gas, the absence of the additional energy security and of improvement to the balance of payments, and the absence of the positive economic benefits to the state. The no-action alternative would mean that none of the impacts to the natural or human environment of Alaska described in this document would occur.

SECTION 3

AFFECTED ENVIRONMENT OF THE PROPOSED ACTION AND ALTERNATIVES

SECTION 3.0 AFFECTED ENVIRONMENT FOR THE PROPOSED ACTION AND ALTERNATIVES

3.1 INTRODUCTION

This section analyzes the environment that would be affected by the proposed Trans-Alaska Gas System (TAGS) from Prudhoe Bay to the Prince William Sound-Anderson Bay LNG plant site and terminal facilities and the Cook Inlet-Boulder Point alternative. The affected environment discussions for the proposed project varies with type of resources being considered--for some, the discussion is confined to the immediate area of the anticipated disturbance; for others, a more regional approach is used. Impacts to these areas are generally considered by discipline in appropriate sections of this document. Subsections summarize the important environmental impacts in each of these areas.

The area that would be occupied by the proposed TAGS project has been the subject of detailed study and analysis since the decision was made to develop the Prudhoe Bay area for the production of oil and natural gas. Initial environmental studies began in the early 1970s, culminating with the publication of a Final EIS for the TAPS project in 1972 and construction of the TAPS project from 1974 through 1977.

During the period of TAPS construction, three natural gas projects were proposed for the construction of a system to transport North Slope natural gas to U.S. markets by the Alaskan Arctic Gas Pipeline Company, the El Paso Alaska Company, and the Alcan Pipeline Company (subsequently Northwest Alaskan Pipeline Company). Two of these proposals were for an all-pipeline route and one was for a pipeline - LNG tanker system. EIS's were published for all three of these projects by the Department of the Interior (DOI) or the Federal Power Commission (FPC). Additionally, the Federal Energy Regulatory Commission (FERC) completed an FEIS for the Western LNG Cook Inlet proposal. Thus, the environmental description and assessment for consideration of the TAGS project include FEIS's for the:

- Proposed Trans-Alaska Pipeline, DOI, 1972.
- ANGTS, Proposed Alaska Arctic Gas Project, DOI, 1976.
- ANGTS, Proposed El Paso LNG Project, FPC, 1976a.
- Supplement, ANGTS, Proposed Northwest Alaskan Project (Alcan Project), FPC, 1976b.
- Cook Inlet LNG project, Proposed Western LNG Project, FERC, 1978.

The Affected Environment Sections of these previously prepared EIS's are adopted herein by reference and updated more recent information. Since socioeconomics appeared to be the key issue during the scoping process for the proposed action, it is the first subsection presented.

3.2 PROPOSED TAGS PROJECT TO ANDERSON BAY

3.2.1 Introduction

The following subsections describe the existing environment and ambient conditions for the proposed route from Prudhoe to Anderson Bay. The topics result from issues derived at scoping meetings and agency comments. In all cases the description begins at the northern end of the route and proceeds southward, unless there is a statewide description. The technical sections are grouped into similar or related topic whenever possible.

3.2.2 Socioeconomics

3.2.2.1 Statewide Socioeconomic Conditions

Oil and gas development is the dominant force in the Alaska economy because the industry supplies more than 90 percent of the state government's revenues. Table 3.2.2-1, which summarizes statewide population since 1960, shows that the most dramatic period of population increase occurred from 1974-1977--the TAPS construction era. In only three years Alaska's population rose from 348,100 to 481,000, an increase of 38 percent. However, the end of the pipeline boom was followed by an economic slump, high unemployment, and a 16 percent population decline. By 1980 Alaska's population had dropped to 401,900.

Alaska's economic downturn ended abruptly as skyrocketing oil prices quickly pushed the state's annual oil revenues (which had been only $500 million in 1977) past the $2.2 billion mark in 1980. These burgeoning state revenues were accompanied by an enormous increase in state government spending for operating expenses, low-interest loan programs, and capital construction projects. The state's population began a rapid increase in 1981 in response to construction employment and infrastructure development. That same year oil prices hit a record $37 per barrel, and in 1982 state oil revenues peaked at nearly $3.6 billion (See Table 3.2.2-1).

Between 1970 and 1985 Alaska's population grew an average of four percent annually, compared to less than one percent annually for the nation as a whole during the same period. In the decade between 1970 and 1980 Alaska's population increased by nearly 100,000 persons, but in the five years between 1980 and 1985 the state population grew by nearly 138,000.

These population trends are mirrored in Alaska's employment statistics. Total average annual statewide employment peaked in 1985 at 231,400. As shown in Table 3.2.2-2, the 150 percent increase in state employment between 1970 and 1985 was accompanied by significant shifts in the relative importance of various sectors. In 1970 government employment accounted for nearly 40 percent of the Alaska's wage and salary employment. By 1985 government represented less than 30 percent of the total employment. The most notable change was the declining role of federal employment in the state's economy. There were 17,600 federal workers in 1985, virtually the same number employed in 1970 when one Alaska worker in five worked for the federal government. By 1985, only one worker in 12 was a federal employee. State and local government employment grew at roughly the same rate as overall employment.

Between 1970 and 1985 more than two-thirds of Alaska's 140,000 new jobs were in the state/local government, trade, and service sectors. In 1985 there were more construction workers than federal employees. Finance, insurance, and real estate employment, which tripled between 1970 and 1985, exhibited the largest percentage increase but accounted for less than 6 percent of total employment. Transportation, communications, and public utilities employment growth was somewhat lower than the overall rate of employment increase. Only 14 percent of the new jobs created since 1970 were in basic industries such as mining (which includes petroleum development) and manufacturing (primarily timber and seafood processing).

Since statehood in 1959, most of Alaska's population growth has been concentrated in urban and suburban areas of the state. In 1985 about 44 percent of the state's residents lived in the Municipality of Anchorage. Alaska Natives, which constitute 16 percent of the statewide population, are Alaska's largest minority group. The remainder of the statewide population is 77 percent white, 3 percent black, and 4 percent other races. Nationally, 83 percent of the population is white, 12 percent black, and 5 percent other races.

A difference between Alaska's population and the nation's is age--Alaskans are younger. In 1980 the median age of Alaska residents was 26.1, compared to the national

Table 3.2.2-1 Alaska Statewide Socioeconomic Indicators 1960 to 1987

	Population		Employment		Oil Revenue(1)	
Year	Number	Percent(2) Change	Number	Percent(2) Change	Number ($)	Percent(2) Change
1960	230,400	--	N/A	--	N/A	--
1961	236,700	2.7	N/A	--	N/A	--
1962	242,800	2.6	N/A	--	N/A	--
1963	249,900	2.9	62,090	--	N/A	--
1964	253,200	1.3	65,380	5.3	N/A	--
1965	265,200	4.7	70,530	7.9	N/A	--
1966	271,500	2.4	73,127	3.7	N/A	--
1967	277,900	2.4	76,784	5.0	N/A	--
1968	284,900	2.5	79,803	3.9	N/A	--
1969	294,600	3.4	86,565	8.5	N/A	--
1970	302,583	2.7	92,467	6.8	N/A	--
1971	319,600	5.6	97,584	5.5	47.0	--
1972	329,800	3.2	104,243	6.8	48.4	3.0
1973	336,400	2.0	109,851	5.4	50.3	3.9
1974	348,100	3.5	127,200	15.8	80.2	59.4
1975	384,100	10.3	160,900	26.5	90.4	12.7
1976	409,800	6.7	173,100	7.6	391.5	333.1
1977	481,000	17.4	164,200	-5.1	477.6	22.0
1978	411,600	-14.4	166,900	1.6	441.5	-7.6
1979	413,700	0.5	166,600	-0.2	821.6	86.1
1980	401,851	-2.9	171,100	2.7	2,256.5	174.6
1981	435,200	8.3	186,500	9.0	3,304.3	46.4
1982	460,837	5.9	201,000	7.8	3,574.8	8.2
1983	495,290	7.5	214,300	6.6	3,026.6	-15.3
1984	523,048	5.6	225,000	5.0	2,861.6	-5.5
1985	539,600	3.2	231,400	2.8	2,743.5	-4.1
1986(3)	545,299	1.0	N/A	--	2,657.9	-3.1
1987(3)	543,900	-0.2	N/A	--	1,011.0	-62.0

(1) Total unrestricted petroleum revenue in millions of dollars
(2) Percent change from prior year
(3) Figures for 1986 and 1987 are projected estimates

Sources: Alaska Department of Labor, Research and Analysis Section; "Revenue Sources," Alaska Department of Revenue, Division of Petroleum Revenue, December 1986.

Table 3.2.2-2 Distribution of Employment, by Sector
Statewide, Fairbanks, and Anchorage
1970 and 1985 Comparisons

Industrial Sector	1970 Number	1970 Percent	1985 Number	1985 Percent	Percent Increase 1970-1985
STATEWIDE					
Mining	2,994	3.3	9,400	4.1	214
Construction	5,400	5.9	18,600	8.0	244
Manufacturing	7,838	8.6	11,800	5.1	51
Tran/Com/Utility	9,109	10.0	19,100	8.3	110
Trade	15,357	16.9	46,300	20.0	201
F.I.R.E.*	3,098	3.4	12,800	5.5	313
Service & Miscelleous	11,627	12.7	45,499	18.6	289
Federal Government	17,100	18.8	17,600	7.6	3
State/Local Government	18,450	20.3	50,400	21.8	173
TOTAL	90,974	100.0	231,400	100.0	154
FAIRBANKS					
Mining	86	0.6	200	0.7	133
Construction	1,255	8.7	3,100	10.6	147
Manufacturing	249	1.7	600	2.0	141
Tran/Com/Utility	1,646	11.4	2,900	9.9	76
Trade	2,614	18.1	6,200	21.2	137
F.I.R.E.*	518	3.6	1,000	3.4	93
Service & Miscelleous	1,725	11.9	5,800	19.8	236
Federal Government	2,533	17.5	2,700	9.2	7
State/Local Government	3,825	26.5	6,800	23.2	78
TOTAL	14,451	100.0	29,300	100.0	103
ANCHORAGE					
Mining	958	2.3	4,200	3.7	338
Construction	3,514	8.4	8,900	7.7	153
Manufacturing	1,018	2.4	2,800	2.4	175
Tran/Com/Utility	3,907	9.3	10,000	8.7	156
Trade	8,617	20.5	27,700	24.1	221
F.I.R.E.*	1,980	4.7	8,700	7.6	339
Service & Miscelleous	6,455	15.4	26,400	23.0	309
Federal Government	9,509	22.6	9,800	8.5	3
State/Local Government	6,037	14.4	16,400	14.3	172
TOTAL	41,995	100.0	114,900	100.0	174

* Finance, Insurance, and Real Estate

Source: Alaska Department of Labor, Research, and Analysis, Statistical Quarterly, various issues.

average of 30. Alaska also consistently has had fertility rates above the national average. Between 1980 and 1985 the age group that experienced the highest growth rate was the 25 to 34 years old segment--young adults in the prime ages for family and household formation. Alaska males outnumber females 53 percent to 47 percent, compared to the U.S. as a whole where females outnumber males 51 percent to 49 percent.

Alaska has traditionally had a young, mobile work force due to the preponderance of highly seasonal jobs in construction, fishing and fish processing, recreation and tourism, and mining. Peak unemployment normally occurs during winter.

Between 1985 and 1986 Alaska's population grew only 1 percent, which is less than the rate of natural increase, and which indicates net outmigration from the state.

Alaska has a vast, modern infrastructure of public and private facilities such as roads, schools, shopping centers, airports, housing, ports, receation facilities, utilities, and office buildings. These developments have reshaped the skylines of Alaska's cities, but major housing, transportation, school, and utility improvements have also been made in virtually every rural village. The availability of this vast infrastructure is in marked contrast to the inadequate transportation, communication and public utility facilities, overcrowded schools, and housing shortages which existed prior to construction of the oil pipeline.

3.2.2.2 Regional Socioeconomic Conditions

The following section gives an overview of existing socioeconomic conditions in regions and communities which would be affected by the construction and operation of TAGS. The location of communities within 50 miles of the TAGS corridor are shown on the maps in Figure 3.2.2-1.

3.2.2.2.1 North Slope Borough

The North Slope Borough (NSB), created in 1972, includes eight Native villages and a number of military and industrial sites--most notably the Prudhoe Bay oil field. Although none of the borough's villages is located within 50 miles of the pipeline corridor, the first 180 miles of the proposed TAGS pipeline route and two compressor stations would be located within the borough and subject to local property taxes.

Table 3.2.2-3 summarizes population trends for the four North Slope Borough villages, Anaktuvuk Pass, Barrow, Kaktovik, and Nuiqsut. These communities have all experienced substantial growth since 1970, particularly in the 1980-85 period when they grew at an average rate of more than 37 percent. This growth is attributable to several factors including: 1) high immigration and low outmigration by Natives due to the availability of a larger number of relatively high-paying jobs with the North Slope Borough, 2) the construction of new housing and other amenities, 3) new elementary and high schools in the villages so students did not have to be sent to distant boarding schools, and 4) a high birth rate.

Statistics on the oil industry and construction workers based at Prudhoe Bay and other locations are difficult to collect and maintain because of high seasonal variation in employment. Since 1980 the number of workers based at Prudhoe Bay and adjacent fields has typically exceeded the population of all the North Slope Borough villages. In 1983 estimates of the Prudhoe Bay work force ranged from 5,300 to 7,000.

The dominant force in the North Slope economy is NSB tax revenues from the Prudhoe Bay and adjacent developments. Table 3.2.2-4, which summarizes North Slope property values from 1972 to 1986, shows that taxable property in the NSB rose from only $250 million in 1972 to $3.6 billion in 1977 when the oil pipeline was completed.

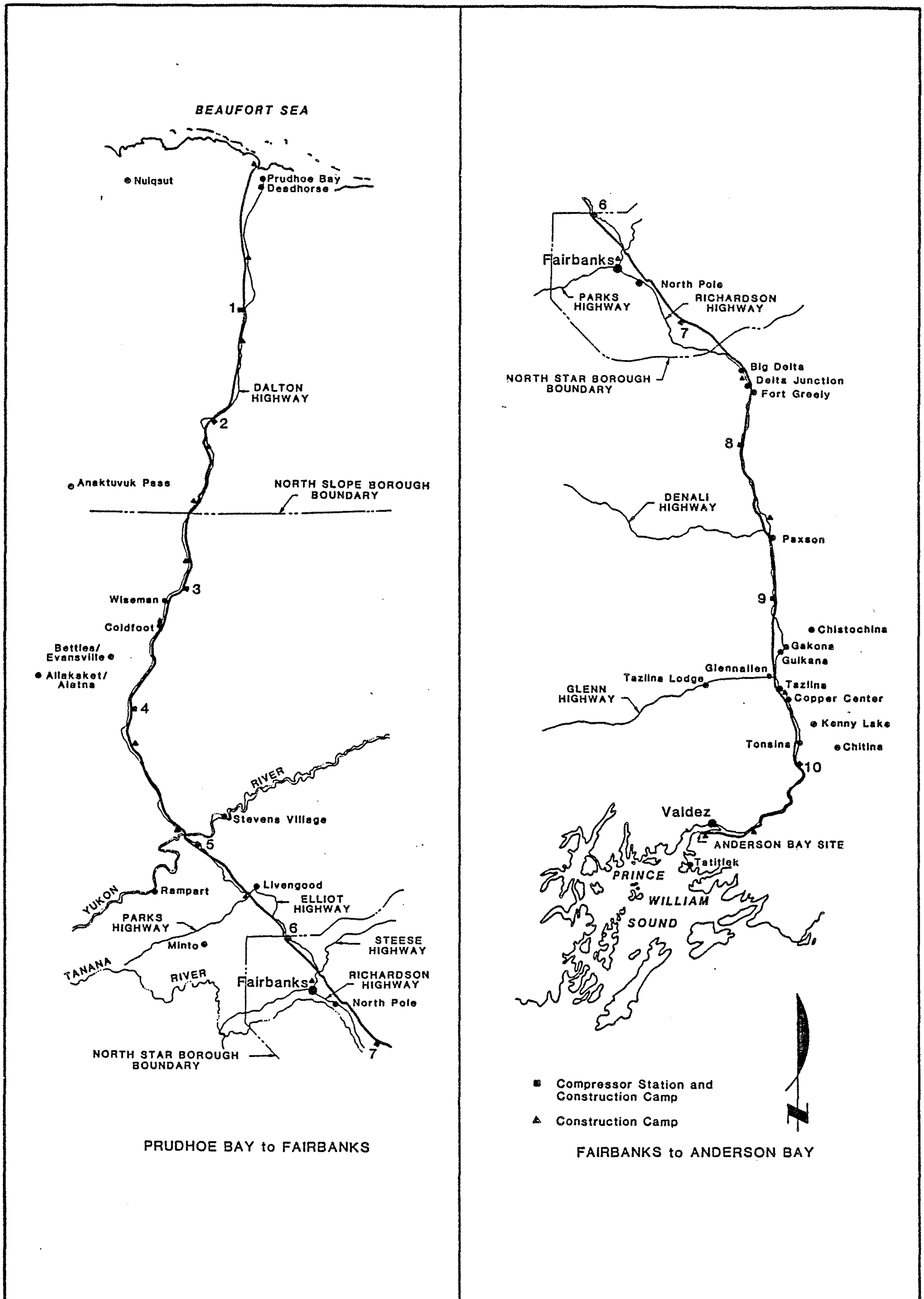


Figure 3.2.2-1 Location of Communities within 50 Miles of the Proposed TAGS Project

Table 3.2.2-3 Proposed TAGS Corridor Population Statistics
1970, 1980, and 1985 Comparisons

Location	1970	1980	1985	Percent Change 1980-1985
North Slope Borough (NSB) - Villages				
Anaktuvuk Pass	99	203	278	36.9
Barrow	2,104	2,267	3,075	35.6
Kaktovik	123	165	220	33.3
Nuiqsut	*	208	332	59.6
TOTAL	2,326	2,843	3,905	37.4
NSB - Other				
Prudhoe Bay	N/A	N/A	N/A	--
Pump Stations #1 thru 4	*	N/A	80	--
TOTAL	N/A	N/A	N/A	--
Between NSB and FNSB - Villages				
Wiseman	N/A	N/A	30	--
Bettles/Evansville	57	94	88	-6.4
Allakaket/Alatna	174	163	188	15.3
Stevens Village	74	96	110	14.6
Rampart	36	50	48	-4.0
Minto	168	153	231	51.0
Livengood				
TOTAL	509	556	695	25.0
Between NSB and FNSB - Other				
7-Mile DOT	*	N/A	10	--
Yukon Crossing	*	B/A	9	--
Nolan/Linda/Emma/Tamway	*	N/A	26	--
Coldfoot	*	N/A	15	--
Pump Stations #5 thru 7	*	N/A	60	--
TOTAL	*	N/A	120	--
Fairbanks North Star Borough (FNSB)				
City of Fairbanks	14,771	22,645	27,099	19.7
City of North Pole	265	724	1,640	126.5
Other	30,828	30,614	46,340	51.4
TOTAL	45,864	53,983	75,079	39.1
Delta Area				
Delta Junction	703	945	1,207	27.7
Fort Greely	1,820	1,635	1,832	12.0
Other (including Pump Station #9	609	1,797	1,846	2.7
TOTAL	3,132	4,377	4,885	11.6
Glennallen/Copper Center				
Chitina	38	42	63	50.0
Chistochina	33	55	80	45.5
Copper Center	206	203	174	-14.3
Gakona	88	87	87	0.0
Glennallen	363	511	929	81.8
Gulkana	53	104	104	0.0
Kenny Lake	N/A	--	--	--
Paxson	N/A	30	25	-16.7
Tazlina	N/A	31	104	235.5
Pump Stations #10 thru 12	*	N/A	40	--
TOTAL	781	1,063	1,606	51.1
Valdez	1,005	3,079	3,687	19.7

* Information not available

Sources: 1970 and 1980 Census; Alaska Department of Community and Regional Affairs; 1985 estimates for the area between the North Slope Borough and the Fairbanks North Star Borough were taken from the Utility Corridor RMF/EIS.

Table 3.2.2-4 Full Taxable Property Value
Municipality of Anchorage, Fairbanks North Star Borough,
North Slope Borough, and the City of Valdez
1970 to 1986

	Value in Millions of Dollars			
Year	Anchorage	Fairbanks	North Slope	Valdez
1970	1,106	305	--	35
1971	1,399	341	--	61
1972	1,661	391	250	47
1973	2,010	476	203	50
1974	2,302	567	256	94
1975	2,935	795	561	228
1976	3,740	1,237	1,794	545
1977	4,538	1,589	3,570	1,212
1978	5,269	1,905	4,716	1,670
1979	6,543	2,305	5,111	1,653
1980	7,495	2,312	5,818	1,748
1981	8,003	2,607	6,705	1,743
1982	10,612	2,996	8,269	1,701
1983	10,867	3,357	10,076	1,697
1984	13,199	3,628	12,355	1,720
1985	15,755	4,211	12,877	1,740
1986	19,343	4,727	13,571	1,693

Note: Collection of these statistics is required under AS 14.17.140, "Determination of Full and True Value by Department of Community and Regional Affairs."

Source: Alaska Department of Community and Regional Affairs, Division of Municipal and Regional Assistance, Office of the State Assessor.

In 1986 the taxable property in the NSB totalled $13.6 billion. By comparison, taxable property in Anchorage totals $19 billion. In FY 1974 the NSB collected only $3.5 million in property taxes. By FY 1986 the borough's tax revenues totalled $236 million. More than 95 percent of the borough's assessed valuation is oil industry-related property.

These property tax revenues have enabled the local government to collect hundreds of millions of dollars in property taxes and borrow more than $1 billion to fund a vast capital improvement program. North Slope Borough employment statistics for 1985 showed a total of 9,392 jobs within the borough, and most are located at Prudhoe Bay. Nearly all employment in Barrow and other borough villages, however, was with the government--132 federal workers, 35 state employees and 1,402 local government workers. Much of the local government employment in this period was actually construction work on local capital improvement projects.

3.2.2.2.2 Corridor Villages (Between North Slope Borough and Fairbanks North Star Borough

The discussion that follows gives an overview of the small communities, villages, and industrial sites located south of the NSB and north of the Fairbanks North Star Borough (FNSB) and within 50 miles of the proposed TAGS corridor. As summarized in Table 3.2.2-4, in 1985 this area had a population of more than 800 person, 80 percent Alaska Native.

Wiseman, an historic mining community, is located 200 miles northwest of Fairbanks very close to the TAPS pipeline. In 1985 Wiseman had about six families for a total of 30 permanent residents. The Wiseman economy is tied to mining and Dalton Highway transportation. Two guiding services are based there.

Bettles/Evansville is located on the south bank of the Koyukuk River 180 air miles northwest of Fairbanks. During winter residents maintain an ice road between the community and the Dalton Highway. The 1980 Census enumerated 94 residents, and the 1985 population was about the same. Bettles Field is the major airstrip in this region, and air support services are an important part of the local economy. The Gates of the Arctic National Park headquarters and several guiding services are based in Bettles. The community has a lodge, two general stores, fuel service, and an FAA flight service station.

In addition to Evansville there are five other small Native villages in the area with a combined population of nearly 600, more than 90 percent of which is Native. These villages have subsistence-based economies with only a few cash employment opportunities, usually with the school or village council programs. BLM firefighting and local construction projects furnish opportunities for cash employment during summer. Allakaket and Alatna, population 188, are located across from one another on the Koyukuk River. Alatna was originally settled by Eskimos from the Kobuk River area and Allakaket is an Athapaskan Indian village. Stevens Village, population 95, is located on the north bank of the Yukon River and is the closest community to the Yukon River bridge. Rampart, population 48, is located on the south bank of the Yukon River. Minto, population 231, is located on the Tolovana River. Minto is the only Native village in this region with road access to Fairbanks. Road access combined with a high birth rate, new housing, new water and sewer system, new school, and other amenitites have contributed to the community's growth.

Livengood is a primarily white community located near the junction of the Elliott and Dalton Highways. No population figures are available. Livengood provides a rest stop for travelers along the highways. During construction of the TAPS a construction camp was located there.

TAPS Pump Stations No. 5 through 7 are located in this region. Each pump station has a full-time staff of about 20. Coldfoot was the site of one of Alyeska's camps during construction of TAPS. Later the camp was taken over by the Alaska Department of Transportation and Public Facilities (DOT/PF) as a state camp in about 1980 BLM issued a lease to an individual who established a service center for traffic along the Dalton Highway. In 1985 this center had a population of 45 including 31 adults and 14 children. DOT/PF has a transportation center and the Alaska State Troopers maintain a station at Coldfoot.

DOT/PF employs eight people at the Yukon crossing during summer . The transportation center has a gas station, restroom facilities, and staff housing. There are more than 25 people living at several scattered mine sites on Linda Creek, Emma Creek, and Tramway Bar.

Propect Creek, near the former Alyeska Prospect Creek construction camp, is currently occupied by about seven households. The settlement is near Pump Station 5. Most residents are DOT/PF employees who maintain the Dalton Highway.

3.2.2.2.3 Fairbanks North Star Borough

The FNSB is Alaska's second largest population center. It is located approximately midway between Prudhoe Bay and Valdez. Fairbanks is the transportation, trade, and service center for the vast interior of the state. In 1985 the FNSB had an estimated population of about 75,000, a 39 percent increase over its 1980 population of 53,983 persons. In 1976, during construction of TAPS, Fairbanks' population reached more than 70,000, but it fell sharply in the postpipeline period. From 1980 to 1985 the Fairbanks experienced an economic boom fueled by increased state spending. In 1985 the economy began to level off, but this was offset somewhat in 1986 by additional military personnel.

Between 1970 and 1985 Fairbanks' average monthly employment more than doubled, from 14,451 to 29,300. During the peak of pipeline construction (1974-77) Fairbanks employment reached 30,407. As shown in Table 3.2.2-2 the two major changes in the Fairbanks economy since 1970 have been the decreasing importance of federal government employment and the increasing role of service employment. Employment in construction, transportation, communications, and utilities has grown faster than overall employment. Pump Station No. 8, near Salcha, employs about 25 local residents, most of whom live in the North Pole area. Alyeska has about 16 other employees in Fairbanks.

One of the most significant legacies of the TAPS has been the increased tax base for pipeline and compressor stations located within the FNSB. In 1977 the oil and gas property constituted about 37 percent of the FNSB's total assessed valuation. In FY 1986 it accounted for only 18 percent of the FNSB tax base. The value of taxable property in the FNSB rose from $305 million in 1970 to 2.3 billion in 1980 to $4.7 billion in 1985.

3.2.2.2.4 Delta Area

The Delta area, located about 100 miles southeast of Fairbanks at the junction of the Alaska and Richardson highways, includes the cities of Delta Junction, Big Delta, and Fort Greely (an Army post). Delta Junction does not assess municipal sales or property taxes.

The most current population information available for Delta Junction comes from a local survey made in 1984, which estimated the area had 5,458 residents-1,175 within the city of Delta Junction and 4,284 outside the city. This represents increase of 25 percent over the 1980 population of 4,377.

Most private employment in the Delta Junction area is in highway-related services and small retail businesses. In 1978 the state began the Delta Agricultural Project to grow cereal and feed grains for state and export markets. Although nearly 85,000 acres have been cleared for agriculture, in 1986 only about 17,000 were under cultivation. The project has not been an economic success due to falling world grain prices and the lack of processing and export facilities.

Except during construction of the oil pipeline, Ft. Greely has been the area's major employer. A TAPS construction camp 8 miles north of the city had 1,550 workers in 1975. In January 1987 only about 20 persons were employed at TAPS Pump Station No. 9 located about 8 miles south of Delta Junction. Alaska Department of Labor statistics for 1985 show average annual civilian wage and salary employment for the area at 776--353 federal government workers, 15 state employees, 151 local government employees (primarily school district personnel), and 257 workers employed by private businesses. However, due to the number of farmers and other self-employed people, private sector employment is somewhat underestimated in these figures. Problems with the agricultural development, combined with a statewide downturn in economic conditions, have caused a serious slump in the local economy. There is presently a high vacancy rate in rental housing and a large number of homes are for sale.

3.2.2.2.5 Glennallen/Copper Center Area

The Copper Center-Glennallen region, with a total population of approximately 1,600 persons, is located about midway between Delta Junction and Valdez. Most of the support services for the area are located in Glennallen, a primarily white community with a 1985 population of 929. The largest Native community in the region is Copper Center, which has a population of 174.

Seven other small communities (Chitina, Sourdough, Gakona, Gulkana, Upper Tonsina, Kenny Lake, and Paxson), with a total population of about 781, are in the region. All of these communities are located adjacent to the proposed TAGS corridor except Kenny Lake, which is situated 8 highway miles away, and Chitina, which is 30 highway miles from the corridor. None is incorporated. Their only regional governmental organization is a rural school advisory board. Native residents are also represented by AHTNA, the Native regional corporation, and Copper River Native Association, a regional nonprofit corporation. Some Native communities also have traditional village councils.

Two TAPS camps, Glennallen and Tonsina, were located in this region during pipeline construction. The total number of workers here peaked at nearly 2,300 in October 1975.

The recent employment information for this area is for 1984, when there was a total of 701 jobs including 32 federal employees, 127 state workers, 93 local government employees, and 449 private employees.

3.2.2.2.6 Valdez

Valdez originated as part of a major transportation route to the Interior. That role ended in 1923 during gold rush days with completion of the Alaska Railroad between Seward and Fairbanks. Valdez briefly became a busy port again during World War II. When Alaska became a state, Valdez had only 555 residents. During 1964 the city was relocated 4 miles southwest to a new townsite after much of the community was destroyed by an earthquake tsunami.

The role of Valdez as a major port was revived when it was chosen as the southern terminus for the TAPS. By 1970 the population of Valdez was 1,005. During peak pipeline construction in 1976, the population of Valdez swelled to more than 8,000, but by 1980 had declined to 3,079. In 1985 Valdez had a population of 3,687, a 360 percent increase since 1970 and a modest growth of 20 percent since 1980.

Prior to construction of the pipeline, government accounted for more than 60 percent of the employment in Valdez. The largest employer was Haborview Development Center, a state facility for the mentally and physically handicapped. In 1968 state and local government accounted for 69 percent of the jobs in Valdez. In 1976, during the peak of pipeline construction, total employment rose to 4,584, with more than 25 percent of the jobs in government employment.

In 1985 the total employment in Valdez was 1,850--15 federal government workers, 399 state employees, 311 local government workers, and 1,125 employees of private companies. About 200 people are employed by Alyeska.

Table 3.2.2-4 summarizes the enormous increase in the Valdez tax base which occurred due to construction of TAPS. In 1970 Valdez had an assessed valuation of only $35 million. In 1978 the assessed valuation was $1.7 billion and has remained fairly constant at that level. The oil and gas property within the city limits accounts for more than 90 percent of the community's assessed valuation. However the depreciation in the value of TAPS is expected to seriously erode the community's tax base over the next two decades.

3.2.3 Land Use and Ownership

3.2.3.1 Introduction

The proposed pipeline with its associated compressor stations and LNG plant and terminal have the potential to alter the present land use of the existing pipeline corridor to a certain extent. The following subsection discusses the existing land use of the corridor and the nearby area in order to establish a framework for the discussion of potential TAGS project impacts to land use.

3.2.3.2 General Land Use Patterns

The proposed TAGS project would be built primarily on federal and state land within an existing utility corridor that contains a public/private road, a major oil pipeline, and lands that have been authorized to contain chilled gas ANGTS pipeline. Therefore, the corridor area and its vicinity is already partially industrialized, even though it may be surrounded in many areas by undeveloped, essentially inaccessible country.

Since the utility corridor was established by the federal government in 1971, portions have been transferred to state and Native ownerships. This is especially true between the Yukon River and Fairbanks and in the Copper River drainage. Appendix K shows the generalized land ownership along the route TAGS proposes. Presently land ownership along this route is approximately 45 percent state (either patented, tentatively approved, or pending), 50 percent federal (under BLM, military, or USFS jurisdiction), 5 percent Alaska Native (selected, but not approved, under the Alaska Native Claims Settlement Act), or in private ownership.

In the Prudhoe Bay area the land is primarily state-owned industrial (oilfield development and production), with some sport and subsistence hunting outside the lease area and pipeline corridor and fishing along the coast and the Sagavanirktok River. Sport hunting-related land use has increased with the development of the oil field, while subsistence use has decreased due to restrictions placed on leased state lands.

Federal lands located north of the 68-degree parallel close to TAGS have been initially screened for wilderness opportunities. Lands determined to possess wilderness characteristics are not available for any use until such time as Congress releases them. Small portions of the preferred TAGS routing near TAPS Pump Station No. 3 have been relocated to less desirable sites pending Congressional decisions.

From Prudhoe to Fairbanks, the primary use of the area near the corridor is mineral extraction, including gravel and gold mining, hunting and fishing, and as an entryway for recreationists. Hunting, both sport and subsistence, is a primary land use along this section but is greatly inhibited by the restriction on discharge of firearms within 5 miles of the Dalton River Highway Corridor Bill. Gold mining occurs primarily from the Chandalar Shelf to Fairbanks, mostly on small streams and tributaries. Gravel mining occurs along the entire route. TAPS construction alone opened 270 borrow pits (FPC/1976a). Considerable gravel resources would be required for the proposed construction.

The proposed route passes through some farming areas along the corridor, primarily near Fairbanks and the Delta Junction area. The primary crop is barley for feeding livestock.

The route corridor from Fairbanks to Valdez passes through partially more developed lands with a number of peripheral roads and developments. Prevailing land use is typical of a major transportation route through a thinly populated region. Fishing and hunting are still very important uses, but there are many small towns and lodges along the route which depend on travelers for cash income. Recreation is also an important use in this area.

Valdez area land uses are primarily recreation, transportation, and light industrial. Those activities include sightseeing and tourism, the state marine transportation system and the Richardson highway, and the TAPS terminal, respectively.

The forestry potential along the route is only slight to moderate. Much of the commercial grade timber involves pure stands of white spruce, birch, and balsam poplar along the floodplains. Present timber usage includes logs for homes and outbuildings and for mining and other miscellaneous local construction.

Land-use plans exist for much of the region, including the North Slope Borough's Comprehensive Plan and the Coastal Management Program, the Fairbanks North Star Borough Land Use Plan and other ordinances, the Delta and Gulkana Wild and Scenic Rivers Plan, the Copper River Basin Land Use Plan, the Valdez Coastal Management Program, and the Valdez Area Land Use Plan. Two government installations are crossed by the pipeline at Poker Flats and Nasa Flats near Fairbanks. Also considered were the BLM Corridor Management Framework Land Use Plan and the Denali Scenic Highway Plan by the Alaska Land Use Council. This evaluation reflects preliminary conclusions and recommendations contained in the Corridor Resource Management Plan (C-RMP) now being prepared by the BLM for public lands north of Fairbanks. The C-RMP address broad land use decisions including the need for transportation and utility projects such as TAGS. The project would comply with all existing land-use plans since most of those plans already incorporate the existing utility corridor as a authorized industrial area.

3.2.3.3 Potential Areas of Critical Environmental Concern (ACEC)

The Federal Land Policy Management Act (FLPMA) directs the BLM to identify, evaluate, and as appropriate give special attention to ACEC's. Congress defined an ACEC as an area "...within public lands where special management attention to protect and prevent irreparable damage to important historic, cultural or scenic values, fish and wildlife resources or other natural systems or processes..."

The BLM, in its Corridor Resource Management Plan, has identified several areas of public lands associated with the TAGS project north of the Yukon River that have prospective ACEC value. These designations take into the account the primary purpose of the corridor, which is for transportation and utility systems--and the occurrences of other superlative public values that need special management attention. ACEC designations are proposed by BLM for the following eight areas: Sagwon Bluffs, Slope Mountain, Galbraith Lake, Westfork Atigun, Snowden Mountain, Sukakpak Mountain, Nugget Creek, and Jim River (Figure 3.2.3-1). Management objectives in several other prospective ACEC's formalize earlier management decisions made to protect special resource values during the planning, construction, operation, and maintenance of TAPS and the Dalton Highway and for planning the ANGTS.

In addition to the above eight areas, four other prospective ACEC areas that are in the general region of TAGS, including the Ivishak River, Toolik Lake, Pass Mountain, and Kanuti Hot Springs, are believed to be sufficiently removed by distance or separated by topographic features from the proposed TAGS route, that they will not be directly impacted by TAGS construction or operation. The following discussions summarize values for which the eight potential ACEC's that are proximate to the TAGS route would be managed.

3.2.3.3.1 Sagwon Bluffs ACEC (Potential)

This prospective ACEC involves 42,240 acres. Its western boundary is the Dalton Highway in the general vicinity of TAGS Compressor Station No. 1 (Milepost 66.5). It extends eastward to the Ivishak River ACEC. It contains approximately 20 percent of the known nesting pairs of peregrine falcons along the Sagavanirktok River. This proposed ACEC also contains habitat for gyrfalcons and rough-legged hawks. Riparian zones are important for caribou, moose, and brown bear. The northernmost archeologic sites associated with the Athapaskan culture are in this unit. A sensitive plant species Erigeron muiriis is also found in the area. A Habitat Management Plan focusing in peregrine falcon habitat was developed by BLM in 1979 for portions of this proposed ACEC.

This area provides walking access to the nearby Gates of the Arctic National Park and Preserve from the former TAPS construction camp area on the west side of Galbraith Lake. The lake serves as a base for air transportation for floatplanes both to the Arctic National Wildlife Refuge and to the

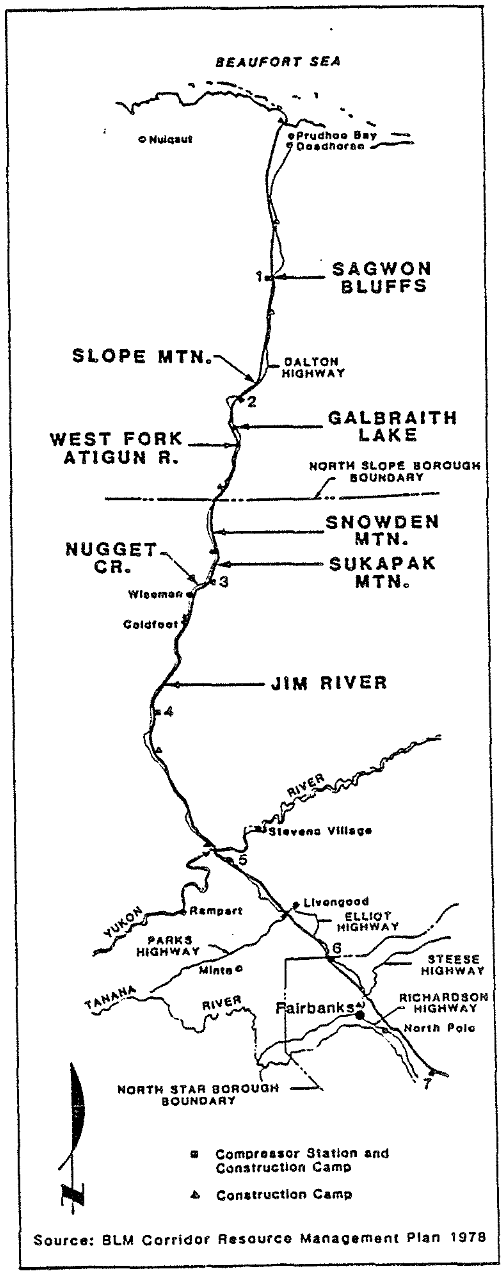


Figure 3.2.3-1 General Location of Potential Areas of Critical Environmental Concern (ACEC) Having Close Proximity to the TAGS Alignment

Gates of the Arctic National Park and Preserve. The nearby state-owned airstrip also serves as a major focal point for resource users and visitors to North Slope areas to the east and west. The general area at Galbraith Lake has served as a temporary summer base for federal and state resource evaluation teams and for BLM management of the area. It also acts as a base for commercial guiding operations.

Special management practices proposed by BLM are: continue to exercise special care to assure peregrine falcon habitat and sensitive plants are not adversely affected and incorporate protection measures identified in the Peregrine Falcon Recovery Plan (USFWS 1982).

3.2.3.3.2 Slope Mountain ACEC (Potential)

This prospective ACEC involves 2,600 acres. It is bounded on the east roughly by TAPS in the vicinity of material site near TAGS Milepost 115. This unit contains known lambing habitat and mineral licks for Dall sheep and contains raptor nesting habitat. The vertical faces of the TAPS material site have been established as a raptor nesting habitat. Dall sheep are frequently observed in this material site using the revegetated areas as a food source and the steep material pit slopes as escape habitat.

Because a growing number of sport hunters are using the Dalton Highway to hunt sheep, critical sheep habitats require special protection.

BLM proposes that special care be exercised in authorizing new uses in this area. It is further proposed the mineral lick be withdrawn from mineral entry to protect its existing natural values.

3.2.3.3.3 Galbraith Lake ACEC (Potential)

This prospective ACEC encompasses 115,000 acres, or generally, all public lands between the Arctic National Wildlife Refuge and the Gates of the Arctic National Park and Preserve. The land is essentially between TAGS Mileposts 135 and 145. This unit contains critical wildlife and fisheries habitat, sensitive plants, historical and archeological sites, paleontological and geologic sites, and scenic values.

This area has the highest concentration of historic and prehistoric cultural resources of any region along TAGS. It includes three sites nominated to the National Register of Historic Places. The area has been recommended as an Ecological Reserve by the Joint Federal-State Land Use Commission and has been recommended for entry into the Register of Natural Landmarks by the US Geological Survey and the National Park Service. Scenic values are rated by BLM as "outstanding".

BLM management practices propose that new uses be authorized only after special care to ensure that existing public values are not unreasonably threatened.

3.2.3.3.4 Westfork Atigun River ACEC (Potential)

This area covers 4,700 acres to the west of the proposed TAGS alignment near Milepost 155. Its primary value is for Dall sheep lambing habitat and as a sheep mineral lick. As such it has habitat values similar to those described for the Slope Mountain ACEC area (Subsection 4.2.3.3.2). Management objectives by BLM for Westfork Atigun River ACEC are similar to those for the proposed Slope Mountain ACEC.

3.2.3.3.5 Snowden Mountain ACEC (Potential)

This area involves 19,520 acres along the western side of the Dietrich River between TAGS Milepost 188 and 198. It contains areas of unusual geologic and paleontologic values associated with the Devonian and lower Paleozoic epochs. It contains formations with Devonian corals and Cambrian trilobites. In addition, there are two Dall sheep mineral licks on Snowden Mountain.

Close proximity to public access allows for scientific research. Dall sheep habitat is also important for wildlife viewing and sports hunting. Overall management objectives by BLM for this area are similar to those described for the Galbraith Lake ACEC. Areas containing sheep mineral licks would be withdrawn from mineral entry.

3.2.3.3.6 Sukakpak Mountain ACEC (Potential)

This unit involves 2,944 acres containing Sukakpak Mountain. It is bounded on the west by the lower slopes of the eastern mountain at the 1,500 foot counter levels and on the east by the western bank of the Bettles River. It is closely associated with TAPS in the vicinity of Milepost 208. The area has unique geological, picturesque, colorful structures, folds and faults representing mountain building processes of the Brooks Range. It contains a sensitive plant species, Orthotherichum diminutivum. Scenic values are rated as "outstanding" by BLM.

The primary area values lie in the excellent opportunities to view the basic geologic processes responsible for the Brooks Range.

BLM will continue the special management practices initiated with TAPS construction when applications for mineral material removal sites along the talus slopes were denied.

3.2.3.3.7 Nugget Creek ACEC (Potential)

This unit contains 3,300 acres on the west side of the middle fork of the Koyukuk River near Milepost 215 of TAGS. Its primary values are Dall sheep lambing habitat and mineral licks. As such, it has values similar to those described for the Slope Mountain and Westfork Atigun River ACEC's (Subsection 4.2.3.3.2).

BLM management practices for this area would be similar to those for Slope Mountain.

3.2.3.3.8 Jim River ACEC (Potential)

This unit involves 200,320 acres in the headwaters of the Jim River between TAGS Mileposts 260 and 275. Its principal resource values are: chum and king salmon spawning habitat, overwintering habitat for both resident and anadromous fish species, sportfishing use, raptor habitat, scenic and recreation values and archeology.

Chum and king salmon fisheries of the Jim River are very important to runs in the upper Koyukuk drainage. Fish produced here are suspected to have important subsistence and commercial value. The river is one of the most heavily used recreational streams north of the Yukon River along the TAGS alignment.

Archeology is known to be rich, with a high concentration of prehistoric Athapaskan sites, of which three may be of National Register quality. Most present knowledge is related to studies done when TAPS and the Dalton Highway were built. Several large sites that were identified have only been examined insofar for the actual areas occupied by TAPS or the Dalton Highway.

Scenic values are rated as outstanding by BLM. This general area also contains one of the few peregrine falcon nesting areas between the Yukon River and the Brooks Range.

In addition to standard cultural and raptor management practices, BLM recommends that no disturbances be permitted to active waterways having fishery values. Special evaluations would be required of upland mineral material sites that have potential for adverse effect on existing fishery values.

3.2.4 Transportation

3.2.4.1 Introduction

Alaska presents a unique transportation system, integrating air, highway, marine, and railway transport. This transportation system must overcome the inherent characteristics of a small population, tremendous geographical size, difficult terrain, dramatic climate range, and, outside the few major population centers, lack of specific infrastructure.

Alaska presently is served by approximately 7,000 miles of highway connecting its major cities. This is augmented by a "marine highway" system connecting various southeastern and southcentral ports by passenger and car ferry. The Alaska Railroad, operated by the state, carries passengers and freight from Seward to Fairbanks. Barges operate seasonally on the Yukon and Tanana rivers. An annual late summer marine transport system (Sealift) carries materials to Prudhoe Bay.

Scheduled and charter air transport play major roles in both passenger and cargo transportation.

3.2.4.2 Prudhoe Bay Area

The Prudhoe Bay and the Kuparuk development areas are serviced by the Spine Road and a series of gravel roads which originated from and surround Lake Colleen at Deadhorse. Marine freight is brought in by a single large sealift and off-loaded by lighter and barge to one of four operating dockheads (Oliktok, West Dock, East Dock, Endicott) during the ice-free seasonal window of August and early September. The State of Alaska operates Deadhorse Airport for commerical and charter aviation. THe airport has a Federal Aviation Administration flight service station and a full range of navigational aids.

3.2.4.3 Dalton-Elliott Highways

The Dalton Highway is a gravel road which extends south from Prudhoe Bay to Livengood; there it joins the Elliott Highway. Highest observed daily count on this highway was 465 vehicles in March 1977 (DOTPF 1980). By 1980 daily traffic had stabilized to approximately 154 vehicles per day during August, the busiest month (Eaklund 1982). In 1982 the route from Fairbanks to Prudhoe was traveled by a record 42,000 trucks transporting cargo north in support of petroleum development at Kuparuk. DOT/PF sets daily capacity of the Dalton Highway at about 600 vehicles.

Beginning in the summer of 1981, the Dalton Highway from the Yukon River to Deitrich Camp has been open to public use from June 1 to September 1. Other months, and north of Deitrich Camp, travel is by state permit only. Permits are usually issued only to local residents and industrial/commercial users. There is virtually no other form of transportation other than charter aircraft between Prudhoe Bay and Fairbanks, but there are several small airstrips. Only two, the Cold Foot and Galbraith Lake strips, are maintained by the state. They are heavily used by hunters during August and September.

3.2.4.4 Fairbanks Area

Fairbanks occupies an important position in central Alaska transportation. It is considered the jumping-off place for Prudhoe-bound air and truck freight. The northern terminus of the Alaska Railroad at Fairbanks deposits freight to be trucked or flown to Prudhoe.

Fairbanks also acts as the origin or northern terminus for both north-south state highways, including the major artery south to Anchorage (Parks Highway) and the Alaska Highway. Fairbanks receives some goods by barge from the Yukon River and barges goods up the Tanana River to the south. Fairbanks is served by several major airlines and has full charter air service.

3.2.4.5 Richardson Highway and Valdez Area

Paralleling the Tanana River south of Fairbanks the proposed TAGS line would follow the Richardson Highway. This highway is intersected by the Alaska Highway at Delta Junction and the Glenn Highway at Glennallen. From Glennallen the Richardson parallels the Copper River, the Tonsina River, and Ptarmigan River to Thompson Pass in the Chugach Mountains and along the Lowe

River to Valdez. There are several small fixed-wing charter services along the Richardson Highway between Fairbanks and Valdez.

Valdez is a transportation hub on northern Prince William Sound. There is scheduled and charter air service available. Valdez is a deep-water seaport and has considerable marine vessel traffic, including private, charter, commercial fishing, sight-seeing, and tanker vessels. The TAPS marine export system is located on Port Valdez across from the city of Valdez. Approximately three supertankers per day call at this facility, which is located in this deep, natural, sheltered harbor. There is a great increase in private and commercial marine vessels during the summer. Most commercial traffic is related to the state ferry service and fishing/crabbing vessels. Outside Port Valdez, in Prince William Sound and the Gulf of Alaska, severe storms can last for several days. In 1986, there was only one instance weather prevented vessels from reaching the TAPS terminal for a sufficient period so that the pipeline was shut down for a day.

3.2.4.6 Anchorage Area

The Anchorage transportation system consists of an international airport, a major railroad center, a major highway system and is the hub of small-plane traffic in the state. Merril Field and the Lake Hood floatplane facility are two of the busiest small-plane airports in the United States.

Whittier and Seward are both ice-free ports and are potential sources or terminals for marine shipping related to the TAGS project.

3.2.5 Noise

The proposed TAGS project would be built almost entirely in the designated utility and transportation corridor. It would be within or near the Prudhoe Bay industrial complex, and parallel the TAPS and ancillary facilities corridor and public highways. For most of the route the proposed TAGS would be within hearing distance of the Dalton, Richardson, or Elliott highways. Each of these constitutes a source of localized background noise, as does boat traffic and commercial and light aircraft overflights. Although the corridor itself is developed, most of the area adjacent to the route is undeveloped and sparsely populated, and ambient noise levels are generally low. Most ambient noise is generated by the wind and moving water.

Data for similar locations indicate that typical natural noise levels usually range from 15 to 45 dBA (the dBA scale represents how the human ear hears the various sound frequencies) which is considered quiet. Natural noise levels up to 65 dB may be associated with storms and wildlife (EPA-DOI 1984) and natural levels of 50 to 64 dBA's have been recorded near Wilderness River (Court et al. 1974). An automobile moving at 62 miles per hour at 50 feet emits is about 71 dBA, a bulldozer operating at 50 feet is about 87 dBA, while machines, outboard motors and floatplanes generate noise levels up to 85 dBA's at 50 feet (EPA-DOI 1984).

Along the utility corridor, noise is presently generated at the 12 Alyeska pump stations. At a distance of 600 feet, the noise level from these facilities has been estimated at 74 dBA (DOI 1972b). These ambient levels are affected by wind and other atmospheric conditions. Noise carries considerable distances during calm, cold conditions due to increased air density (DOI 1986).

Background noise in the Valdez area is quite low, with road traffic and aircraft the most significant sources. Valdez is typical of many small Alaska cities with moderate traffic and limited sources of noise. There is some ambient noise from the Alyeska terminal which lies about 3.5 miles east of the proposed TAGS terminal at

Anderson Bay. Anderson Bay has no road access and is virtually undeveloped. Natural background noise levels are low except when transient boats and aircraft pass by.

3.2.6 Meteorology and Air Quality

3.2.6.1 Introduction

The climate along the proposed TAGS route, which includes some of the most extreme temperature ranges in North America, is classified in four major zones (FPC 1976a): Arctic, Continental Interior, Transition, and Maritime. The Arctic Zone extends south from the Beaufort Sea coast through the northern part of the Brooks Range. The southern portion of the Brooks Range down through the upper Copper River basin to the crest of the Chugach Mountains comprises the Continental Zone. The Transition Zone (from continental to maritime climate) includes primarily the Chugach Mountains. Generally, lands south of the Chugach Mountains are in the Maritime Zone, although there is some modification in the Port Valdez area due to the mountain barrier surrounding the basin.

Air quality along most of the route is generally considered to be very good due to minimal human habitation and industrial development. Localized sources of emissions include vehicles, traffic, and wind-generated dust and forest fires, which contribute to temporary increases in air pollution. Seasonal and annual weather variability greatly influences ambient concentrations.

3.2.6.2 North Slope and Brooks Range

Temperature and wind conditions north of the Brooks Range are among the most severe in the state. It is not the coldest area, but since temperatures are quite low and the area invariably experiences moderate to severe winds, chill factors are often below zero. From the Beaufort Sea coast to the Brooks Range, surface winds are predominantly from the east during summer and westerly in winter. The annual average speed is 12 to 13 miles per hour (mph) along the coast and slightly lower inland. Wind speeds of 35 to 50 mph primarily are associated with fall and winter storms (Ruffier and Bair 1977).

Minimum winter temperatures in (°F) average between -15° and -30°. Wind speeds average about 10 to 15 mph. These conditions result in an equivalent chill factor of -40° to -80°. During periods of extreme cold the temperature may drop to -40° or -50°, but winds are usually much lighter during such extreme cold conditions. Daily summer temperatures warm to the 40s and occasionally the 50s, with temperatures up to 60° F common near the foothills (USACE 1984). Extremes of +85°F and -66°F in February, 1987, have been recorded at Umiat about 50 miles west of Prudhoe on the Colville River.

The area averages 4 to 6 inches of precipitation annually, including 30 to 50 inches of dry snowfall in winter (USACE 1984). Drifting snow is common due to strong surface winds and dry snow conditions, producing whiteouts that often last for several days but only include the vertical area within 50 feet of the ground. Whiteouts typically restrict driving, flying, and outside work due to lack of visibility and the danger of getting lost (DOI 1976).

In 1953 the National Weather Service established a climate station in Anaktuvuk Pass, about 100 miles southwest of Prudhoe Bay, that has provided much of the meteorological data collected for the Brooks Range. Records show an average annual snowfall of about 63 inches, which makes up a large portion of the total annual precipitation of about 10 inches.

Present air quality emissions occur primarily from sources associated with the Prudhoe Bay facilities, including oil-production facilities, electric generators, two petroleum refineries, and an industrial incinerator. Other sources include vehicle exhaust, road and pipeline maintenance operations, and buildings' heat systems. Air quality monitoring was performed during 1979-80 (USACE 1984) and again in 1986 in the Prudhoe Bay-Kuparuk area. Results indicate that concentrations for all air pollutants are presently below those allowed by the National Ambient Air Quality Standards (NAAQS), and the area is currently designated as an "attainment zone".

Recent studies by National Oceanic and Administrative Administration (NOAA) have shown that the air quality of the North Slope and nearshore Beaufort Sea has been somewhat affected by pollution from northern Europe and Siberian industrial effluents (COE 1984).

Although YPC is not proposing to construct a gas conditioning facility at Prudhoe Bay, they had conducted a screening analysis to determine if the site could meet the necessary air quality emission requirements. Appendix D presents the potential effects of the gas conditioning facility on the Prudhoe Bay airshed.

3.2.6.3 Fairbanks Area

Temperature extremes are even greater near Fairbanks and in the Interior. Although the climate is considerably milder in summer, it is somewhat colder in winter. There are fewer occurrences and durations of strong winds, and maximum velocities are less except in mountain passes. Some drifting of snow occurs but not nearly as much as on the North Slope.

Temperatures in (°F) during summer are commonly in the upper 60s and 70s, with extremes in the 90s. Average winter lows range from -5°F to -25°F, with extremes between -50° and -65°.

Annual precipitation in the Fairbanks area is 10 to 13 inches. Heaviest amounts occur in summer from thunderstorms. Snow accumulations average from 50 to 70 inches in the Fairbanks area.

Periods of cold temperatures and low wind speeds in northern and central regions of Alaska can lead to long-lasting atmospheric temperature inversions. During severe winter cold periods the relatively large volume of water vapor and other material emitted by vehicles, space heating systems, power generating stations, and industries in Fairbanks is kept near the ground by these extremely high-gradient inversions, often for long periods of time. This produces severe air pollution in the form of ice fog, which hinders vehicular travel and air traffic and poses a health hazard. Carbon monoxide levels can exceed state and NAAQS levels by as much as 200 percent.

3.2.6.4 Fairbanks to Valdez

From Fairbanks south to the Chugach Mountains there is considerable variation in elevation and type of terrain. At Gulkana surface winds are primarily southeasterly during all months except November through February, when wind direction is northerly (FPC 1976a). On either side of the Alaska Range surface winds average 5 to 8 mph annually, and the monthly range is 3 to 10 mph. The strongest winds generally occur during spring and summer. In and near the mountains, however, especially through high passes and narrow valleys, strong winds up to 50 to 60 mph are common, most often in the winter. Snow drift in some areas, especially around Delta Junction, makes it difficult to keep major highways open at times.

Summer temperatures usually range between 60° and 75°F during the day, with night temperatures dropping into the low 50s and upper 40s. Maximum values would be in the 80s and occasionally near 90°. Winter daytime temperatures vary between 5° and 15°F dropping to -10° to -25°F at night. Extreme winter lows range from -45° to -60°F, usually with at least one prolonged period of cold weather each winter. There is little fluctuation of temperature between day and night during these cold snaps, and temperatures average -40°F or colder. Winds are usually lighter during these periods, but wind chill is still of concern to those outdoors.

Precipitation is typically 10 to 12 inches annually in this region, with an annual snowfall of about 35 to 70 inches, although certain areas get much more.

The area from Fairbanks to Valdez is sparsely populated and nonindustrialized except for the pipeline corridor and therefore has good to excellent air quality. There are several small villages along the route, with Glennallen and Delta Junction the major population centers. Very few effluents are of any concern.

The proposed TAGS route would pass through a section of the Chugach Mountains that holds the record for snowfall in Alaska (DOI 1972). An annual average of approximately 400 inches of snowfall was recorded between the years 1952 through 1987 (NWS 1987, pers. comm.). A total of 974.5 inches was recorded during the winter of 1952-53 by the Cooperative Weather Station at Thompson Pass and February 1964 remains as the highest monthly snowfall record was set at 346.1 inches. Surface winds and drifting snow cause considerable trouble for highway crews in the passes, and winds of 30 to 70 mph occur several times each month during the snow season, often causing severe whiteouts.

Because Thompson Pass is affected by the warmer air of the Gulf of Alaska, winter temperatures are much warmer than those to the north. During the coldest part of winter, readings are usually between 0° and 15°F; the coldest temperature recorded was -39°F.

Climatic conditions on the southern slopes of the Chugach Mountains reflect a gradual moderation of temperatures. The annual temperature extremes are +87°F and -28°F. Summer days warm into the 50s and 60s; nights during the coldest months typically have temperatures between 5° and 25°F.

Precipitation is heavy compared to most other areas described. Annual snowfall ranges from 250 to 400 inches and is usually "wet," contributing substantially to the total annual precipitation of 60 to 90 inches. Most precipitation occurs from August through November.

The complex terrain surrounding Valdez greatly influences local climate. The high mountain ridges to the north protect Valdez from extreme cold in winter and prevent warmer air originating in the Interior from reaching there in summer. Mountains to the south provide a barrier to the warm, moist air from the Gulf of Alaska in winter, but any protection they provide in summer is offset by cool drainage winds off nearby glaciers. Temperatures average about 18°F during the coldest month (January) and about 53°F during July, the warmest month (EPA 1979).

In Valdez rainfall is abundant, averaging more than 59 inches per year (EPA 1979). September, the wettest month, averages 7 inches. June, the driest month, averages 2.7 inches. Snowfall is heavy, averaging almost 294 inches annually, with an average of more than 39 inches each month from December through March (EPA 1979). There is considerable cloudiness and low ground fog during the year.

Surface winds in the Valdez area, although strong on occasion, are generally light and northeasterly during the winter and southwesterly during the summer (EPA 1979) and not nearly as strong as through Thompson Pass.

Light winds with surface inversions and above-surface stable layers can lead to high air pollution potential. However, surface inversions are typically short term. Overall, dispersion conditions in the area are considered fairly good (EPA 1979).

Alyeska Marine Terminal facilities were designed to meet National Primary Air Quality Standards and or State of Alaska emission standards (DOI 1972b). Alyeska maintained an air quality monitoring network in Valdez from 1977 through 1981.

Monitoring data indicated that existing air quality pollutant concentrations were quite low in the Valdez area during that period (EPA 1979) and that Valdez was an Attainment Zone.

3.2.7 Solid Wastes, Hazardous Materials, Sanitation

Solid waste disposal is presently handled in a variety of ways by the different communities along the corridor. Along the proposed TAGS route, the primary manner of disposal is through landfill. Due to the low population and small quantity of solid wastes, disposal is not a problem in most areas. During the construction of TAPS, many approved sites in abandoned mineral material sites were developed along the corridor and functioned effectively. Long-term disposal sites north of Fairbanks are under review by the State, BLM and North Slope Borough.

Hazardous materials are presently generated by several entities along the route including TAPS, the highway department, schools, and small generators such as filling stations and cleaners. Currently there is no mechanism for storage or disposal of toxic or hazardous material in Alaska and all such materials must be disposed of by transport to the Lower 48 states.

Sanitary wastes are generated all along the proposed route by the people and industrial facilities present. Due to the low population density, disposal of sanitary wastes is not a problem except on a local level in areas which are wetlands or have a high water table. There is virtually no common sewage disposal sites along the proposed route except at Fairbanks and Valdez. Therefore, most dwellings, businesses, or small shopping centers are left with the problem of disposing of their own liquid wastes. Most do so by leach fields or use of individual package sewage treatment plants. In some areas, contamination levels in surface waters are high in the spring due to a winter's accumulation of waste, but generally water levels are sufficiently high to dilute this contamination to acceptable levels.

Liquid wastes generated by the project would include domestic wastewater and filter backwash; equipment washdown; stormwater runoff; and industrial wastewater. Domestic wastes and filter backwash water produced at the 26 campsites and compressor stations would be treated by package treatment plant systems which are designed to meet ADEC and EPA water quality criteria at the discharge point. These treatment plants would be sized and operated to accept wastes from camp facilities as well as waste from field toilets. Wastewater would average about 100 gallons per person per day.

The TAPS construction used individual package sewage treatment along the route at construction camps and at pump station sites and the same type of disposal is planned for the TAGS project.

3.2.8 Physiography, Geology, Soils and Permafrost

3.2.8.1 Introduction

The topography, geology, and soils along the proposed TAGS pipeline corridor are highly variable. The route crosses the arctic coastal plain, three mountain ranges and intervening uplands and alluvial basins and is generally oriented perpendicular to major structural trends (FPC 1976a). Igneous, sedimentary, and metamorphic bedrock are found along the proposed route. Structurally, these rocks are varied and complex.

Geomorphic processes, including erosion, mass wasting, and deposition, have resulted in a wide range of soil types overlying bedrock. Soils along much of the route have developed in a low temperature environment in which soil horizon development is slow, resulting in generally thin soils subject to dislocation as a result of freeze-thaw processes. Soil types along the proposed pipeline route range from fine-textured and poorly drained to coarse-textured and well drained. Soil formation and drainage are affected by the presence and distribution of permafrost resulting in slow nutrient release.

Permafrost, or perennially frozen ground, is encountered along much of the proposed route. Major engineering problems can arise where warming of permafrost occurs in poorly drained, fine-grained sediments. These materials generally contain large amounts of interstitial ice. As the permafrost warms, the interstitial ice melts, resulting in a volumetric reduction of the soil mass and excessive wetting of the thawed, fine-grained soils. These effects can result in subsidence of the ground surface and downslope movement of the entire thawed mass.

Permafrost is continuous north of Atigun Pass and discontinuous throughout much of interior Alaska, including areas within valleys south of the crest of the Brooks Range. South-facing slopes and ground beneath large bodies of water may be permafrost-free in discontinuous permafrost areas (Brown and Kreig 1983).

Based on topographic and geologic similarities, seven primary physiographic units have been identified along the project corridor. The physiographic units discussed in this document are based on the system described by Wahrhaftig (1965). Some of the Wahrhaftig province have been combined into more general physiographic units with more common descriptors in order to emphasize terrain, geology, and soil conditions along the proposed route. The seven units described herein are as follows: North Slope, Brooks Range, Yukon-Tanana Uplands, Tanana Valley, Alaska Range, Copper River Basin, and Chugach Mountains. These units will provide an organizational framework for the following sections. The boundaries of the physiographic provinces are shown on Figure 3.2.8-1 and in cross section on Figure 3.2.8-2.

3.2.8.2 North Slope

The North Slope physiographic unit encompasses the coastal plain and foothills provinces. This unit is bounded on the north by the Beaufort Sea and by Slope Mountain (near Galbraith Lake) on the south.

The coastal plain has low relief and rises gently from the sea to an elevation of about 600 feet. The average slope of the land surface in most areas is less than 10 feet per mile toward the north (FPC 1976a). Coastal bluffs, sand dunes, lake and river banks, and pingos (ice-cored hills) provide occasional breaks in the landscape.

The flat terrain results in very poor drainage and marshy conditions in summer. Thousands of shallow, wind-oriented thaw lakes dot the landscape. These lakes range in depth from 2 to 20 feet and, as spring thaw continues, they expand. When they intersect a gully or a streambed, they drain, leaving a depression in the land surface. A network of ice-wedge polygons form patterned ground between the thaw lakes.

Rivers from the Brooks Range flow northward across the coastal plain. The Sagavanirktok River, which is typical of major streams in this province, traverses the coastal plain through a series of interconnected braided channels which form a broad floodplain. Spring flooding typically occurs in May and June. Open water occurs in the active channels from June through September. Erosion has resulted in exposed bluffs along the margins of the floodplain. Oxbow lakes and flood channels are common along major rivers such as the Sagavanirktok. Aufeis (sheet icing) conditions are common in such areas during the winter.

The coastal plain is underlain by 10 to 150 feet of unconsolidated Quarternary sediments resting on nearly flat-lying Cretaceous and, in some areas, lower Tertiary sedimentary rocks. The northern foothills are underlain by Cretaceous sedimentary rocks, folded into long anticlines and synclines. The east-west

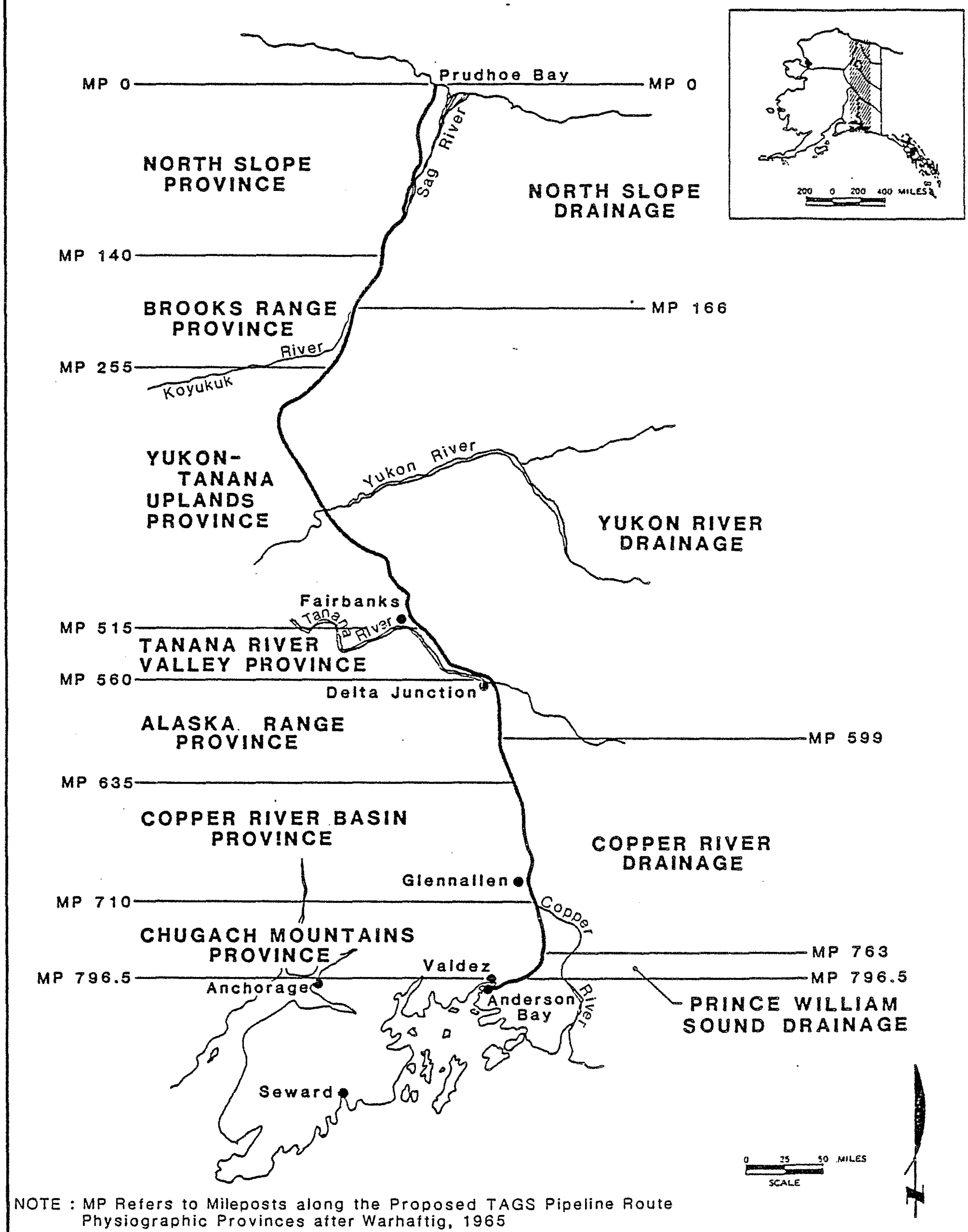
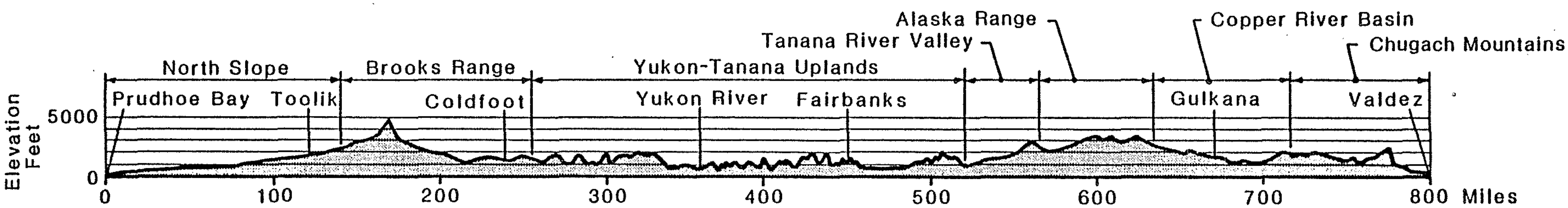


Figure 3.2.8-1 Physiographic Provinces and Major Drainage Basins Along the Proposed TAGS Pipeline Route



SOURCE: Brown and Kreig, 1983

Figure 3.2.8-2 Cross Section Along Proposed TAGS Route trending ridge topography was produced by unequal erosion of layers of rock differing in hardness. The southern part of the foothills is underlain by diverse sedimentary rocks and igneous intrusions of Devonian to Cretaceous age.

On the plain, soils are poorly drained and generally do not thaw to depths of more than 20 inches and are susceptible to slides in steeper areas. Soils encountered between the northern terminus of the proposed TAGS route and the Sagavanirktok River floodplain are extremely ice-rich silt and fine sand overlying frozen sand and gravel. Most soils of the foothills are poorly drained, occurring on long slopes and in microtopography. A few moderately well-drained to well-drained gravelly soils occur on ridges and large river terraces. Organic soils are uncommon and occur mostly in polygonal ground of old drained lake basins (Brown and Kreig 1983).

The coastal plain and foothills are underlain by thick permafrost that reaches a maximum depth of approximately 1,800 feet at Prudhoe Bay. Thickness of the active layer is generally less than 1.5 feet in predominantly fine-grained soils. Unfrozen zones are generally limited to deep river channels, some of which are underlain by unfrozen gravel and deep lake basins (Brown and Kreig 1983).

3.2.8.3 Brooks Range

This physiographic unit encompasses the Brooks Range mountains through the Ambler-Chandalar ridge and lowland province. The TAGS route enters the Brooks Range unit at Slope Mountain north of the continental divide which extends to the South Fork Koyukuk River on the south.

The Brooks Range rises abruptly from the arctic foothills to an elevation of 8,000 feet. Glaciation has sculpted the mountain ridges into ragged forms dominated by cliffs and benches. The east-west trend of ridges was caused by alternating bands of hard and soft rocks of sedimentary and volcanic origin.

Rivers flow in glacially eroded valleys 0.5 to 2 miles wide. Minor tributaries flow east-west, parallel to the structure of the bedrock.

The proposed route crosses the Brooks Range through Atigun Pass, which is narrow and steep-sided. It then descends to the broad valley of the upper Chandalar River. Descending the Chandalar Shelf, the route follows a valley system formed by the Dietrich River and Middle Fork Koyukuk River.

Landslides are present along the proposed route. Presence of steeper slopes and occurrence of up to 30 freeze-thaw cycles a year decrease the resistance of rock fragments and soil to downslope movement.

The Brooks mountains in this area are composed chiefly of folded and thrusted Paleozoic limestone, shale, quartzite, slate, and schist with some sandstone and conglomerates. The north front of the range is light colored, cliff-forming limestone. Bedrock south of 68 degrees north latitude is metamorphosed (FPC 1976a).

Hills in the Ambler-Chandalar ridge and lowland area are mainly metamorphosed basalt. Lowlands are underlain largely by sedimentary rocks folded into anticlines and synclines.

In higher parts of the Brooks Range are mostly steep, exposed bedrock and coarse, unstable colluvial deposits with local areas of poorly drained, gravelly soils.

North of the continental divide, shallow permafrost retards internal drainage and consequently most soils are wet, poorly differentiated, and contain significant organic material. In the foothills and mountain areas south of the treeline, mass movement results in poorly drained, silty or gravelly soils with thin organic horizons. Seasonal thaw is generally less than 20 inches (Brown and Kreig 1983).

The Atigun River Valley is underlain by silt, sand, gravel, and locally by bedrock. In the divide area it is underlain by talus and rubble mantling bedrock. South of the divide, the route is underlain by a veneer of generally frozen glacial silt, sand, and gravel over bedrock.

In the southern foothills, the area is underlain by unconsolidated deposits of frozen glacial silt, sand and gravel, colluvial silts, alluvial deposits, and bedrock (DOI 1972).

Permafrost is continuous north of the continental divide and discontinuous south of the divide. Bedrock and unconsolidated deposits on slopes are generally perennially frozen. South of the divide, permafrost is probably absent in most areas beneath active channels of large rivers. Thaw bulbs occur beneath smaller drainages. Fine-grained deposits of the Brooks Range usually contain massive ice as ice wedges. Coarse-grained materials contain ice between particles.

3.2.8.4 Yukon-Tanana Uplands

The Yukon-Tanana Uplands physiographic unit encompasses the Kokrine-Hodzana Highlands province, the intervening Rampart Trough province, and the Yukon-Tanana Uplands province. TAGS enters the Yukon-Tanana Uplands unit at the South Fork Koyukuk River on the north and extends to Shaw Creek on the south.

The northernmost section of the unit is comprised of the Kokrine-Hodzana Highlands. Even-topped, rounded ridges from 2,000 to 4,000 feet elevation characterize the northernmost section of the unit. Isolated areas of rugged mountains stretch above the ridges. The divide separating the Yukon and Koyukuk river drainage systems wanders through the highlands. The Hodzana, Tozitna, Melozitna, and Dall rivers drain into the Yukon. The Kanuti and South Fork Koyukuk rivers drain the uplands into the Koyukuk.

The proposed route crosses the Jim River and a series of colluvial fans before leaving the valley at Prospect Creek. The terrain between the Jim and Ray rivers consists of a series of lightly forested, east-west trending foothills and narrow ridges.

The Rampart Trough separates the Kokrine-Hodzana Highlands provinces from the Yukon-Tanana Uplands province. The Rampart Trough is a narrow depression with gently rolling topography 500 to 1,500 feet in elevation. The proposed route crosses the trough south of the Yukon River in the vicinity of Hess Creek. The Rampart Trough was eroded along a tightly folded belt of soft continental coal-bearing rock of Tertiary age. Hard rock hills and the surrounding uplands are partly metamorphosed sedimentary and volcanic rocks of Mississippian age that are cut by granitic intrusions.

From the Rampart Trough to the Fairbanks area, the route crosses the Yukon-Tanana Uplands primarily along ridge crests. The route follows natural ridge crests and saddles and crosses valleys of major east-west trending drainages before descending into the Tanana River valley (FPC 1976a).

The Kokrine-Hodzana Highlands are underlain chiefly by Paleozoic and Precambrian (possibly) schist and gneiss cut by several granitic intrusions.

Rocks along the north side of the Yukon-Tanana Uplands province are comprised of highly deformed Paleozoic sedimentary and volcanic rocks containing limestone units. The rest of the upland province is chiefly Precambrian schist and gneiss. Small elliptical granitic intrusions are found in the northwestern part. Large irregular granitic batholiths make up the muck (a mixture of frozen organic matter and silt) of the southeastern part. A thick mantle of windborne silt lies on the lower slopes of hills and thick accumulations of muck overlie deep stream gravels in the valleys.

North of the Yukon River in the Kokrine-Hodzana Highlands, the proposed TAGS route is underlain by a wide range of unconsolidated deposits and bedrock. The broad, open Jim River valley is an area of discontinuous permafrost, and limited zones of thawed gravel are found in the Jim River floodplain. Soils in the Rampart Trough include frozen colluvial silt, sand, rock fragment, gravel, and ice-rich, reworked, wind-blown silt (DOI 1972; FPC 1976a).

Between the Yukon River and Livengood the area is mantled by loess. Well-drained soils over a deep permafrost table are common on steep slopes, alpine ridges, and summits. Organic soils are common in poorly drained sites.

South of Livengood much of the proposed TAGS route is underlain by reworked wind-blown silt, colluvial silt, alluvial silt, sand and rock fragments, sand and gravel, and dune sand.

Alluvial soils that lack permafrost or are perennially frozen below 4.5 feet tend to be well drained, while those with permafrost shallower than 4.5 feet are not. Upland soils on south-facing slopes are generally well drained and free of permafrost. Soils on both north-facing slopes and long, flat slopes and valleys are poorly drained, usually with a shallow permafrost table (Brown and Kreig 1983).

South of the Brooks Range the presence of permafrost and thickness of the active layer are closely related to slope angle, aspect, vegetation, thermal properties of parent material, and drainage (Brown and Kreig 1983). Generally, permafrost is discontinuous and locally depressed. In the Fairbanks area perennially frozen ground is widespread, and the relatively warm, sensitive permafrost degrades if the surface is disturbed.

South of Fairbanks much of the area is thawed, but large accumulations of ice are locally present in reworked silts.

3.2.8.5 Tanana Valley

The proposed route crosses this unit beginning at Shaw Creek, runs through the Tanana River drainage area, and crosses the river at Big Delta to a point near Donnelly Dome south of Fort Greely, which is the southern boundary of the unit.

Rivers from the Alaska Range flow for a few miles at the heads of the fans in broad terraced valleys 50 to 200 feet deep. Thaw lakes occur in areas of fine-grained alluvium; thaw sinks are abundant in areas of thick loess cover (FPC 1976a).

The Tanana Valley is covered with surficial deposits, including outwash fan deposits from the Alaska Range. Scattered low hills of granite, ultramafic rocks, and schist rise above the outwash. Tertiary conglomerate in the foothills of the Alaska Range dips beneath the valley in a monocline (DOI 1972).

Soils along this portion of the alignment include frozen, ice-rich silts over alluvial gravels from Shaw Creek, and across the Shaw Creek flats, frozen loess over bedrock from the southern end of Shaw Creek flats to the Tanana River, and generally thawed alluvial gravel and sand from the Tanana River to south of Fort Greely along the Delta River. Areas north of major streams are underlain by thick deposits of muck. Parts of the southwestern section have a thick loess cover, but central and eastern parts are free of loess south of the Tanana River (DOI 1972).

Permafrost is essentially continuous from Shaw Creek to the Tanana River and discontinuous from the Tanana River to south of Fort Greely. Interstitial ice includes massive lenses and ice wedges in silts overlying alluvial gravel or bedrock.

3.2.8.6 Alaska Range

The Alaska Range physiographic unit encompasses the Northern Foothills province as well as the Alaska Range mountains. The point at which the TAGS route enters the Alaska Range unit is Donnelly Dome on the north and the route crosses at Isabel Pass (near Paxson) on the south.

The northern foothills of the Alaska Range are flat-topped, east-west ridges, 2,000 to 4,500 feet high and 5 to 20 miles long that are separated by rolling lowlands. The lowlands average 700 to 1,500 feet in elevation and 2 to 10 miles wide.

The foothills are largely unglaciated, but some valleys have been widened by glacial action.

The Alaska Range consists of rugged, glaciated ridges 6,000 to 9,000 feet high. These ridges run parallel and trend east-west, broken at intervals of 10 to 50 miles by low passes.

Mountains in the vicinity of the route reach 8,500 feet, but the route avoids these rugged peaks by passing through the Delta River gorge.

Ridges of the northern foothills are mostly crystalline schist and granitic intrusions. The lowlands are underlain by poorly consolidated Tertiary nonmarine sedimentary (coal-bearing) rocks.

The Alaska Range is a complex synclinorium with Cretaceous rocks in the center and Paleozoic and Precambrian rocks on the flanks. High mountains are underlain by granitic stocks and batholiths. The synclinorium is cut by great longitudinal faults that approximately parallel the length of the range. These faults are marked by lines of valleys and low passes running parallel to the range.

The proposed TAGS route follows along the east side of the Delta River valley, crossing an area underlain generally by glacial deposits, including till and stratified drift, though limited areas of bedrock are encountered in some places.

Terraces along the route through the mountains consist of generally unfrozen coarse sand and gravel, mantled in places with organic-rich silts. In short sections where the route leaves the terraces, subsurface materials are dense glacial till over bedrock (DOI 1972; FPC 1974)

Permafrost is essentially discontinuous through the range. Frozen zone ice forms include interstitial ice, massive lenses, and ice wedges in surficial deposits overlying either bedrock or alluvial gravel (FPC 1976a).

3.2.8.7 Copper River Basin

The Copper River Basin physiographic unit encompasses the Gulkana Uplands as well as the Copper River Lowlands provinces. The proposed TAGS route enters the Copper River Basin unit at Isabel Pass on the north and exits near the town of Tonsina on the South.

The Gulkana Uplands are characterized by subtle east-west ridges varying in elevation from 3,500 to 5,500 feet, separated by lowlands ranging 2 to 10 miles wide. The ridges are cut every 5 to 15 miles by notches which were eroded by glaciers or glacial meltwaters. At Hogan Hill the proposed TAGS route enters the Copper River Lowlands. The eastern part of the lowlands is a relatively flat to gently rolling plain 1,000 to 2,000 feet high. The smooth plain has been eroded by the Copper River and many of its tributaries. Resultant river valleys have steep walls 100 to 500 feet high.

The Copper River and most of its tributaries are braided glacial streams in their upper courses.

Bedrock in the Gulkana Uplands is chiefly metamorphosed basalt with interbedded sediments. Both rock types have been cut by large granitic intrusions. Bedrock beneath the southern part of the Copper River is primarily easily eroded sandstone and shale of Mesozoic age. Bedrock beneath the northern part is chiefly resistant late Paleozoic and Mesozoic metamorphosed volcanic rock with granitic intrusions.

Soil conditions are highly variable along the Gulkana Uplands, consisting of glacial till, ice-content deposits, colluvial deposits, and talus. However, stream gravel and sand are common. Soils in the Copper River Lowlands include glaciolacustrine clay, silt and sand, fluvial silt, sand and gravel, colluvium, and deposits of peat, and organic silt.

North of the Klutina River, permafrost is essentially continuous except in major river valleys. South of the Klutina, permafrost is discontinuous with the permafrost table often depressed as much as 25 feet below ground. In the vicinity of Summit Lake permafrost occurs in isolated zones 5 to 25 feet thick. Segregated ice is generally absent except in silty materials where it takes the form of lenses and seams. Where the upper Gulkana River would be crossed just north of Summit Lake, the floodplain is underlain by gravelly, silty sand which tends to liquefy when disturbed (DOI 1972; FPC 1976a).

3.2.8.8 Chugach Mountains Prince William Sound

The Chugach Mountains form a rugged barrier along the north coast of the Gulf of Alaska. Extremely rugged east-west trending ridges ranging from 7,000 to 13,000 feet dominate the high areas. The low areas are comprised of discrete massive mountains 5 to 10 miles wide and 3,000 to 6,000 feet high, separated by a system of valleys and passes 0.5 to 1 mile wide.

The entire range has been heavily glaciated, and topography is marked by horns, aretes, cirques, U-shaped valleys, and rock basin lakes. The coast is indented by fjords and sounds with ridges extending southward as chains of islands. The range is drained by short, swift streams, most of which originate at glaciers. All higher areas are buried in great ice fields from which glaciers radiate. Most glaciers on the south side of mountains end in or near tidewater.

The proposed TAGS route enters the Chugach Mountain unit south of Willow Lake and runs along glacially scoured valleys of the Tonsina, Tiekel, and Tsina rivers. It follows the Richardson Highway, crossing out of the Copper River basin as it goes through Thompson Pass. Steep rocky slopes are encountered south of the pass, particularly in Keystone Canyon. After passing through Keystone Canyon the route descends into the broad floodplain of the Lowe River and continues along the southern margin of Port Valdez to Anderson Bay.

3.2.8.9 Mineral Materials

Construction, operation, and maintenance of transportation and utility systems in arctic and subarctic environments require large amounts of mineral materials (sand, gravel, and crushed rock) to insulate sensitive permafrost regimes. Much has been learned as new successful designs and concepts were tested and used during TAPS construction (1974-77) and in the subsequent development of the Prudhoe Bay and adjacent oil fields. A concept used in the Kuparuk River oil field development in the 1980s was to use a temporary ice road, eliminating the need for a gravel construction pad. Small segments of TAPS also were constructed from snow and ice workpads without damage to the environment.

Overall TAPS construction required approximately 41 million cubic yards of mineral materials. An additional 24 million cubic yards of mineral materials were granted the State of Alaska for construction of the Dalton Highway. The need for mineral materials from federal lands for ANGTS is estimated to be in excess of 20 million cubic yards.

The Alaska Department of Transportation and Public Facilities estimates highway maintenance for annual needs, periodic resurfacing, and reconstruction during the 30-year life of TAGS to be 60,800 cubic yards per mile on unpaved highways and 47,300 cubic yards per mile on paved highways. Overall this translates to about 48.3 million cubic yards (M. Tinker 1987, pers. comm.).

3.2.9 Surface and Ground Water

3.2.9.1 Introduction

The TAGS pipeline route encompasses four separate river route drainage systems: North Slope, Yukon River, Copper River, and Prince William Sound drainages.

The pipeline crosses more than 200 streams. Twenty-nine have drainage areas greater than 100 square miles within the proposed TAGS corridor. Many small drainages are ephemeral and flow only during breakup or during heavy rains.

The relationship of those drainage systems with the physiographic provinces upon which TAGS route geology was based can be seen in Figure 3.2.8.1.

3.2.9.2 North Slope Drainage

The North Slope Drainage, from TAGS Mileposts 0 to approximately 174, is bounded on the north by the Beaufort Sea and on the south by the Brooks Range. Within this area, the pipeline is located almost entirely within the drainages of the Putuligayuk, Sagavanirktok, or Kuparuk rivers. The Arctic Slope Drainage is composed of three distinct physiographic divisions, each with its own distinct hydrologic characteristics. These divisions are: the Arctic Coastal Plain, Arctic Foothills, and the Brooks Range (Wahrhaftig 1965). All hydrologic processes in this drainage are dominated by the dry arctic environment and by the shallow seasonal thaw depth. There are no large active glaciers along the TAGS route that could affect the system.

3.2.9.2.1 Surface-water Hydrology

Numerous studies related to North Slope development as well as USGS studies and stream gauging for TAPS provide a major base of hydrologic data and information for planning, design, and construction of TAGS. The hydrologic year in the Arctic can be divided into four major periods of unequal length (Mortensen 1982). The longest is the winter period beginning in early November. During this period surface-water flow recedes slowly until, in late winter, all surface stream flow ceases, except in local zones of ground-water discharge (USGS 1977). The second period, breakup, begins in late March in the foothills and may extend to mid-July on the coastal plain. During the early stage of breakup, the first flow is over the ice and flood diversions around channels blocked by icings or snow drifts are common. Almost all flow during breakup results from melting of snow and ice. During most years the maximum discharge occurs during late breakup in late May to mid-June.

The ice-free summer period follows breakup. Occasionally very large floods result from infrequent summer storms, particularly on streams in the Brooks Range and the foothills. In general, however, flow rates for coastal plain streams recede, and in smaller streams sometimes cease, during the summer. Runoff from larger streams passing through the coastal plain, results from storms in the Brooks Range. The presence of impervious permafrost causes wide fluctuations in discharge because runoff is not appreciably modified by ground-water recharge or storage. Freezeup is the shortest period, taking three to five weeks, and is accompanied by rapid flow recession.

There are two basic causes of floods in arctic streams. The first is the breakup flood. Staging resulting from this flood may be increased by icing or ice jams. The second type is the summer or fall rainfall flood. This is caused by infrequent intense rainstorms. Rain floods are frequent on small Brooks Range streams and rarely observed on small coastal plain streams.

Average runoff rates are poorly defined but seem to range from about 3 inches per square mile on the coastal plain to 12 or more inches in the Brooks Range. For small coastal plain streams, three-fourths of the years runoff occurs during June. For large rivers and small Brooks Range streams the runoff is more evenly distributed over June, July, and August.

3.2.9.2.2 Surface Water Quality

In the arctic region, water temperature is a dominant factor and varies, as does air temperature, with elevation, latitude, and exposure to sunlight. The range of temperatures varies more in the tundra area and least in the spring-fed streams. Summer temperatures of arctic streams seldom exceed 60°F, although the surface temperature of shallow, clear lakes may sometimes be 68°F.

The quantity, size, and nature of sediment depends on the waters origin and various other factors such as recent heavy rains. Most of the surface waters in this area of the TAGS route are not affected by glacier runoff. Major nutrients such as nitrates and phosphates are generally in low concentrations in arctic streams. Hobbie (1973) reports phosphate concentrations to be quite low in arctic streams and lakes throughout the year. Nitrates are typically low in the deeper lakes and higher in ponds and rivers.

Of the three types of flowing water, only the tundra streams have natural color imparted by the high level of organic material dissolved from the peat.

Arctic lakes are normally at or near saturation levels for dissolved oxygen (DO) during the open-water season; however, severe oxygen depletion may occur under the ice during the winter (Howard and Prescott 1971).

Tundra ponds typically have low dissolved solids during breakup, increasing to very high levels later in the summer and during/after freezeup due to solids rejection during freezing.

3.2.9.2.3 Ground-water Hydrology

Permfrost soils have an extremely low permeability, several orders of magnitude lower than the same soils in their unfrozen state and prevent recharge of ground water. In areas of continuous permafrost such as the Arctic Slope, ground water occurs only in unfrozen sands and gravels below major rivers, in large alluvial fans, and as outflow from bedrock springs. Water in alluvium below rivers and in fans is limited in volume and can be easily depleted (Williams 1973).

Springs and related icings are the most conspicuous active hydrologic feature of the Arctic Slope during the winter season. During the winter, water from springs freezes downstream from its source to form icings. The extent and thickness of these icings depend primarily on the rate of spring flow (USGS 1977). Icings tend to occur at the same locations each year. The location of major springs and icings are described by the USGS (1976). Icings can, and often do, fill stream channels to above normal open water flood levels and cause diversions of flow during breakup.

On the coastal plain, permafrost is thick and subpermafrost water is brackish or saline. The best quality ground water on the coastal plain occurs in the alluvium below major rivers. Springs in the Brooks Range that flow all year-round are of excellent quality. For bedrock springs, the discharge and quality remain nearly constant year-round.

3.2.9.2.4 Hydrologic Hazards

Hydrologic hazards include floods, channel scour and lateral erosion. Flood hazard evaluations are complicated by potential diversions of breakup floods by icings and ice jams. Hazards also include the impact and uplift forces of floating ice on structures such as bridge piers. Snow avalanches are a minor hazard in Atigun Pass. Additional hazards occur because of the possibility of creating new icings because of construction.

3.2.9.2.5 Present Water Use

At the present time a minor amount of both surface and ground water is used as a source of domestic water for existing oil industry and government camps. An additional amount of surface water is used during the summer months of industrial purposes such as road watering and hydrotesting.

3.2.9.3 Yukon River Drainage

The Yukon River drains all of the 433 miles of the TAGS route lying between the Brooks Range and the Alaska Range (TAGS Mile 174 to 615) with the pipeline crossing 127 identified streams. The pipeline route generally follows the highway, and for much of its way is located on the terraces of the Dietrich, Middle Fork Koyukuk, and Delta Rivers, and Phelan Creek. The physiographic environment is diverse, ranging from alpine brooks in the Alaska Range to thaw lakes of the Tanana-Kuskokwim Lowlands. The hydrologic environment is equally diverse, with mean annual precipitation ranging from 10 inches at the Yukon River to 80 inches or more on the active glaciers of the Alaska Range (USGS 1971).

3.2.9.3.1 Surface-water Hydrology

As discussed in 4.9.2.1, the hydrologic year can be divided into four parts: the longest is the winter period followed by a short very active breakup period, a summer ice-free period, and an early winter freezeup period. The winter period begins after the ice cover is formed, usually by early December. During the winter, flow recedes in response to diminishing ground-water inflow until by early April, flow is diminished to nearly nothing. Small streams are dry except in the immediate area of springs. Breakup occurs in May. During many years the largest flood of the year occurs during breakup. The early summer period lasts to mid-July and is characterized by recession of snowmelt flow. After mid-July, summer storms become frequent and runoff increases and decreases rapidly in response to variations in rainfall. The largest flood discharges on all but the Yukon River occur as a result of summer storms. Summer flow in streams draining the Alaska Range are substantially increased by glacial melt.

Runoff rates are substantially modified by ground-water storage and discharge. Flow recession rates tend to be slower than in the Arctic. Average annual runoff rates vary widely. Typical values are about 1 cfs per square mile in the Brooks Range, 0.5 cfs per square mile near the Yukon River, and about 4 cfs per square mile in the uplands of the Alaska Range. Average rates in a given year tend to vary widely from the long-term average.

Glaciers are a common feature of the Alaska Range and impact all major streams. Streams draining the Brooks Range, as well as the north bank tributaries of the Tanana River, are not affected by glaciers. For most large streams, glacier impacts are limited to an increase in flow during warm weather and an increase in turbidity. For headwater streams, the impacts are more pronounced. The suspended sediment load is close to the maximum conveyance capacity of the stream, and a large diurnal variation in flow rate responds to daily temperature fluctuation. A few of these glacial streams may be affected by outburst floods from glacial dammed lakes, should the glacial regime change enough to form a lake. There is no history of glacial outburst flooding of these minor streams nor are any significant changes in the present glacial regime anticipated. Larger rivers may be affected by changes in glaciers. The Black Rapids glacier has surged several times, blocking the Delta River and creating outburst floods downstream (USGS 1971). Phelan Creek has flooded from releases at Gulkana Glacier in the past.

3.2.9.3.2 Surface Water Quality

Water resources of this region are as varied as the topography, which consists of low river valleys, foothills, plateaus, and high mountains.

Water quality of streams for which data are available was generally good (FPC 1976a).

There is wide variation in color and turbidity concentrations in these surface waters due to glacial or spring origin and passage of slow-moving streams through peat bogs where the highly organic substrate imparts a tea color to the water. Many streams originate from glaciers and are highly turbid.

Lakes in this drainage have relatively abundant nutrients and DO is typically high in the surface waters except during late winter. Surface waters range from 32°F to 65°F during late summer.

Present water use in the Fairbanks area consists of considerable domestic, industrial, agricultural, and placer mining. Discharge from primary and secondary treatement centers is fairly heavy in the Tanana drainage and Fairbanks area. Bacterial and fuel oil contamination of superpermafrost water is common in populated acres whereas subpermafrost contamination is rare.

3.2.9.3.3 Ground-water Hydrology

There is more ground water available in the Yukon drainage basin than in any other part of Alaska. Within the Yukon River drainage the largest sources of ground water are in the alluvial deposits of the major river valleys and their larger tributaries. These are the lower and middle Koyukuk, Yukon, Tanana, and Delta river valleys. Smaller, but not less important, sources are alluvial fans in mountain valleys. Ground water also exists in fractured bedrock (Williams 1973).

Near Fairbanks, water-bearing alluvium is 820 feet thick and wells 200 feet deep yield 1,000 to 3,000 gallons per minute yields. Wells finished in bedrock in the same area usually yield less than 50 gallons per minute. In general, ground water is abundant along the route in the area. Ground water does not recharge through permafrost (USGS 1953), therefore it may not be available at specific sites.

Ground-water discharges to the surface as springs as well as directly to rivers and lakes and provides all of the late winter flow in streams. In many areas ground-water discharge from the toe of alluvial fans provides areas of open water in the winter that are critical to fish overwintering (Wilson 1977). These open water areas along the toes of fans are particularly prevalent along the Dietrich, Koyukuk, and Delta river systems. Springs discharging in winter create icing downstream. In some cases the ice levels can be well above open-water flood levels and at times cause diversions of breakup flow. Icing along the TAPS is well described; the method of formation and their locations (USGS 1976).

Bacterial and fuel oil contamination of superpermafrost water is common in populated areas. Contamination of subpermafrost water is rare.

3.2.9.3.4 Hydrologic Hazards

Hydrologic hazards include floods, channel scour, and lateral erosion. Flood hazards are compounded by the possibility of diversions by ice jams and icing. Hazards also include impact and uplift forces of floating ice on structures such as bridge piers. Diversion of channels in aggrading streams is a possibility. A particular flood risk in the Delta River drainage is associated with glacier outburst. Avalanches are a hazard in the Chandlar River valley and in the upper Delta River and Phelan Creek valleys.

3.2.9.3.5 Present Water Use

Water is used at many separate locations in the Yukon River drainage for domestic, military, mining, petroleum refining, and other industrial purposes. The total use is believed to be in excess of 20 mgd however this is a small fraction of the available resource. Ground water is the source of virtually all of the water used. Within the basin, but not close to the pipeline, thermal springs are used for domestic heating and for small farming operations (USGS 1978).

3.2.9.4 Copper River Drainage

The Copper River Drainage is bounded by the Alaska Range on the north and by the Chugach Mountains on the south (TAGS Mile 598 to 775). Within this basin the route generally follows the Gulkana River to its confluence with the Copper River, the Copper River to the Tonsina River. From there it follows up the valleys of the Tonsina, Tiekel, and Tsina rivers to the summit of the Chugach Mountains at Thompson Pass. The hydrologic environment is diverse; streams range from low gradient lake and spring fed streams to precipitous glacial streams.

3.2.9.4.1 Surface-water Hydrology

As with the two areas previously described, the hydrologic year is divided into four parts. The winter period begins after the ice cover is formed, usually by early December. During the winter flow recedes in response to diminishing ground-water inflow until by late March, flow is at its annual minimum. Small streams are dry except in the immediate area of springs. Breakup occurs in May in response to seasonally warming weather and rapid melt of snow and ice. Breakup flood stages are often increased dramatically by ice jams on the larger streams. The early summer period lasts to mid-July. After mid-July summer storms become frequent, and runoff increases and decreases rapidly in response to variations in rainfall. The larges flood discharges on all streams without glacier-dammed lakes, occurs as a result of summer storms augmented in some cases by glacier lake dumps. Summer flow in streams draining the Chugach Mountains are substantially increased by glacier melt but the Alaska Range provides little glacier melt.

Average annual runoff rates very widely. Typical values are about 1 cfs per square mile near Copper Center and about 8 cfs per square mile at the southern extremity. Typical winter runoff rates vary linerarly along the pipeline route from 0.2 cfs per square mile in the Alaska Range to 0.5 cfs near Thompson Pass (USGS 1971).

Most large streams south of Glennallen, with the exception of Squirrel Creek and the Little Tonsina River are impacted to some degree by glaciers. The most severe impacted stream, the Tazlina River, is subject to frequent, severe lake outbursts from both Tazlina and Nelchena glaciers. Flood discharges from outbursts have been 10 times as high as the highest discharge from nonoutburst floods, (USGS 1971). The Klutina, Tonsina, and Tsina rivers are also subject to infrequent outburst flooding. It is conceivable, but not likely, that an outburst lake could form on any glacier.

3.2.9.4.2 Surface Water Quality

This drainage extends from the south slopes of the Alaska Range to Thompson Pass and includes mountainous areas of moderate rainfall and glacially originated streams. Except for the Gulkana most large streams in the region are heavily sedimented in the spring and summer and clear during the fall and winter. Concentrations reach 2,000 mg/l on glacial headwater streams in the summer.

There are several large, deep lakes along the route, including Paxson and Summit Lakes. Water quality of these lakes is good, although phosphate levels are very low, and nitrate levels are often quite high.

There is only limited domestic and industrial use of surface water in this area. There are only a few small communities along the route and most do not have a water system; houses typically have a well and a leach field.

3.2.9.4.3 Ground-water Hydrology

The Copper River Basin is located within the discontinuous permafrost zone, although permafrost is sporadic in the southern portion. Infiltration rates to ground water is limited by this permafrost and occurs mainly through the beds of larger rivers and lakes and other unfrozen zones (USGS 1978). Consequently, ground-water supplies are difficult to locate in the central part of the basin and quality tends to be poor.

Springs draining the alluvial deposits on the south flank of the Alaska Range and the north flank of the Chugach Mountains are common. Springs provide a major component of surface water flow in several streams (Sourdough and Squirrel Creeks). Hillside springs near Squirrel Creek and near the Little Tonsina River create icings on the hillside, particularly in disturbed areas. Well yields, in bedrock wells, are about 10 to 20 gallons per minute (USGS 1978).

3.2.9.4.4 Hydrologic Hazards

Hydrologic hazards include floods, channel scour, lateral erosion, and meander cutoffs. Hazards also include the impact and uplift forces of floating ice on structures such as bridge piers. Diversions by icings or by aggrading streams is also a possibility. Streambeds may scour rapidly as the result of meander cutoffs. A particular flood risk is associated with glacier outburst floods. Large slab avalanches are a hazard in the Chugach Mountains. Ground icings from springs near Squirrel Creek and the Little Tonsina Rivers are likely.

3.2.9.4.5 Present Water Use

There is very little water use in the Copper River basin. Domestic use is limited to use by a few small communities and construction camps. There is limited use by TAPS and DOT/PF maintenance camps.

3.2.9.5 Prince William Sound Drainage

The Prince William Sound Drainage is the smallest basin crossed and is bounded by the Chugach Mountains on the north and Prince William Sound on the south. The proposed TAGS pipeline follows the Lowe River to Port Valdez then goes along the south side of the arm to the terminal (TAGS Mile 775 to 796). With the exception of the Lowe River, streams are short and swift; most head in glaciers. The climate is considerably warmer in winter and wetter. Most streams do not freeze in winter. Annual precipitation rates range to 160 inches.

3.2.9.5.1 Surface-water Hydrology

Runoff rates are unusually high; up to 12 inches per year. Rates vary less from season to season than for any other portion of the pipeline. Runoff is rapid, infiltration and evaporation rates are low; and streams respond rapidly to changes in precipitation rates. The largest floods occur in late summer or fall as the result of general rainstorms. Floods are sometimes augmented by melt of snow or ice by rain. Winter floods caused by rain are not unknown. Mean annual low flow occurs in the winter (about one cfs per square mile) and results largely from return of ground water infiltrated into bedrock.

Glaciers are a dominant feature of the Chugach Mountains. All major streams are impacted by glaciers. Outburst floods have occurred on Sheep Creek, most recently in 1945. Glacier melt augments summer flow and is responsible for the turbidity of streams.

With the exception of the Lowe River, all streams in the basin are controlled by bedrock and have limited alluvium. The Lowe River's braided channels within the floodplain are unstable and subject to rapid change. Outburst floods, as well as any other large flood, tend to wash sediment from the floors of the rock stream channels and deposit this material as fans in receiving streams. The most recent Sheep Creek outburst deposited 25 feet of debris as a fan in the Lowe River (USGS 1971). Streams southerly of the mouth of the Lowe River discharge directly into tidewater.

3.2.9.5.2 Surface Water Quality

Water quality is generally good with the exception of occasionally high suspended solids in summer and early fall due to glacial runoff.

Water quality data shows less fluctuation in most parameters for streams in this area. Dissolved oxygen values appear to be uniformly high, with low phosphates and fairly high nitrates present. Very little information exists for lake water quality in the area, and low human use is presently being made of surface waters except for the private fresh fish hatchery at Solomon Creek.

3.2.9.5.3 Ground-water Hydrology

The Prince William Sound Drainage is free of permafrost at lower elevations. The principal aquifers in alluvium recharge easily and wells yield about 200 gallons per minute of goods-quality water. Additional aquifers are found in the joints and fractures of bedrock. Yields vary widely.

Ground-water discharges occur as springs from bedrock and at the base of alluvial fans. These discharges tend to form icings, principally in the Lowe River floodplain. These icings, however, tend to be small because of the warm temperatures.

Water from deeper wells sometimes exceeds the U.S. Public Health Service limits for chloride, sulfate, and magnesium (USGS 1971).

3.2.9.5.4 Hydrologic Hazards

Hydrologic hazards include floods and the channel scour, lateral erosion, and meander cutoffs associated with them. Hazards also include the impact and uplift forces of floating ice on structures such as bridge piers. Diversions by icings or by aggrading streams is a possibility in the Lowe River. A particular flood risk is associated with glacier outburst floods on Sheep Creek as well as other similar streams. A unique hazard in this area is the possibility of extremely large flood discharges on Solomon Gulch Creek should the upstream dam fail. Large slab avalanches are a hazard to much of the route.

3.2.9.5.5 Present Water Use

Present domestic use of water is limited to the municipal supply for the City of Valdez and a very limited number of individual wells. There is a limited industrial water use by the TAPS at their terminal. The Solomon Gulch Hydroelectric Project is essentially a run-of-the-river plant which does not alter the seasonal runoff pattern but will alter short-term runoff rate. A second hydrologic project, Allison Lake, is authorized for construction by the USACE. Its potential regulation of stream flow is not known at this time.

3.2.10 Marine Environment

3.2.10.1 Physical Oceanography

3.2.10.1.1 Introduction

The main affected environments of the proposed TAGS project are the nearshore environment in the vicinity of the LNG and terminal facilities and the route of LNG tankers through Prince William Sound and the central Gulf of Alaska.

The proposed LNG plant and tanker terminal are located on the western shore of Port Valdez, an east-west trending fjord about 3 miles wide by 12 miles long. The bottom is notably flat and approximately 750 feet deep (Figure 3.2.10-1). Steep mountain walls extend along the northern and southern sides of Port Valdez up to altitudes of 3,000 to 5,000 feet. The seafloor of Port Valdez slopes more gradually in the eastern end of the port into the outwash plain of the Lowe River, the Robe River, and Valdez Glacier streams. At the far western end of Port Valdez, and typical of a glaciated fjord, lies a narrow double-silled entrance,

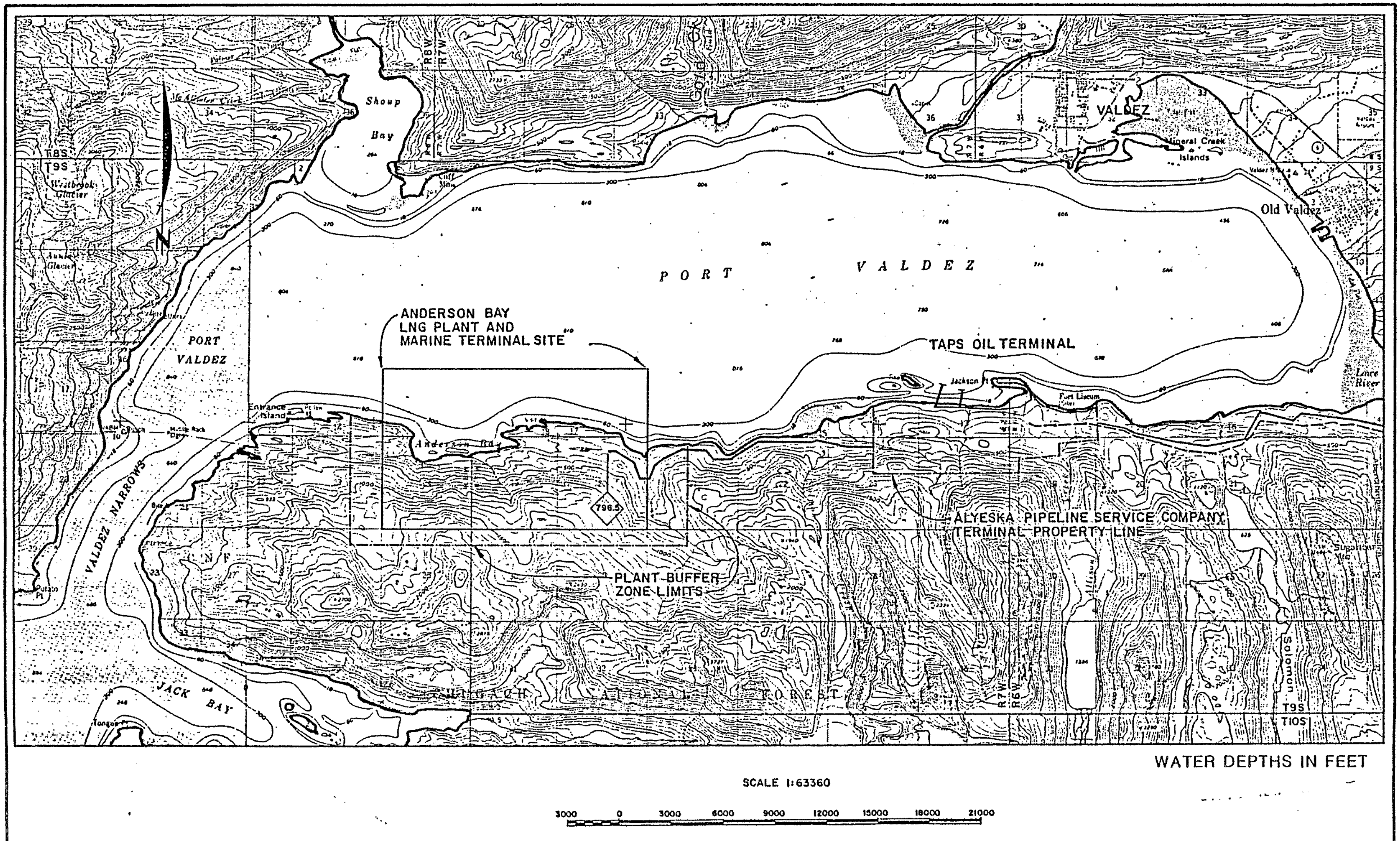


Figure 3.2.10-1 Port Valdez and Vicinity

Valdez Narrows, which connects with the Valdez Arm into Prince William Sound and the Gulf of Alaska. Water depth in the constricted area is in the range of 350 to 500 feet. The shore of Port Valdez is rocky everywhere except where deltas and moraines have been built into the fjord by streams and glaciers.

The physical oceanography of Port Valdez has been described in a number of documents, including Hood et al., 1973; DOI, 1972; and Colonell (ed.), 1980.

3.2.10.1.2 Circulation, Currents, Tides

Circulation within Port Valdez is determined by interactions of tidal currents, wind-driven currents, and freshwater input from both glacial and nonglacial streams. Tides, which normally provide the primary driving force for Port Valdez circulation, are mixed semidiurnal with a mean tidal height of approximately 10 feet and an extreme range of approximately 22 feet. Tidal currents are predominantly east-west in conformance with the configuration of the bay.

Local wind conditions have a major influence on near-surface currents. Because of the channeling effect of the mountains surrounding Port Valdez, prevailing winds in the general vicinity and thus, wind-driven currents, are also directed into an east-west direction. Highest currents that have been observed near Jackson Point, just north of Anderson Bay, were approximately 1.7 feet per second but are most often below 0.6 feet per second. Currents below 50 feet are generally quite low, less than 0.05 feet/second. Finally, prevailing winds in the Gulf of Alaska have also been shown to drive coastal upwelling and downwelling in the Gulf of Alaska and to cause intrusions of bottom waters into Port Valdez from Prince William Sound between March and July.

During summer a strongly stratified two-layered system results from increased freshwater input and higher surface temperatures. Warmer, less saline water has a net movement seaward, while colder, more saline water flows in through Valdez Narrows at depth. Late fall to early spring conditions generate uniform water column salinity and temperature, and flow due to tidal current is generally more restricted to the near surface waters (upper 50 feet). Studies in published reports have detected shifts in flow directions under both stratified and unstratified conditions but have not been fully able to correlate such occurrences with climatic factors. The net effect of tides, wind-driven currents, and storm-induced flows is a "residence time" or period of full exchange of Port Valdez water in the range of a few weeks to a conservative 40 days (Niebauer & Nebert 1983).

3.2.10.1.3 Waves

Waves in Port Valdez are locally generated by winds. Wave height and period is a function of wind, speed, duration, and fetch. An estimated maximum one-hour average wind speed of 62 knots from the east, building up over a 12-mile fetch, was used to calculate an estimated maximum significant wave height of over 10 feet (Dames & Moore 1979). This wind speed and direction often occurs in winter. Wave heights in the vicinity of Anderson Bay would be expected to be substantially less. More commonly, wind speeds are such that significant wave heights are less than 1 foot, with a significant period under two seconds, 90 percent of the time during winter months and 98 percent of the time during the summer (Dames & Moore 1979).

3.2.10.1.4 Sedimentation

Annual input of suspended material into Port Valdez from the three largest sediment sources, the Lowe River, Mineral Creek, and Valdez Glacier Stream, was estimated to be more than 2.76 x 10^6 metric tons, with virtually all of the sediment retained within the port (Sharma & Burbank 1973).

Sedimentation rates were estimated to range from 5 inches/year 1.5 miles west of the Lowe River mouth to less than 0.4 inches/year in the western portions of the port. In addition to sediment transport by typical processes of floccuation of suspended sediments, resuspension, and redeposition, processes that are generally prevalent in spring through early fall, atypical processes, submarine slides, and subsequent turbidity currents have also been described for Port Valdez as the result of tectonic activities. These have generally occurred on the steep slopes of unconsolidated sediments that form the submerged river deltas and glacial terminal moraines.

3.2.10.1.5 Ice

One of the primary features of Port Valdez for use as a port is that it is icefree year-round. Even during the most severe winters, oceanographic conditions preclude free formation of sea ice in the Gulf of Alaska (DOI 1984). Though ice discharged by Columbia Glacier is sometimes driven into Prince William Sound by north winds, and sea ice sometimes forms in the arms of the sound, the only ice generally found in Port valdez is the occasional floating Shoup Glacier ice that has escaped from Shoup Bay (AEIDC 1983). Large Columbia Glacier icebergs may occupy vessel traffic lanes into and out of Valdez Arm, especially during summer and fall.

3.2.10.1.6 Water Quality

Temperatures in Port Valdez range from 36 to 59°F. Highest temperatures occur near the surface during summer. Observed salinities range from 0 to 32 ppt with lowest values found in surface waters flowing out from rivers and creeks draining into the port during late spring to early fall. Lowest salinities found in central portions of the port below the uppermost 5 feet was rarely below 24 ppt.

Various aspects of chemical oceanography, nutrient concentration, and hydrocarbon levels for the waters of Port Valdez have been discussed in detail in Hood et al. (1973) and updated in Shaw (1984). Of water-quality parameters measured by Hood et al. for which EPA water quality standards have been established, the following values are relevant.

- Dissolved oxygen (DO) - lowest measured DO at 1 meter above the bottom was 7.6 mg/l; lowest observed value was 6.7 mg/l;
- pH - surface water range was 8.1 to 8.85; lowest bottom water pH was 7.96;
- Concentrations of arsenic, chromium, copper, mercury, nickel, and selenium were described as all within specifications. Two values of aluminum and one value of cadmium exceeded the range;
- Hydrocarbon concentrations were nearly all below 1.0 ppb and never greater than 10 ppb.

3.2.10.2 Marine Biology

3.2.10.2.1 Introduction

The LNG facility, the port and its associated facilities, and the marine transportation have the potential to affect the nearshore marine life in Port Valdez and the shipping route of the TAGS system through Valdez Arm and Prince William Sound. The existing marine resources for these areas are described for Port Valdez and the sound as far as Hinchinbrook Entrance, which opens into the Gulf of Alaska about 60 miles southeast of the Anderson Bay marine terminus.

These resources are important as a part of the local and nearshore ecosystem and support subsistence, commerical, and sport fishing; a transportation route for deer, bear, and waterfowl hunting; and some marine mammal harvesting. Since many species in the area migrate over vast distances, they are of international interest.

3.2.10.2.2 Benthos

The shoreline of Port Valdez is steep and rocky on the western half but extends into boulder-cobble beaches and extensive mudflats to the east where the Lowe and Robe rivers enter. The composition and abundance of organisms along the rocky shores vary widely on an annual basis (Feder 1983). Species abundance and diversity are generally greater in the upper part of the intertidal zone (Dames & Moore 1979).

The intertidal zone supports a biota characteristic of southcentral Alaska coastal areas, including a fairly sparse plant community but a relatively large animal biomass. The most important animals appear to be clams, blue mussels, barnacles, harpacticoid copepods, and several species of polychaete worms (Feder 1983). Intertidal algae species include the fucoids and eelgrass important for the herring egg fishery.

The subtidal infauna of Port Valdez is dominated by deposit-feeding organisms typical of soft substrates, including polychaete annelids and bivalve molluscs. Total number of species, species diversity, and biomass are relatively low, probably symptomatic of an environment with repeated seasonal disturbance associated with high sedimentation rates (Feder 1983).

Benthic studies of the deeper areas of Port Valdez indicate that polychaetous annelids were the most important group of benthic organism. More than a hundred species of annelids were identified, making them the most diverse taxa in the Port Valdez benthic communities. Molluscs were second in importance with approximately 60 species present. Echinoderms were the only other significant group present (Feder and Matheke 1980).

Data from the three benthic subtidal sampling stations nearest to Anderson Bay had general composition, total species, numbers of organisms, and species diversity that showed them to be generally similar to other benthic sampling stations throughout the western Port Valdez (Feder and Matheke 1980).

In the shallow subtidal zone adjacent to the proposed construction area both rocky and soft habitats occur. Where present, the shallow rocky areas contain rich kelp bed communities with a diverse group of marine invertebrates. This type of community is important to some species of fish and is also important in the kelp-herring roe fishery.

3.2.10.2.3 Fish

Four species of Pacific salmon (pink, chum, silver, and red) inhabit Port Valdez during some portion of their life history. King salmon are occasionally present but are not known to spawn in local streams and are therefore excluded from the following discussion. Commercial values of these and other important species are discussed in Subsection 3.2.10.2.6.

During summer adult salmon enter Port Valdez and spend from a few hours to six weeks in the area before entering their natal spawning streams. Pink and red salmon usually arrive in late June, spawning in July and early August. The other species arrive somewhat later. Silvers, for example, arrive in August and spawn as late as October.

Another period of importance occurs when pink salmon fry emerge from the gravels of their home streams in spring and shortly thereafter proceed downstream into the estuarine environment. This migration occurs somewhat more slowly for chum salmon, and may take two to three years for silver and red salmon, the latter usually spending two years in a lake before entering the marine environment.

Marine species in the deep, offshore area appear to be present in low numbers, but the equipment used in previous surveys may have been inefficient at capturing larger, more mobile fish. Studies report the presence of 23 species, including five species of flounder, one skate, and several types of cod and sculpin. Pacific perch and yellow-eyed rockfish, pollock, and halibut have also been observed. Shallow regions are more diverse and include large numbers of black rockfish, Pacific cod, ling cod, and greenling. Herring utilize the shallow subtidal algae beds of Jack Bay and Valdez Arm for spawning during April and May (Valdez CDD 1982).

3.2.10.2.4 Birds

Port Valdez is classified as a "high use area" for seabird and waterfowl and there are seabird and shorebird colonies in Shoup Bay and vicinity, in the shallow, eastern end of Port Valdez, and in areas in Valdez Arm (DOI 1984).

A specific discussion of birds in the Port Valdez area can be found in the EIS prepared for the proposed ALPETCO project (EPA 1979). A summary of that report is presented in the following paragraphs.

Approximately 113 species of birds typically occur in the Port Valdez and Valdez Arm areas each year. The highest diversity and abundance is found in the nearby deciduous forest community during the summer. The marine littoral waters and intertidal zone support the greatest densities during winter months.

Seasonal migration patterns are similar to other areas of Prince William Sound, but relative abundance within each species appears to be quite low.

The Robe Lake freshwater marsh is perhaps the most important wildlife habitat in the study area, followed by salt marshes at Dayville Flats, Island Flats, Mineral Creek delta, and Shoup Bay. All support waterfowl nesting sites are scarce in Port Valdez. During spring and fall migration, salt marshes at Island Flats and Shoup Bay are often used as staging or resting areas by several hundred migrating Canada geese. The small Dayville Flats marsh also receives some use by migrating waterfowl.

In winter, diving and sea ducks are relatively abundant. Barrow's golden-eyes, common golden-eyes, buffleheads, harlequin ducks, and white-winged scoters typically move onto intertidal flats to feed on pink-shelled clams during high tide. Nearshore waters are clearer during winter and feeding conditions better than during the summer. Primary feeding areas are located near Solomon Gulch Creek and Island Flats.

3.2.10.2.5 Marine Mammals

Whales use the offshore marine habitats much more than other marine mammals, which are associated with various shoreline features. The five species of whales noted in Valdez Arm and Port Valdez include the killer whale (occasional); minke whale (rare); humpback whale (rare); finback whale (rare); and sei whale (rare). The latter three are on the endangered species list.

Two species of porpoise occur occasionally in the area--the harbor porpoise and the Dall porpoise. Other marine mammals common in the area include the Steller sea lion, the sea otter, and the harbor seal (Valdez CDD 1982; EPA 1979).

3.2.10.2.6 Commercial and Sport Fisheries

The fish resources of the Gulf of Alaska play an important part in the Alaskan and the international commercial fishing industry. Of commercial importance are salmon, halibut, herring, ocean perch, black cod, pollock, Pacific cod, turbot, and other bottomfish. Commercial shrimp and crab and other shellfish operations are also very productive in the gulf. In 1980 the Gulf of Alaska provided 8.2 percent of the total domestic and foreign fisheries harvest in U. S. waters (MMS 1984).

Commercial value of Prince William Sound fisheries for the most recent years that published data were available (1984) were: salmon, $41 million; other finfish, $4 million; and shellfish, $2 million--totalling $47 million (ADF&G 1986). During 1985 the commercial purse seine catch in pounds for Port Valdez and Valdez Narrows (statistical area 221-60) was 0.35 million and for Valdez Arm (statistical area 221-50) was 10.1 million. These represented 1.2 percent and 35.0 percent of the record 28.9 million pound Prince William Sound catch for 1985. For both commercial and sport fishing salmon activitiy in the general project area fishing is heaviest through Valdez Narrows and into Port Valdez as far as a fishing closure line running north/south across the port near the eastern end of the proposed LNG site (146°30'30"W). Port Valdez is closed to commercial salmon fishing east of this point.

For Confusion Creek, which empties into Anderson Bay, peak observed salmon escapement during the occasional years when observations were made, has been on the order of 40 to 550 pinks. No chum observations have been made since 1963 (J. Brady, pers. comm.).

The Lowe River and Robe Lake systems have been principal producers of sockeye and coho salmon, though the quality of the Robe run Lake has declined in recent decades due to natural changes in sedimentation in Corbin Creek eutrophication after a 1950's diversion of Corbin Creek away from Robe Lake. Previously, the Robe Lake system supported runs in excess of 40,000 sockeye; but by 1982 the average run was approximately 5,000 (Valdez CDD 1986).

The Valdez Fisheries Development Association's Solomon Gulch Hatchery, about 8 miles east along the shoreline from Anderson Bay, had a forecast return of 294,000 pink salmon from the 1984 fry release of 8.4 million (Randall et al., 1985). A return of two million pinks was expected in 1986 (Fairbanks Daily News Miner 1986). Chum, chinook, and coho salmon are also spawned at the Solomon Gulch Hatchery and coho are being pen-raised just offshore of the hatchery. The first coho returns occurred in 1986. Beginning in 1984 chinook salmon fry raised in the hatchery were held and released in Anderson Bay. The first return of three-year-old kings is expected in 1987.

The International Pacific Halibut Commission reported 168,298 halibut landed in the Valdez area in 1984 (ADF&G 1986).

Since 1964, herring roe has been commercially harvested in Prince William Sound. In 1969 Prince William Sound became Alaska's main herring-eggs-on-kelp harvest area with an annual production of nearly a quarter-million dollars worth of export product (NOAA and BLM 1980). Though herring do not return to the same spawning area each year, they generally utilize shallow subtidal (intertidal to 60 feet) algae beds for spawning in April and May. The nearshore area in the vicinity of Anderson Bay is among the areas that have historically been utilized (J. Brady pers. comm.).

The 1984 Prince William shellfish harvest consisted of: clams 168,000 lb.; Dungeness crab 824,000 lb.; king crab 34,000 lb.; shrimp 1,411,000 lb (ADF&G 1986).

There are two major fish processing plants in Valdez, which has a fleet of more than 40 commercial fishing boats (Alexiev 1983).

3.2.11 Fish

3.2.11.1 Introduction

The fisheries resources of Alaska are among the most abundant and valued in the world. They are an essential part of the livelihood of many Alaskans and a highly important industry for Alaska's present and future economy. Fish also comprise a component of the environment vulnerable to both local and general population levels throughout their range. More than 200 rivers and streams inhabited by fish would be crossed by the TAGS project, including some exceptionally productive salmon streams listed in Table 3.2.11-1.

This section adopts previously prepared EIS sections by reference wherever applicable but includes a discussion on the physical aspects of the drainage and brief life history of the important species. Limiting factors, where understood, are also discussed as well as updated information on present stress to these organisms. Table 3.2.11-1 summarizes life history information for the key species found along the entire TAGS route. No threatened or endangered fish species are known to live in waters traversed by the TAGS project.

3.2.11.2 Arctic Slope Drainage

The arctic drainage is that area from the Beaufort Sea coast to the south end of Atigun Valley. It includes the nearshore Beaufort Sea coast.

Marine and anadromous fish are important to the North Slope Eskimo (Inupiat) subsistence fishery as well as a limited but valuable sports fishery and a small commercial fishery. The affected environment of fish on the coastal plains and the nearshore Beaufort Sea area of the North Slope is discussed in the FEIS on the Northwest Pipeline Gas Conditioning Plant (FERC 1980) and in the Endicott EIS (COE 1984) and is incorporated by reference. However, some discussion of critical habitat and updated life history information is included.

Perennial springs, larger lakes, and deep pools (greater than 7 feet) in rivers and major tributaries may provide the only source of flowing or unfrozen water during the long winter freezeup period and are therefore critical to the survival of overwintering populations of freshwater and anadromous fish and their eggs in the arctic drainage (DOI 1986). The integrity of the riparian habitat is also very important for maintenance of fish stocks in coastal plain water bodies.

The life histories of most arctic region fish are complex and not completely understood. It is known that these fish grow and develop slowly and have life spans of up to 40 years. These characteristics are probably the result of low primary and secondary productivity of the waters, the short growing season, and low water temperature.

Arctic char are found primarily in the Sagavanirktok River and its major tributaries entering from the east. Both the strictly freshwater and the anadromous populations of char are present. Most of the char in the Sagavanirktok River are anadromous and migrate upstream from the Beaufort Sea in late July or August of each year.

Arctic grayling are widely distributed in the arctic drainage and are found in the clear waters of most streams and lakes. Overwintering occurs in the deep pools of the lower rivers and tributaries and the deeper lakes.

Round whitefish are one of the most widespread and common species in northern waters, inhabiting both lakes and streams. They are an important subsistence species, taken primarily with gillnets. They occur in most major North Slope drainages and in coastal lagoons. The Sagavanirktok River appears to be a major whitefish spawning area (McCart et al. 1972).

Other species such as Arctic cisco, broad whitefish, and salmon are not typicaly found in the Sagavanirktok River.

Inupiat use all species found in these arctic drainages to some extent for subsistence, both along the coast and in the Sagavanirktok River and larger lakes.

Sport fishing pressure has increased in recent years due to the haul road (Dalton Highway), which has greatly increased accessibility and the number of people using the area. Although grayling and char can still be caught by anglers near the highway, these fish are typically much smaller and less numerous than before road access. The

Table 3.2.11-1 Fish Streams Along the Prudhoe Bay to Valdez Route

Stream	Milepost*	Fish Species	Most Critical Time	Least Critical Time
1. Putuligayuk River	3.1	GR, SB	May-Sept.	Oct.-Apr.
2. Sagavanirktok River	20.8-37.0[1/][2/]	GR, WF, BU NS, SC, AC,	May-Sept. May-Sept. 15	Oct.-Apr. Oct.-Apr.
3. Happy Valley Creek	84.5	BU, SC, GR, WF		
4. Toolik River	124.6	GR, BU, WF, AC	May-Oct.	Nov.-Apr.
5. Kuparuk, East Fork	125.3	BR	May-Sept.	Oct.-Apr.
6. Kuparuk River	126.9[2/]	GR, BU, WF, AC, SC	May-Aug. 15	Nov. Apr.
7. Oksrukuyik Creek	115/117.6[2/]	AC, GR, SC, BU, WF	May-Aug. 15	Nov.-Apr.
8. Galbraith Lake Inlet	137.3[2/]	BU, GR, LT	May-Oct.	Nov.-Apr.
9. Atigun River	154.8/162.2	AC, SC, LT, GR, BU, WF	May-Dec.	Jan-Apr.
10. Chandalar River	167.9[1/]	DV, GR, SC NP, WF	May-Oct.	No.-Apr.
11. Dietrich River	174.3/178[2/][1/]	WF, DV, GR, BU, SC	May-Oct.	No.-Apr.
12. Nutirwik River	183.5	GR	May-Oct.	No.-Apr.
13. Snowden Creek	197.5	GR, SC	May-Oct.	Nov.-Apr.
14. Linda Creek	214.0	Sc, GR	Apr.-Oct.	Nov.-Mar.
15. Sheep Creek	215.4	GR, SC	Apr.-Aug.	Nov.-Mar.
16. Wolf Deep Creek	215.8	SC	none	none
17. Nugget Creek	216.4	GR	Apr.-June	Jan.-Mar.
18. Over Creek	217.7	BU, GR	Apr.-June	Jan.-Mar.
19. Coon Gulch	220.1	GR	Apr.-June	Jan.-Mar.
20. Minnie Creek	224.0	WF, GR, BU, SC, DV	Apr.-June	Aug.-Dec.
21. Marion Creek	231.4	WF, GR, BU, SC, DV	Apr.-June	Aug.
22. Clara Creek	234.7	GR	Apr.-June	Aug.-Mar.
23. Slate Creek	236.0	KS, GR, DV WF, SC	Apr.-Oct.	Nov.-Mar.
24. Rosie Creek	241.4	GR, SC, WF, DV	Apr.-June	Aug.-Mar.
25. Windy Arm Creek	246.5	SC, GR	Apr.-June	Aug.-Mar.
26. Upper Chapman Creek	248.9	GR	Apr.-June	Aug.-Mar.
27. Koyukuk River, South Fork	255.0[2/]	GR, KS, SC, CS, WF, SU	Apr.-Oct.	Nov.-Mar.
28. Grayling Creek	261.9	GR	Apr.-June	July-Mar.
29. Jim River	265.8[2/]	GR, CS, KS, WF, SC, SU	Jan.-Dec.	--
30. Douglas Creek	268.6	GR, SC	Apr.-June	Aug.-Mar.
31. Prospect Creek	275.3[2/]	CS, KS, GR, WF, SC, SU NP	Apr.-Oct.	Nov.-Mar.
32. Bonanza Creek, North Fork	282.1	GR, WF, SC, SU, NP	Apr.-June Sept.-Oct.	July Jan.-Mar.
33. Bonanza Creek, South Fork	284.0	GR, WF, NP, SC	Sept.-June	Aug.
34. Fish Creek	292.0/293.7/294.8	GR, WF, SC, SU	Apr.-June	Aug.-Mar.
35. Kanuti River	300.2[2/]	NP, BU, RW, WF, SS, GR, SC, CS	Apr.-June Aug.-Oct. Nov.-Dec. Aug.-Mar.	Jan.-Mar. July
36. Dall River, West Fork	312.7/315.0	WF, IN, GR, NP	May-June	Aug.-Mar.
37. Unnamed Stream (tributary to Ray River)	326.7/346.5	SC, IN, WF NP, GR, BU	Apr.-June	Aug.-Mar.

Table 3.2.11-1 Fish Streams Along the Prudhoe Bay to Valdez Route (continued)

Stream	Milepost*	Fish Species	Most Critical Time	Least Critical Time
38. Yukon River	349.2[2/][3/]	PS, RS, CS, KS, WF, GR, SS, IN, NP, BU, SC, SU, TP	Jan.-Dec.	--
39. Isom Creek	358.9	GR	May-Sept.	Nov.-Apr.
40. Fish Creek	373.3	GR	May-Sept.	Nov.-Apr.
41. Hess Creek	373.6[2/]	SC, WF, IN, CS, SU, NP, GR, BC, SC	May-Sept.	Nov.-Apr.
42. Erickson Creek	379.6/383.0	GR, SU	May-Sept.	Nov.-Apr.
43. Lost Creek	387.3	GR, WF, SC	May-Sept.	Nov.-Apr.
44. Tolovana River	393.6[2/]	NP, BU, WF, KS, CS, IN, GR	Apr.-Nov.	Nov.-Apr.
45. Slate Creek	402.8	GR	May-July	Sept.-Apr.
46. Tatalina River	407.2[2/]	IN, WF, GR, BU, NP	May-Aug.	Dec.-Apr.
47. Globe Creek	412.4	GR	May-July	Nov.-Apr.
48. Aggie Creek	418.0/418.8	GR	May-July	Nov.-Apr.
49. Washington Creek	426.0	GR, WF, SC	May-July	Nov.-Apr.
50. Chatanika River	432.3[2/]	WF, IN, NP, BU, SS, KS CS, GR	Jan.-Dec.	--
51. Treasure Creek	436.1	SC	May-July	Nov.-Apr.
52. Goldstream Creek	442.1	GR, WF, NP, BU	May-July	Aug.-Apr.
53. Little Chena River	452.5	check	check	check
54. Chena River	452.9[2/]	IN, WF, NP, BU, KS, SS, CS, GR, SC, SU	May-Nov.	Dec.-Apr.
55. Moose Creek	467.7	GR, NP, SU,	Apr.-Nov.	Dec.-Mar.
56. French Creek	469.7/470.4	GR, WF, BU, NP	Apr.-Nov.	Dec.-Mar.
57. Little Salcha River	483.0[2/]	GR, WF, KS, CS, SC	May-Nov.	Dec.-Apr.
58. Salcha River	488.1[2/]	WF, BU, NP GR, KS, CS SS, SC, SU	Jan.-Dec.	--
59. Redmond Creek	492.1[2/]	KS, CS, GR, WF, SC, BU	May-Oct.	Nov.-Apr.
60. Gold Run Creek	499.0	check	check	check
61. Rosa Creek	506.1/511.2	GR	Mar.-Oct.	Nov.-Feb.
62. Shaw Creek	512.1	BU, GR, WF, SC, CS, SU, NP	Jan.-Dec.	--
63. Tanana River	524.0/[2] 1/	KS, SS, WF, GR, CS, NP, BU, SC, IN, SU	Jan.-Dec.	--
64. Ruby Creek	563.0	GR, WF	--	Jan.-Dec.
65. Bear Creek	564.3	GR, WF	--	Jan.-Dec.
66. Darling Creek	566.4	GR, WF	--	Jan.-Dec.
67. One Mile Creek	569.8	No Data	--	--
68. Gunnysack Creek	570.6	GR, WF	--	Jan.-Dec.
69. Boulder Creek	573.9	GR, WF	--	Jan.-Dec.
70. Whistler Creek	574.6	GR, WF	--	Jan.-Dec.
71. Floyd Creek	576.8	GR, WF	--	Jan.-Dec.
72. Michael Creek	577.8	GR, WF	--	Jan.-Dec.
73. Castnes Creek	580.6	GR, WF	--	Jan.-Dec.
74. Lower Miller's Creek	581.3	GR, WF	--	Jan.-Dec.
75. Phelan Creek	587.8	BU, SC, DV, GR, WF	Aug.-Nov.	Dec.-July
76. Upper Gulkana	610[2/]	SC, GR, RS, DV	May-Sept.	Nov.-Apr.

Table 3.2.11-1 Fish Streams Along the Prudhoe Bay to Valdez Route (continued)

Stream	Milepost*	Fish Species	Most Critical Time	Least Critical Time
77. Gillespie Creek	627.8	BU, SC, GR, KR, RS	Sept.-Mar.	Apr.-Aug.
78. Haggard Creek	634.8 2/	GR, SU	May-June	Nov.-Apr.
79. Gulkana River	649.1 2/1/	BU, DV, GR, KS, LT, RS, SH, SS, SC, SU, WF, RT	May-Oct.	Nov.-Apr.
80. Tazlina River	678.4 2/	BU, DV, GR, KS, SU, LT, RS, SH, SS, WF	May-Oct.	Nov.-Apr.
81. Yetna Creek	683.4/681.8	GR	May-June	Sept.-Apr.
82. Klutina River	688.9 2/	BU, DV, GR, KS, LT, RS, SS, WF, SH, GR	May-Sept.	Dec.-Mar.
83. Willow Creek	698.1	GR	May-June	Sept.-Apr.
84. Rock Creek	703.1	GR	May-June	Sept.-Apr.
85. Squirrel Creek	707.9	SC, DV, GR,	July-Oct.	Apr.
86. Tonsina River	714. 2/	SB, WF, SH, BU, DV, GR, KS, LT, RS, SS	May-Oct.	Dec.-Mar.
87. Little Tonsina River	2/715.8 2/	BU, SC, DV, GR, CS, LT, RS, SS, WF	July-Feb.	Mar.-June
88. Little Tonsina Tributary (Little Tonsina Flats)	716.2/725.1 2/	DV, KS, SS, SC, GR	July-Sept.	Apr.-June
89. 59-Mile Creek	730.9	DV	Aug.-Dec.	Apr.-July
90. Squaw Creek	734.7	DV	Aug.-Dec.	Apr.-July
91. Boulder Creek	737.5	DV	Aug.-Dec.	Apr.-July
92. Stuart Creek	743.2	DV	Aug.-Dec.	Apr.-July
93. Tsina River	748.2/755.3/757.1	DV	--	Nov.-July
94. Ptarmigan Creek	761.5	DV, RB	Aug.-Sept.	Nov.-July
95. Sheep Creek	768.8	SS	Aug.-Nov.	Dec.-July
96. Lowe River	770.6/774.6 1/	CS, DV, PS, RS, SS	July-Dec.	June-July
97. Clear Stream	2/778.2	DV, PS, SS	July-Feb.	June-July
98. Abercrombie Gulch	787.1	CS, DV, PS, SS	July-Feb.	June-July
99. Solomon Creek	789.1	CS, PS	July-Feb.	Mar.-June
100. Dayville Flats Creek	790.1	SC, DV, PS	July-Feb.	Mar.-June
101. Allison Creek	791.0	SC, CS, DV, PS	July-Feb.	June-July
102. Sawmill Creek	2/792.4	PS, CS	July-Feb.	June-July
103. Unnamed (Terminal Site)	2/793.8	PS, CS	July-Feb.	June-July
104. Unnamed (Terminal Site	2/796.1	PS, CS	July-Feb.	June-July

KEY

Arctic Char	AC	Dolly Varden	DV	Pink Salmon	PS	Sockeye (Red) Salmon	RS
Burbot	BU	Grayling	GR	Rainbow Trout	RT	Suckers	SU
Chinook (King) Salmon	KS	Inconnu	IN	Sculpin	SC	Trout Perch	TP
Chum (Dog) Salmon	CS	Lake Trout	LT	Steelhead Trout	SH	Whitefish and/or Cisco	WF
Coho (Silver) Salmon	SS	Northern Pike	NP	Stickleback	SB		

1/ Encroachment onto floodplain
2/ Denotes highly sensitive fish stream crossing
3/ Aerial crossing
* Milepost indicators to be provided when preferred route is selected

Source: BLM 1986, Fish Streams Along TAPS and ADFG, 1980 Fish Resources of ANGTS.

potential of these populations to support a larger fishing effort and still maintain a high degree of quality is unknown (DOI 1986).

There is no commerical fishing in, and little subsistence use of, the upper Sagavanirktok River drainage at present. The only commercial fishery in the arctic drainage is on the Colville River, 50 miles to the west.

3.2.11.3 Yukon River Drainage

The Yukon River drainage extends from Atigun Pass in the north to the Tanana River drainage in the south. The affected fish resources found in the Yukon drainage are discussed in the TAPS/ANGST and El Paso EIS's which are incorporated by reference in this section. However, some aspects of critical habitat and updated information on fish resources is presented below.

The Yukon River drainage is a huge area and includes many large lakes and rivers and a highly variable set of primary and secondary tributaries; therefore, its fisheries resources are more diverse than the arctic drainage. Salmon are present in large numbers and are especially important because they are commercial, subsistence, and sport fishing resources. The Yukon's major tributaries from the Brooks Range and those to be crossed by the TAGS pipeline include the Dietrich, the South and Middle Forks of the Koyukuk, and the Jim rivers. all are relatively clear with gravel- to cobble-size material comprising their streambeds.

There are nearly 50 rivers and streams inhabited by fish to be crossed by the TAGS pipeline in this region. These flowing waters contain a diverse variety of habitat. Rivers contain grayling, sculpins, suckers, whitefish, chum salmon, and a few king salmon which migrate up the Koyukuk as far as Coldfoot. Lake trout and Dolly Varden are found in some mountain streams, and burbot, suckers, inconnu, and northern pike are found in many lakes or streams from the Brooks Range south.

The Chena River near Fairbanks has burbot, northern pike, grayling, and several species of forage fish and is representative of slow-moving, deeper rivers of the Yukon drainage.

The route parallels the Delta River for a considerable distance. The Delta River mainstem is turbid and highly braided, although its headwaters are clear. Many tributaries of the Delta River crossed by the proposed TAGS route further downstream are fed directly by glaciers, have a steep gradient, and contain few fish. Salmon and most other species use the highly turbid mainstem mostly for migration, preferring the larger, clear tributaries for spawning.

The Tanana River is fed by glaciers from the Alaska Range and is heavily laden with silt during the warmer months, although several of its major tributaries are clear. Subpermafrost springs in certain locations, particularly sloughs and side channels of the Tanana and Delta rivers, provide spawning habitat for coho and chum salmon when these waters become clearer in the fall.

All of the lakes, rivers, and streams of this region freeze over to a depth of up to 5 feet during the long cold winters. Deep pools (10 feet or more) in the larger rivers and lakes are highly valuable as overwintering habitat, which may be the limiting factor for nonsalmonid fish populations in these waters. Subsurface springs and intergravel flow keep the maturing eggs from freezing during the winter. The tributaries of the Yukon serve as important migratory corridors for most of the species of fish present in the systems.

Many of the Yukon drainage rivers and streams are fairly accessible and accommodate a significant amount of sport fishing. The lower Chena River supports burbot fishing, and the headwaters support excellent grayling fishing. Many of the lakes near the proposed TAPS route support good populations of lake trout and northern pike, and most are heavily used by fly-in fishermen during the summer months.

3.2.11.4 Copper River Drainage

The Copper River drainage includes some of the most valuable fish-producing waters crossed by the proposed route. Extending from Isabel Pass in the Alaska Range to Thompson Pass in the Chugach Mountains, the river systems along the proposed route are fairly accessible to fishermen by road and boat. This, coupled with the high fishing quality of many streams and lakes, has resulted in an intensive and valuable sport fishery in much of this area. The Copper River system also is the spawning grounds for millions of commercially caught salmon in northern Prince William Sound, especially king, pink, and red salmon.

There are many large lakes in the drainage. Paxson and Summit lakes in the the alpine country of the Alaska Range are large, clear, and deep. Both are accessible by road and support considerable sport fishing for grayling and lake trout and some whitefish, burbot, and rainbow trout. They are also important rearing areas for sockeye salmon hatched in the upper Gulkana River and Fish lakes. Their accessibility can be a problem. During the winter of 1986-87 these lakes were closed to burbot and lake trout fishing due to severe reductions in breeding stock.

The Gulkana River is clear and accessible by road for most of its length and is the most important sports fishing stream in the Copper River system. Large numbers of red and king salmon and some steelhead trout annually migrate up this stream to traditional spawning areas. Additionally, there are significant resident populations of rainbow trout and grayling. There is a salmon egg taking and spawning facility on the upper Gulkana in this area.

Major tributaries of the Copper River include the Tazlina, Klutina, and Tonsina rivers. These large streams characteristically have a milky color due to glacial silt, yet support sizeable runs of red, king, coho salmon and some steelhead trout which spawn in smaller clearwater tributaries.Important personal use and subsistence fisheries exist on the lower Copper River, where dipnetting and fish wheels have traditionally been allowed. Personal use fishing pressure is primarily for red and king salmon; however, subsistence fishing occurs on other major tributaries within this basin.

3.2.11.5 Prince William Sound Drainage

The five species of Pacific salmon (chum, king, coho, pink, and red), comprise the major anadromous fish present in coastal area streams and rivers. During fall adult salmon migrate from northern Prince William Sound up freshwater streams to spawn. Many are caught by commercial fishermen offshore and many more by sports fishermen closer to shore and in the lower rivers.

Depending on the species, eggs of salmon are generally laid in the fall and hatch in the spring. Fry may migrate directly to sea or remain in fresh water for a year or so before migration. Salmon then spend one to five years in the North Pacific, again depending on the species, before returning to their parent streams to spawn and die.

Each salmon species and life stage has its own food preferences, which change seasonally and during growth. Juvenile salmon typically feed on plankton. Pink, red, and chum salmon continue to eat primarily plankton as adults, although they may also eat larger food items such as squid and shrimp. King and coho salmon juveniles and smolts subsist largely on insects and small fish when in fresh water. They switch to herring and other small marine fish as well as some planktonic organisms when in the ocean. With few exceptions, salmon do not feed after entering spawning streams.

The Lowe River, which is paralleled by the proposed route for several miles, is representative of most area rivers and is typically turbid in the summer due to silt from melting glaciers. In fall and winter these rivers are typically clear. Resident populations of Dolly Varden are present, and the Lowe River is an important production area for sockeye, pink, and chum salmon. Much of the salmon spawning occurs in the tributaries, sloughs, and side channels to the Lowe.

Other streams flowing directly into Prince William Sound crossed by the proposed TAGS route are typically smaller, but the lower reaches of most streams, frequently in intertidal zones, are spawning areas for pink and chum salmon. Many of these streams have impassable fish barriers a short distance upstream, and movement of fish upstream from the sound is limited. Streams that do not have natural barriers typically support runs of coho salmon.

3.2.12 Vegetation and Wetlands

3.2.12.1 Introduction

The vegetation along the proposed TAGS pipeline corridor is exceedingly variable, responding to differences in regional and local climates, surficial geology, and soils. The distribution of vegetation is further influenced by disturbances such as fire, flooding, and human alterations that have affected plant succession. Table 3.2.12-1 provides a summary of the major vegetative type along the proposed TAGS route.

The major vegetation types in Alaska have been classified in numerous ways since the earliest work by Spetzman (1963), but classifications are very similar (see Table 3.2.12-2). Later descriptions by Viereck and Little (1972), the Joint Federal-State Land Use Planning Commission for Alaska (1973), and in the Alaska Regional Profiles (Selkregg et al. 1975a,b) added to the geographic information. The Joint State/Federal Fish and Wildlife Advisory Team (Pamplin 1979) modified these classification schemes to emphasize wildlife habitat types. These broad classification schemes are supported by the more detailed hierarchical vegetation classifications especially designed for mapping in northern Alaska (Walker 1983) and the Alaska Vegetation Classification (Viereck et al. 1983). The major vegetation types, as they occur in the tundra, taiga, and coastal biomes are described below.

Wetlands perform important physical and ecological functions that deserve special consideration (OCM 1981). Wetlands play a major role in maintaining hydrologic systems and the quality and quantity of surface and groundwaters. Some wetlands can absorb large quantities of water and act as natural flood control systems for rivers by gradually releasing floodwaters and reducing the magnitude of high flows. Wetlands may slow the rate of runoff during periods of normal rainfall, and help recharge aquifers. In some cases, sediments and pollutants may be filtered out of water draining through wetlands, and water quality may thus be improved. Wetlands are extremely important to resident and migratory birds for resting, feeding, and nesting and can be important foraging grounds for large mammals such as caribou, moose, and bear.

A wetlands classification (Cowardin 1979) has also been developed to emphasize the hydrologic and wildlife habitat characteristics of vegetation. An earlier wetlands classification was used by Bergman et al. (1977) for waterbird habitat studies. Wetlands have been defined by the USACE (33 CFR 323) as "those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support a prevalence of vegetation, typically adapted for life in saturated soil conditions." The wetlands classification of each major vegetation type is included with the following descriptions based on the COE description and as identified in Table 3.12.1-1 would be approximately 51 percent of the proposed route. This value includes habitat types not specifically classified as "wetlands" by Pamplin (1979), but which are considered by others to meet the definition set forth in 33 CFR 323. (See affected enc.)

Table 3.2.12-1 Estimates of Major Vegetative Types Crossed by the Proposed TAGS Route

		Percent of Route
Arctic Tundra	Total	22
Wet Tundra		4*
Moist Tundra		13*
Alpine Tundra		1
Shrub Thicket		2*
Unvegetated Areas (floodplain and barren)		2**
Interior Taiga	Total	75
Upland Spruce-Hardwood Forest		26
Lowland Spruce		14*
Bottomland Spruce-Poplar Forest		3
Bogs		4*
Shrub Thicket		23***
Moist Tundra		5*
Unvegetated Floodplain		Trace*
Coastal Forest	Total	3
Spruce-Hemlock Forest		2***
Shrub Thicket		1
Bottomland Spruce-Poplar Forest		Trace

* Designated as wetlands.
** May be regulated as wetlands
*** A portion of this figure may be wetlands

Note: 51% of the total shown in this table is assumed to be wetlands.

Table 3.2.12-2 Comparable Vegetation Classes used in the Classification System of Selkregg (1975) and Viereck et al. (1982)

Selkregg et al. (1975)	Viereck et al. (1982) - Level II
Wet Tundra	Graminoid Herbaceous (wet graminoid herbaceous - Level III)
Moist Tundra	Graminoid Herbaceous (moist graminoid herbaceous - Level III)
Alpine Tundra	Dwarf Scrub, Low Scrub, Forb Herbaceous, Bryoid Herbaceous
High Shrub Thickets	Tall Shrub Scrub
Low Shrub Bog and Muskeg	Dwarf Tree Scrub, Low Shrub Scrub, Dwarf Shrub, Graminoid Herbaceous, Forb Herbaceoius, Bryoid Herbaceous, Aquatic (non-emergent) Herbaceous
Upland Spruce-Hardwood Forest	Needleleaf Forest, Broadleaf Forest, Mixed Forest
Lowland Spruce-Hardwood Forest	Needleleaf Forest, Broadleaf Forest, Mixed Forest
Bottomland Spruce-Poplar Forest	Needleleaf Forest, Broadleaf Forest, Mixed Forest
Coastal Spruce	Needleleaf Forest

The classification used here is that of Selkregg et al. (1975) because it provides a broad framework for describing the major ecosystems along the route.

A comparison of these classes with those of the Alaska Vegetation Classification (Viereck, et al. 1982) is presented in Table 3.12.1-2. The Selkregg classification is useful for a general description of the route because it provides discrete classes of vegetation that are related to landscape characteristics. The Alaska Vegetation Classification, which has been commonly accepted for detailed surveys, has been used for vegetation mapping (Levels III and IV) of the Copper River basin and Tanana River basin by the Alaska Department of Natural Resources but has not been used for mapping other land areas along the route. The disadvantages of using the Alaska Vegetation Classification for general descriptions are that at finer levels of resolution (Levels III through V) require information that is not generally available until the design phases of a project.

3.2.12.2 Arctic Tundra

The arctic tundra region, characterized by low-growing vegetation of mosses, lichens, grasses and sedges, and dwarf shrubs, is divided into three major physiographic provinces: the coastal plain, the foothills, and the mountains of the Brooks Range. The coastal plain generally supports wet tundra vegetation due to the shallow, saturated active layer above the permafrost. The foothills generally support moist tundra on the slopes, wet tundra in the swales, and alpine tundra on the more exposed, drier sites. In the Brooks Range, alpine tundra predominates as a result of the higher elevation and the coarser soils of mountain slopes. High shrub thickets develop on floodplains in less exposed areas or where enough snow accumulates to protect vegetation against harsh winter winds. In the active channel of the braided floodplains the surface is frequently barren.

Wet tundra consists of an almost continuous cover of sedges and grasses. Mosses and dwarf shrubs are frequently present in better drained sites; in standing water, rooted aquatic plants predominate. This wetland vegetation type (Palustrine, emergent, permanently, semipermanently, or seasonally flooded) provides important habitat for waterfowl.

Moist tundra in upland terrain varies from stands where cottongrass tussocks predominate to stands where dwarf shrubs, sedges, and mosses are dominant. Diamond-leaf willow and dwarf birch are important shrubs. This wetland vegetation type (Palustrine, emergent, persistent/scrub-shrub, broad-leaved deciduous, saturated) is important habitat for tundra birds and caribou.

Alpine tundra occurs in mountainous areas within both the tundra and taiga and on well-drained gravel ridges in the Arctic. It generally consists of prostrate shrub and lichen with occasional forbs, sedges, and mosses. This vegetation type is not classified as a wetland.

High shrub thickets of willow grow in protected sites on the floodplains of the Sagavanirktok and Atigun rivers and are common in small drainages in the foothills. These riparian shrublands (Palustrine, scrub-shrub, broad-leaved deciduous, temporarily flooded) are very productive and are important habitat for song birds, moose, and caribou.

3.2.12.3 Interior Taiga

Most of the proposed TAGS corridor passes through the subarctic forests of the interior region. The interior route passes primarily through forested areas, interrupted occasionally by treeless bogs in the lowlands and high shrub thickets near timberline and along floodplains. The major vegetation types found in the Interior are the bottomland spruce-poplar forest, upland spruce-hardwood forest, lowland spruce-hardwood forest, high shrub and low shrub bogs and marshes, which are briefly described as follows.

The bottomland spruce-poplar forest type is a tall, relatively dense forest along actively meandering rivers and streams and is one of the most productive interior forest types. The forest generally occurs as a narrow, permafrost-free band along the rivers as a result of a succession on freshly deposited alluvium.

Upland spruce-hardwood is the most extensive forest type along the route. Interior forest are greatly affected by fire, which leads to a patchwork of vegetation types throughout the region because of the many local areas in different stages of succession. On moderate south-facing slopes the forest is composed of white spruce, paper birch, or aspen in either pure stands or in combinations. This forest type along the Yukon-Tanana Uplands is an important source of sawtimber and firewood for interior residents. Black spruce, often with scattered paper birch, grows on northern exposures or on shallow, nutrient-poor soils. Black spruce stands are by far the predominant subtype in the upland spruce-hardwood forests, especially along the route alignment between Coldfoot and Fairbanks. On well-drained soils in upland areas, black spruce stands are not considered wetlands; however, on saturated soils underlain by permafrost (primarily on north facing slopes) this type is classified as wetlands.

Lowland spruce-hardwood forest is characterized by extensive pure stands of black spruce or by stands of black spruce mixed with paper birch, balsam poplar, and aspen. Treeless bogs occur in depressions throughout this forest type. Large areas burned since 1900 are covered by willow scrub and by dense stands of small black spruce. Where permafrost is present or the soils are saturated, this forest type is classified as a wetland.

High shrub thickets in the Interior occur along floodplains and near treeline, in a transition zone between upland spruce-hardwood forests and alpine tundra. Along floodplains, shrubs develop quickly on freshly formed alluvium that is subject to periodic flooding. Tall willows and alder dominate the canopy. The riparian shrub thickets (riverine unconsolidated shore, temporarily flooded) are very productive and are important wetland habitats for wildlife.

Low shrub bogs and marshes occur where conditions are too wet for tree growth, primarily in lowland unglaciated areas, old abandoned floodplains, in partly filled ponds and abandoned stream channels, and occasionally on gentle north-facing slopes. Some areas contain a nearly continuous cover of low shrubs; others are characterized by a cover of sedges and moss. These vegetation types are classified as wetlands (Palustrine, emergent and scrub-shrub, saturated to semipermanently flooded). The major occurrences of these wetlands are along the Chatanika Flats, Chena River flats, Shaw Creek flats, and portions of the Copper River drainage.

3.2.12.4 Coastal Forests

The vegetation in the Chugach Mountains south of Thompson Pass is influenced by the warmer and wetter maritime climate. At higher elevations in Keystone Canyon, nearly continous high shrub thickets occur. Coastal spruce and hemlock forest occur at lower elevations. The broad floodplain of the Lowe River supports productive bottomland spruce-poplar forests and high shrub thickets on gravel bars next to the braided channels. In poorly drained areas at low elevations, low shrub bogs and marshes are common.

Coastal spruce and hemlock forests are dominated by Sitka spruce and western hemlock, with a scattering of mountain hemlock and Alaska cedar.

Bottomland spruce-poplar forests along the floodplains of the Lowe River are dominated by black cottonwood and Sitka spruce.

High shrubs, dominated by Sitka alder, form extensive thickets on the mountain slopes near treeline and often have a well-developed grass and fern layer below. Willow and alder are also prominent on the floodplain forming riparian wetlands.

Low shrub bogs and marshes in the coastal region vary in species composition, but commonly have thick moss mats with some sedges and low shrubs and would be considered wetlands. A few slow-growing western hemlock or Alaska cedar are scattered on drier sites. Ponds containing aquatic plants are often present in lowlying areas. This vegetation type is classified as a wetland by the USACE.

3.2.13 Wildlife

3.2.13.1 Introduction

The route of the proposed TAGS project transects a broad spectrum of wildlife habitats and resources. Of the 67 species of terrestrial mammals (both native and introduced) recorded in Alaska (MacDonald 1980), at least 48 of them occur along the TAGS route. Similarly, of the 417 species of birds recorded in Alaska (Gibson 1986), at least 225 species inhabit areas along or adjacent to the TAGS route. Most birds along the corridor are migratory. Peak use of terrestrial habitats occurs during the summer breeding season (May-August), and a number of species occur in seasonal concentrations during the spring (March-May) and fall (August-October) migration periods.

Wildlife resources are discussed within the context of the four major drainage divisions used in subsection 3.2.9. In biogeographic terms, however these divisions are not necessarily distinct. In this sense the fauna of the Yukon and Copper river drainages are quite similar, although arctic influences dominate in the northern part of the Yukon River drainage and coastal in the southern Copper River drainage.

The information presented in the following sections has been drawn largely from previous EISs (DOI 1972, FPC 1976, DOI 1976) and has been corrected and updated where appropriate. More complete discussions of birds in Alaska were prepared by Gabrielson and Lincoln (1959) and Kessel and Gibson (1978). No comprehensive, authoritative reference has yet been compiled for Alaska mammals, but useful information can be found in several regional treatments, including Bee and Hall (1956) and Buckley and Libby (1957). General distribution maps for mammals were presented by Mannville and Young (1965) and Hall (1981). Konkel et al. (1981) prepared synopses of habitat-use data for mammals and birds. Specific information on wildlife habitats along the proposed route is delineated in map atlases prepared by the Alaska Department of Fish and Game (1973; 1978; 1985; 1986(a,b) and by Hemming and Morehouse (1976). A summary of sensitive wildlife habitat from Prudhoe Bay to Anderson Bay is presented in Table 3.2.13-1.

3.2.13.2 Arctic Slope Drainage

3.2.13.2.1 Large Mammals

Caribou are by far the most abundant large mammals in the Arctic Slope drainage and have been the focal point of a substantial amount of research regarding the effects of petroleum development. The Central Arctic Herd (CAH) resides year-round in the region between the Colville and Canning rivers from the Beaufort Sea coast inland to the Brooks Range as shown in Figure 3.2.13-1. Herd size was estimated at about 16,000 animals in the summer of 1986 (R. Cameron, ADFG, pers. comm.) and is increasing. Calving occurs from late May to mid-June on the coastal plain, usually within 15 to 25 miles of the coast and mostly in the Kuparuk oil field and Bullen Point/Canning River delta areas, although in years of extensive snow cover calving occurs farther inland (Shideler 1986). After calving, the majority of the herd spends the summer on the coastal plain, traveling to

Table 3.2.13-1 Sensitive Areas for Wildlife Along the Proposed TAGS Route

Species	Area	Primary Use	Period
LARGE MAMMALS			
Caribou	Prudhoe Bay to Franklin Bluffs	Calving	Late May to mid-June
Caribou	Prudhoe Bay to Galbraith Lake	Spring migration	March to June
Moose	Upper Sagavanirktok River	Wintering	October to May
Dall Sheep	Slope Mountain, Atigun Canyon, Dietrich River area	Lambing, mineral licks	May to August
Brown Bear	Dietrich River and Middle Fork Koyutuk River Valleys	Feeding concentrations	Spring, Fall
Moose	Jim River, Prospect Creek, Fish Creek, Bonanza Creek	Wintering	October to May
Moose	Hess Creek	Wintering	October to May
Moose	Tolovana River and Tatalina River	Wintering, calving	October to May, May to June
Moose	Chatanika River to Salcha River	Wintering, calving	October to May, May to June
Moose	Shaw Creek Flats	Calving, wintering	May to June, October to May
Bison	Donnelly Dome to Big Delta	Wintering	September to March
Bison	Delta River (Donnelly Dome to Black Rapids)	Calving	April to June
Dall Sheep	Delta River area (Ruby Creek to Castner Glacier)	Lambing, mineral licks	May to August
Brown Bear	Delta River (Donelly Dome to Black Rapids)	Feeding concentrations	Spring, Fall
Brown Bear	Summit Lake to Paxson Lake	Feeding concentrations	Spring, Fall
Caribou	Paxson Lake to Tazlina River	Migration, wintering	October to May
Moose	Paxson Lake to Sourdough	Calving	May to June
Moose	Hogan Hill to Copper Center	Wintering	October to May
Moose	Tonsina River	Calving	May to June
Moose	Tonsina River, Tiekel River	Wintering	October to May
Dall Sheep	Unnamed mountain just west of Tonsina	Lambing	May to June
Moose	Lowe River	Restricted Range	All year
BIRDS			
Waterfowl	Prudhoe Bay to Ivishak River	Nesting	June to August

Table 3.2.13-1 (Contd)

Species	Area	Primary Use	Period
Raptors	Franklin Bluffs	Nesting	April to August
Raptors	Sagwon Bluffs	Nesting	April to August
Raptors	Saganavirktok River Bluffs near Lupine River mouth	Nesting	April to August
Raptors	Slope Mountain	Nesting	April to August
Raptors	Atigun River Valley area	Nesting	April to August
Waterfowl	Galbraith Lake	Spring migration	May to June
Raptors	Upper Dietrich River Valley	Nesting	April to August
Waterfowl	Cathedral Lakes	Migration	May
Waterfowl	Jim River	Nesting	May to August
Waterfowl	Kanuti River	Nesting	May to August
Waterfowl	Ray River	Migration, nesting	May to August
Waterfowl	Hess Creek	Nesting	May to August
Waterfowl	Tolovana River	Nesting	May to August
Waterfowl	Chatanika River	Nesting	May to August
Waterfowl	Chena River to Salcha River	Nesting	May to August
Waterfowl	Harding Lake	Fall concentration	September to October
Waterfowl	Shaw Creek Flats	Nesting	May to August
Waterfowl	Delta/Tanana River Junction	Wintering	October to April
Sandhill Cranes	Delta Junction area	Spring and fall migration	Late April to mid-May, September
Waterfowl	Paxson Lake to Tazlina River	Nesting	May to August
Waterfowl	Willow Lake	Nesting	May to August
Waterfowl	Robe Lake/Lowe River mouth	Spring and fall concentrations	April to May, September to October
Raptors	Lowe River/Anderson Bay	Nesting	April to August

Source: Hemming & Morehouse, 1976; ADF&G 1985, 1986a, 1986b; FPC 1976a

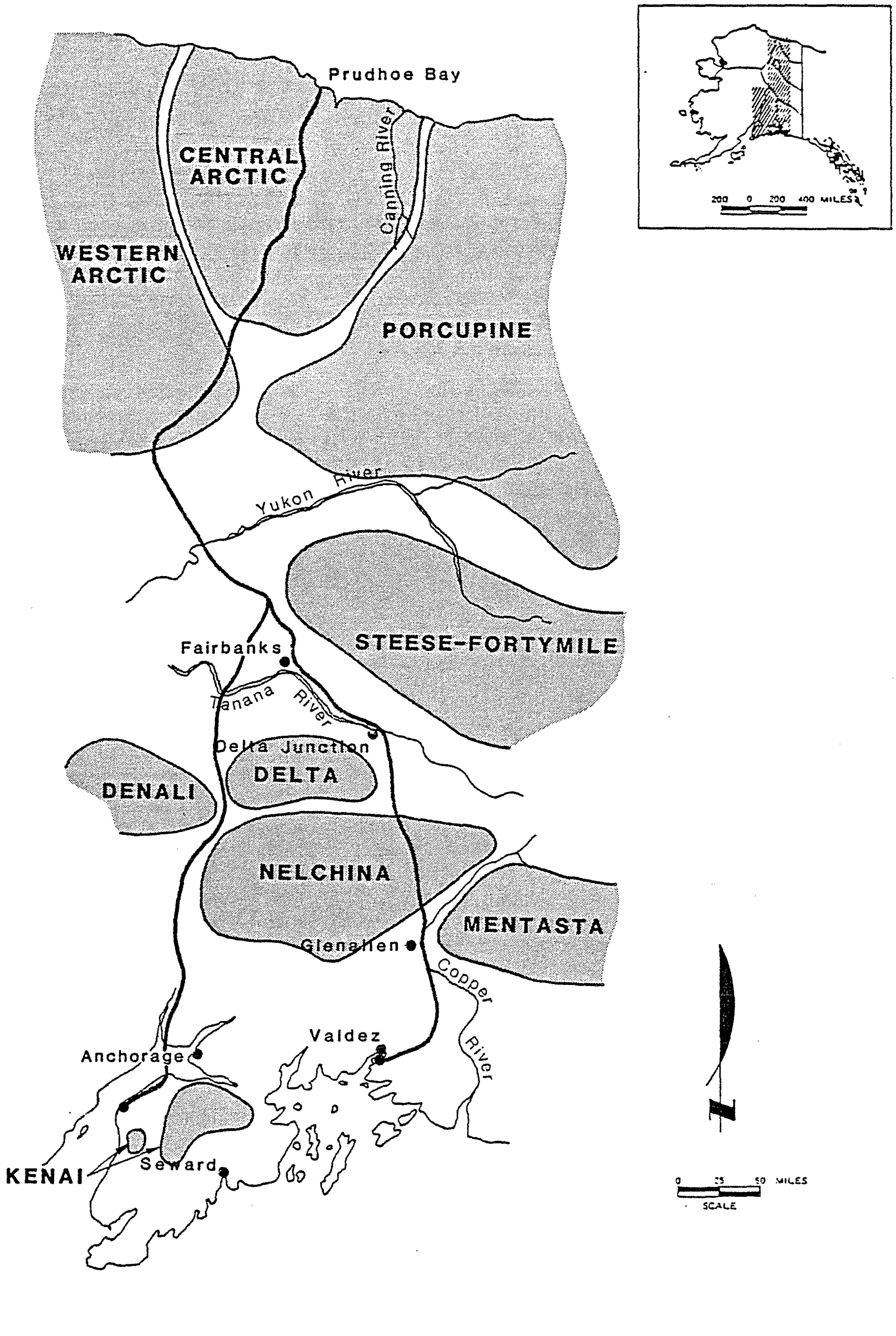


Figure 3.2.13-1 Main Caribou Herds of Alaska Along the Proposed Tags Pipeline Route

the coast during periods of mosquito harassment and moving inland during mosquito-free periods. The herd disperses inland in late summer and fall and winters mainly in the northern foothills and valleys of the Brooks Range. Migration routes between winter and summer ranges are oriented along major rivers, including the Sagavanirktok.

The CAH is flanked on the west by the Western Arctic Herd (WAH), estimated at more than 224,000 caribou in 1986 (J. Davis, ADFG, pers. comm.), and on the east by the Porcupine Herd (PH), estimated at 181,000 caribou in 1986 (K. Whitten, ADFG, pers. comm.). In some years caribou from the WAH may winter as far east as the CAH range, which is transected by the proposed route. Although some interchange of individuals occurs between adjacent herds, it is considered to be very limited at present population levels.

Musk oxen are found primarily to the east of the proposed TAGS route in the Arctic National Wildlife Refuge (ANWR), but individuals (usually bulls) and small groups have been seen in recent years as far west as the Kuparuk and Prudhoe Bay oil fields and as far south as Galbraith Lake (Reynolds et al. 1985). From June to at least October 1986, up to 18 musk oxen were observed repeatedly along the Sagavanirktok River north of Franklin Bluffs (R. Ritchie, ABR, unpubl. data) near where the TAGS line would pass. Musk oxen generally prefer riparian habitats during summer and fall, shifting to windblown ridges and bluffs during winter and early spring and to upland tussock areas during calving season.

Moose reach the northern limit of their range on the Arctic Slope, having populated the region only during the last century. Coady (1980) estimated that about 2,000 moose inhabited the Arctic Slope and considered the population to be stable or increasing slowly. Moose occur in highest density along the Colville River, but "sizable numbers" occur along some rivers east of the Colville (Coady 1980), including the upper Sagavanirktok, which is a winter concentration area (ADFG 1986a). The proposed TAGS route would parallel this concentration area. Moose inhabit most arctic drainages wherever adequate stands of willow occur. The population is probably limited primarily by winter food supply and predation (DOI 1976).

Dall sheep are found along the proposed TAGS route in the mountains of the Brooks Range north to Slope Mountain. The Atigun River valley is bounded on both sides by sheep winter range (ADFG 1986a), and the Atigun Canyon below Galbraith Lake contains an important lambing area (DOI 1976). Over 300 sheep have been reported to use the Atigun River drainage from early winter to early summer. Lambing occurs from mid-May to mid-June (DOI 1976). In addition, two mineral licks are located near the floor at Atigun Canyon and are used by sheep in spring and early summer (DOI 1972); another lick is located on Slope Mountain (ADFG 1986a).

Brown bears (also called grizzlies) are distributed sparsely across the coastal plain, becoming more numerous in the foothills and valleys of the Brooks Range. Bears emerge from winter dormancy in April and May and spend considerable amounts of time during summer foraging and resting in river valleys and on hillsides. The Sagavanirktok and Atigun river valleys are concentration areas (ADFG 1973). Bears enter winter dormancy in October and November (DOI 1972). Dens are usually dug in south-facing slopes in the foothills and mountains through which the proposed TAGS route passes.

Wolves are present in very low densities in the arctic drainage area, probably due to illegal hunting (DOI 1972). They can occur anywhere along the TAGS route, as dictated by the availability of their primary prey (caribou and moose) but are more numerous in the foothills and mountains. Suitable natal den sites are very limited on the coastal plain, essentially restricting denning to well-drained south slopes farther inland in the foothills and mountains (Stephenson 1974) through which the proposed TAGS route passes.

3.2.13.2.2 Birds

More than 200 species of birds have been reported north of the Brooks Range divide (Pitelka 1974, Troy 1985). Nearly half probably frequent the coastal plain and Sagavanirktok River valley. Information in this section has been drawn from a number of references (DOI 1972; Pitelka 1974; Sage 1974; FPC 1976a; Kessel and Gibson 1978; USACE 1984; Troy 1985).

The avifauna of the coastal plain habitats crossed by the TAGS route is dominated by waterbirds, including loons, ducks, geese, swans, and shorebirds. The greatest species diversity occurs in wetlands between the Canning and Colville rivers (USACE 1980), the region in which the TAGS route is located.

The Sagavanirktok River and Delta are among the first waters to open in spring and consequently are occupied by bird groups until other waters are free of ice. Existing road and pipeline systems in the Prudhoe Bay area have altered surface water patterns and snowmelt in some areas, also influencing the distribution of birds (USACE 1980).

Four species of geese regularly breed along the TAGS route in this region. The only breeding colony of snow geese in the United States is found on Howe Island, on the Sagavanirktok River delta (USACE 1984). These snow geese use the area crossed by the TAGS route near the Sagavanirktok River valley and adjacent habitats along the Dalton Highway in spring, arriving in the latter half of May (Burgess and Ritchie 1986). Brant nest in small colonies near the coast. Canada and white-fronted geese are more widespread and are also found nesting inland. Common duck species include northern pintail, American wigeon, old squaw, greater scaup, and common eider.

Gulls and shorebird species are conspicuous in all arctic habitats crossed by TAGS. Coastal areas such as mudflats and beaches are used by staging dunlin, semipalmated sandpipers, and stilt sandpipers (USACE 1984). The most abundant breeding species on the coastal plain are the red phalarope, red-necked phalarope, semipalmated sandpiper, dunlin, and pectoral sandpiper (Truett et al. 1982). The density and diversity of shorebirds and waterfowl decreases considerably as the TAGS route enters upland tundra to the south.

Seven species of raptors regularly occur along the TAGS route, as do ravens. Cliff-nesting raptors and ravens are concentrated along the Sagavanirktok River, especially on Franklin Bluffs, Sagwon Bluffs, and in the Atigun River valley. Rough-legged hawks are the most abundant species, but their numbers fluctuate markedly with numbers of microtine rodents, their primary prey. Nesting in the same areas are gyrfalcons and peregrine falcons. A few golden eagle nests are found on cliffs in the upper Sagavanirktok and Atigun river valleys (Roseneau et al. 1981).

The threatened *tundrius* race of the peregrine falcon traditionally nests on cliffs along the Sagavanirktok River. Prior to declines in the 1970s, six or seven sites probably were active annually along the Sagavanirktok (USFWS 1982). At least nine pairs were present in 1986 (R. Ritchie, ABR, unpubl. data). Most peregrines arrive by mid-May and leave the region by late September.

Two owl species, the snowy owl and the short-eared owl, occur along the TAGS route. Snowy owls nest primarily on the coastal plain; short-eared owls probably breed along the TAGS route.

3.2.13.3 Yukon River Drainage

3.2.13.3.1 Large Mammals

Moose are distributed throughout the region, occurring in a wide variety of habitats ranging from upland shrubs to lowland spruce bogs, old burns, and riparian areas (ADFG 1976a). Riparian habitats are often used intensively, especially during winter (FPC 1976). The TAGS route crosses a number of lowland and riparian areas considered part of general concentration areas during calving season, rutting season, or winter (ADFG 1973, 1986b; FPC 1976).

The proposed route largely avoids caribou ranges in this region. The Dietrich River has been used as a migration route in the past, and the route crosses the eastern portion of the WAH winter range from the Kanuti River north (DOI 1972; ADFG 1986b). The area east of the Middle Fork of the Koyukuk River has been used as winter range by the Porcupine Herd in former years (FPC 1976). The route touches the western portion of the historic winter range of the Steese-Fortymile Herd (estimated at 15,000 caribou in 1986 [J. Davis, ADFG, pers. comm.]), although that portion of the range has not been used since at least 1970 (FPC 1976). Along the Delta River the route parallels the eastern edge of the calving grounds of the Delta Herd (estimated at 7,500 caribou in 1986 [J. Davis, ADFG, pers. comm.]); the Delta Herd winters west of the Delta River (ADFG 1986b).

Dall sheep occur near the proposed TAGS route along both sides of the Dietrich and upper Delta River valleys. In the former area, at least five mineral licks have been located (ADFG 1986b), and the route passes near lambing cliffs near Kuyuktuvuk and Nutirwik creeks (FPC 1976). Movements of sheep down to and across the valley bottoms have been noted. Along the Delta River, sheep are not known to cross the proposed route. At least one mineral lick is located east of the proposed route (ADFG 1973). Windblown ridges and slopes, usually at the mouths of tributaries along major drainages, constitute important winter range for sheep in the mountains of interior Alaska (ADFG 1976a); the TAGS route passes through several such areas. Sheep are highly traditional in their use of summer and winter ranges and mineral licks.

Bison were introduced near Delta in 1928 and have become a popular, intensively managed game species. Herd size is maintained at about 275 (Townsend 1985). The proposed route would cross fall and winter range near Delta Junction, pass through summer range, and parallel the eastern edge of the calving area along the Delta River south of Donnelly (ADFG 1973). Most bison calves are born during May.

Brown bears are relatively common along the Dietrich River and the Middle Fork of the Koyukuk, which are concentration areas during spring and fall (ADFG 1973, 1986b; FPC 1976). The upper Delta River in the Donnelly area has been identified as a spring and fall concentration area as well (ADFG 1986b). Brown bears occur only rarely in the lowland spruce forests near the Yukon and Tanana rivers.

Black bears would occur along the TAGS route because they are widely distributed throughout the forested portions of the Interior and may reach densities up to one per 10 to 20 square miles (DOI 1972). Black bears concentrate near berry patches, particularly in alpine and subalpine habitats, in late summer they tend to avoid extensive open tundra (ADFG 1976a). Moist lowlands are often used in spring.

During TAPS construction, many carnivores, especially bears, interacted with camp and field-related activities to create a major human-canivore problem. Direct feeding by workers, scavenging at dumpsites, and break-in within camps became a serious problem.

Wolves occur throughout the interior region in higher densities than in the Arctic. Moose is major prey species, and caribou and Dall sheep are taken where available. Snowshoe hares are an important supplemental food in some years. Active dens of adjacent wolf packs are usually established 15 to 25 miles apart. Wolves may range as widely as 20 miles from their dens during summer (ADFG 1976a). The overall density of wolves in the interior ranges from about one per 40 to one per 100 square miles (ADFG 1976a).

3.2.13.3.2 Birds

Approximately 225 species of birds have been reported for interior Alaska; however, only 75 percent of these occur regularly (Kessel 1986). Information for this region has been derived mainly from the DOI (1972), FPC (1976), and Kessel and Gibson (1978).

More than 30 species of loons, grebes, and waterfowl summer in interior Alaska (Kessel 1986). Dabbling ducks, including mallard, northern pintail, green-winged teal, American wigeon, and northern shoveler, are common nesting species. Diving ducks include lesser scaup, bufflehead, and goldeneyes. Drought-displacement of ducks from prairie and parkland potholes to northern wetlands, including interior Alaska, increases the number and variety of ducks in some years (Hansen and McKnight 1964).

The principal goose species are Canada and greater white-fronted geese (King and Lensink 1971), which together probably number in the low tens of thousands throughout the Interior (FPC 1976). Trumpeter swans nest in lowland lakes throughout the region; more than 300 of these swans, once considered an endangered species, have used the lower Koyukuk River valley in the spring (DOI 1972).

The proposed TAGS route would cross productive waterfowl nesting habitat in the Kanuti Flats; the Ray, Tolovana, and Chatanika rivers; oxbows and ponds along the Chena and Salcha rivers; and morainal ponds near Donnelly Dome (DOI 1972). The route would also traverse several drainages that enter Minto Flats and the lower Koyukuk River, which are important waterfowl nesting areas. Besides these wetlands, the TAGS route crosses several agricultural fields near Delta Junction used by thousands of migrating waterfowl (Ritchie 1980). Many of these areas are heavily used by recreational and subsistence hunters.

Approximately half of the world population of lesser sandhill cranes passes through the upper Tanana River valley during spring and fall migrations (Kessel 1984). Daily counts in excess of 40,000 birds have been recorded near the TAGS alignment between Delta Junction and Donnelly Dome. Some of these birds nest in lowlands in interior Alaska, but most migrate to or from more important breeding grounds in western Alaska and Siberia.

More than 20 species of shorebirds and gulls commonly nest in or migrate through the Interior. Lesser yellowlegs, solitary sandpipers, and common snipe are typically found in summer in wetlands interspersed in woodland habitats. Spotted sandpipers, mew gulls, and herring gulls are common along rivers. The upland sandpiper and lesser golden-plover are breeders in upland tundra areas near the Alaska Range. Other shorebirds, such as pectoral and semipalmated sandpipers and long-billed dowitchers, migrate through spring and fall.

Nineteen species of raptors can be found on cliffs and in woodland habitats crossed by the proposed TAGS route. Cliff-nesting species include the gyrfalcon, golden eagle, and peregrine falcon. Gyrfalcons and golden eagles are relatively common nesters in the Brooks Range and Alaska Range. Suitable cliff habitat for these species occurs along the upper Koyukuk and Delta rivers.

The endangered anatum race of the peregrine falcon has nested traditionally near the proposed TAGS route on the Yukon and Tanana rivers and on small tributaries of these rivers, such as the Salcha River (USFWS 1982). Peregrines arrive in mid- to late April and depart by September. Active or formerly active aeries occur near the proposed TAGS crossings of the Yukon, Tanana, and Salcha rivers. Potential habitat occurs on the Jim and Koyukuk rivers (Roseneau et al. 1981). At least seven active aeries were reported on the Tanana River in 1970, and in the same period seven aeries had been identified on the middle Yukon from Fort Hamlin to Tanana (USFWS 1982). Significant declines in numbers of peregrines occurred after about 1968, especially on the Tanana River. However, numbers and productivity have increased substantially; seven pairs were recorded along the Tanana between Tanacross and Fairbanks in 1986 (R. Ambrose, USFWS, pers. comm.) several of which are in the vicinity of the proposed TAGS route.

Bald eagles nest throughout the Interior but are especially common on the Tanana River upstream from Fairbanks. Most nests are in spruce and poplar trees along the river and the shorelines of floodplain lakes. Bald eagles attend nests by mid-May. A few birds regularly winter in the Big Delta area (Ritchie 1982).

Four owl species are resident, nesting in woodland habitats along the TAGS route: Great horned owl, northern hawk-owl, great gray owl, and boreal owl. Short-eared owls are common during migration and occasionally breed in the Interior, whereas snowy owls have been reported only during winter.

3.2.13.4 Copper River Drainage

3.2.13.4.1 Large Mammals

Caribou in the Copper River basin are distributed in the Nelchina Herd, currently estimated at about 30,000 animals, and the Mentasta Herd, estimated at about 3,000 animals in 1983 (J. Davis, ADFG, pers. comm.). Both herds are increasing. The TAGS route transects the eastern portion of the Nelchina Herd's winter range, and some spring and fall migration occurs across the route. The Mentasta Herd is distributed to the east of the TAGS route on the northern flanks of the Wrangell Mountains but may winter as far west as the TAGS route. The calving grounds of both herds are located well away from the route (ADFG 1985).

Moose are common in this region, and the proposed route passes through calving and winter concentration areas in the lowlands of the Gulkana River drainage (ADFG 1973, 1985). Seasonal migrations occur across the proposed TAGS route (Van Ballenberghe 1977). This population, like that of the Yukon River region, is important for both subsistence and sport hunting.

Dall sheep inhabit the southern Alaska Range and the northern portions of the Chugach Range near the proposed TAGS route as well as the Wrangell Mountains to the east. The route approaches sheep habitat most closely in the Tonsina area near two mineral licks (ADFG 1985). Dall sheep are found primarily on the northern flanks of the Chugach Mountains due to heavy accumulations of snow on the south side of the range (ADFG 1976b).

Brown bears occur in relatively high densities in the region, primarily in upland tundra areas and river valleys in the foothills and mountains of the Alaska and Chugach ranges. Concentration areas have been identified near Paxson, used for denning, intensive spring activities, and feeding salmon spawning streams (primarily the upper Gulkana River) in late summer and early fall (ADFG 1973). Intensive spring use by both species of bears has been noted in the Klutina and Copper river valleys south of Copper Center, and brown bears probably den in the area just east of and parallel to the Copper River in that vicinity (ADFG 1973).

Black bears are uncommon to rare in northern portions of the Copper River drainage but are quite common in the southern portion, particularly in the foothills of the Chugach Mountains (ADFG 1976b).

Wolves are distributed throughout this region from lowland spruce forests to mountain valleys and slopes. Densities are comparable with those in the Yukon River drainage, although hunting and trapping pressure (both legal and illegal) currently exerts a limiting effect on numbers in the region.

3.2.13.4.2 Birds

The Copper River drainage contains many species of birds common to either the Yukon

River drainage or the Lowe River drainage (DOI 1976). The habitats are typical of interior taiga (Kessel and Gibson 1978). About 120 species occur along the proposed TAGS route in this region. Kessel et al. (1967) described birds and habitats found along the Richardson Highway from Delta Junction to Valdez.

Areas of good waterfowl habitat are found along the Gulkana River between and including Summit and Paxson lakes, thaw lakes between Hogan Hill and Glennallen, Willow, and Pippin lakes, and ponds adjacent to the Tonsina and Little Tonsina rivers (DOI 1972). Greater scaup, green-winged teal, American wigeon, and mallard are the principal duck species nesting in this area (King and Lensink 1971). Lakes in the Gulkana River-Glennallen area and the Tazlina-Klutina area also constitute important trumpeter swan nesting habitat. In 1968 nearly 600 adult and immature swans were observed in late summer surveys in the lowlands of the Copper River-Nelchina Basin region (DOI 1972). Spring concentrations of swans have been identified in several areas, most notably along the Copper River east of Gulkana (ADFG 1985).

Bald eagles are common nesting raptors along the Gulkana and Copper rivers.

3.2.13.5 Prince William Sound Drainage

3.2.13.5.1 Large Mammals

The only three species of hooved mammals that occur along this portion of the TAGS route are moose mountain goat, and Sitka black-tailed deer in the Lowe River-Valdez Arm vicinity (Roberson 1986). Black bears, brown bears, and wolves are present, although wolf density is quite low due to the relative scarcity of ungulate prey.

Moose in this region are limited to the lower 25 miles of the Lowe River valley. The population is small and will likely remain so because of the restricted amount of habitat available (Gusey 1978).

Mountain goats occur throughout the coastal mountains ringing northern Prince William Sound and are found as far north as the southern Wrangell Mountains. Although they are present from the Tonsina area south along the TAGS route, they are considered abundant only in the mountains to the east of Valdez Arm (ADFG 1976b). Goats summer high in steep alpine habitats, moving to lower elevations and wind-blown areas as snow accumulates during winter. Young are born in late May and early June in alpine cliff habitat.

Brown and black bears are considered to be the most important large mammals along the proposed corridor, concentrating in lowlands and tidal flats in spring, moving up mountain slopes as new-growth vegetation becomes available later in the season. Bears tend to concentrate along salmon spawning streams, such as Robe Lake, in late summer (ADFG 1973). Berries are important foods late in the season, and bears concentrate in the vicinity of berry patches at that time.

3.2.13.5.2 Birds

More than 200 species of birds have been recorded in the North Gulf Coast-Prince William Sound region (Isleib and Kessel 1973), which includes coastal forest, alpine, subalpine, and marine environments. Many of these species however, are uncommon, or are most abundant in the area of the Copper River delta. Nearly 150 species of birds can be found in the Lowe River area (DOI 1972).

Bald eagles congregate along the Lowe River in large numbers in fall and winter during salmon spawning. The species nests regularly in the Lowe River-Valdez area (DOI 1972); one nest is located near the proposed LNG terminal site (YPC 1986).

At least 15 species of seabirds commonly occur in Prince William Sound (Isleib and Kessel 1973). Four small seabird colonies, including a black-legged kittiwake and

Arctic tern colony at Shoupe Bay, occur in Valdez Arm (Sowls et al. 1978); Anderson Bay is within the foraging range of birds nesting at those colonies.

Other waterbirds, including ducks, loons, and gulls, also use the area, especially during the winter months, when large numbers of sea ducks and dabbling ducks concentrate to feed in nearshore areas. Major feeding areas include Solomon Creek, Allison Point, and Island Flats (EPA 1979).

Migrating geese, ducks, and shorebirds stop at tidal and marsh areas in and near Anderson Bay during spring and fall migration (EPA 1979). However, the major staging grounds for millions of shorebirds and waterfowl on the Pacific Flyway occur farther to the east, on the Copper River Delta (Isleib and Kessel 1973). Thus, the regional importance of Anderson Bay as a migration stop.

3.2.14 Threatened and Endangered Species

Several species listed as threatened or endangered may inhabit areas near the TAGS route or right-of-way during some part of the year. All threatened, endangered, protected, or candidate species which might occur near the route, including the marine nearshore areas of the Beaufort Sea and northern Prince William Sound are listed in Table 3.2.14-1, along with other species of significant interest.

Of the endangered marine species, the gray whale is present in the Beaufort Sea in such small numbers that they are considered rare. Bowhead whales are common in the Beaufort Sea, but they typically pass the Prudhoe Bay area farther offshore. No bowhead whales have been recorded inshore of the 30-foot contour west of Barter Island (USACE 1984). Whales are discussed more fully in Subsection 4.10, Marine Environment.

The Eskimo curlew is listed but is probably extinct in Alaska, having not been sighted in Alaska for several years. Therefore, there is little likelihood any will occur along the Sagavanirktok River, part of its former range.

Arctic peregrine falcons are an endangered species and nest and feed along the cliffs and foothills near the Sagavanirktok River. As many as 10 nesting pairs have been recorded in the area from Prudhoe Bay to the foothills of the Brooks Range, with concentrations being recorded from the Franklin Bluffs area on the east side of the Sagavanirktok River. General nesting areas of peregrines present along the route are discussed in Section 4.13, Wildlife.

The threatened American peregrine, a different race than the Arctic peregrine, migrates along the coast near Valdez and Cordova and would probably not be affected by the project.

Bald eagles are not endangered in Alaska, but they and their nests are protected by several federal statutes. Bald eagles and their nests are common in the Valdez area. There are known nest sites along the Lowe River floodplain and the Anderson Bay area of Valdez Arm.

Fin, sei, and humpback whales occur in and around northern Prince William Sound and use the Valdez Arm area as a summer feeding grounds, eating marine phytoplankton, zooplankton, squid, and small fish.

The Aleutian Canada goose is an endangered species and may migrate along the coast in the area near and just offshore of Valdez. They are not expected to occur in the project area and are therefore not listed in Table 3.2.14-1.

Plant species considered threatened (Murray 1980) along the route are also listed in Table 3.2.14-1. These species are not formally designated as threatened, but due to their scarcity, deserve special consideration. There are no endangered plant species along the proposed TAGS route.

3.2.15 Recreation, Aesthetics and Wilderness

Table 3.2.14-1 Threatened, Endangered or Candidate Species

Species	Status	Location/Comment
MARINE MAMMALS		
Bowhead whale	Endangered	Occasional in nearshore Beaufort Sea
Gray whale	Endangered	Rare in Beaufort Sea
Fin whale	Endangered	Occasional in summer in northern Prince William Sound
Sei whale	Endangered	Occasional in summer in northern Prince William Sound
Humpback whale	Endangered	Fairly common in spring and summer in Prince William Sound
BIRDS		
Eskimo curlew	Endangered	Probably extinct in Alaska
Arctic peregrine falcon	Endangered	Present in Brooks Range and Tanana River during summer
American peregrine falcon	Threatened	Occasional along southern route
Bald eagle	Federally protected	Common near Valdez and several areas along the route
PLANTS		
Yukon Aster (*Aster yukonensis*)	Candidate as threatened	Found along the upper Koyukuk River
Fleabane (*Erigeron graniflorus*)	Candidate as threatened	Rare along the Sagwon uplands
(*Montia bostockii*)	Candidate as threatened	Yukon-Tanana uplands and around Toolik Lake
Oxytropis kokrinensis	Candidate as threatened	Ray mountains north of Fairbanks
Smelowskia borealis	Candidate as threatened	Calcareous scree in the Alaska Range
Arctic Pennycress (*Thalspi arcticum*)	Candidate as threatened	Well-drained alpine slopes and gravel inactive riverbeds on North Slope
Erigeron muirii	Candidate as threatened	Well-drained gravel foothills north of Brooks Range
Orthothrichum diminutivum	Candidate as threatened	Side of Sukakpak Mountains

3.2.15.1 Recreation

The proposed TAGS project to Anderson Bay involves no Federal Lands within national conservation system units.

Recreational opportunities along the proposed TAGS route include such seasonal and year-round activities as hiking, hunting, sport fishing, camping, sight-seeing, climbing, boating, floating, kayaking, skiing, snow machining, dog mushing, flying, cycling, swimming, photography, wildlife viewing, ice-skating, berry-picking, and recreational mining. Outdoor activities depend on weather, time of year, and access. Since the route parallels year-round highways (Richardson, Dalton, Elliott), access to the corridor area is generally good. The area away from the existing Dalton Highway and TAPS facilities is a vast wilderness stretching from the Canadian Border on the east to the Chuchki Sea more than 300 miles away on the west. Lack of roads and developed trails, private land, and difficult terrain may hinder more extensive use. Aircraft, boats, and all-terrain vehicles offer considerable off-road access during certain times of the year. Such use is very heavy all along the route during the September hunting season.

The North Slope and Brooks Range are most used during summer for wilderness-type recreation. Lakes within the area have been popular for fishing for many years. Guides operate out of Prudhoe Bay, Galbraith Lake, and Sagwon airstrip during the fall. Gates of the Arctic National Park and Preserve is within hiking distance of the Dalton Highway; the Arctic National Wildlife Refuge (ANWR) also provides recreational hiking, fishing and wilderness opportunities, mostly for fly-in hunters and campers from Deadhorse. The gold towns of Wiseman and Coldfoot are of historical interest. The Dalton Highway has limited public facilities, and state access permits are required for all private or commercial traffic above the Dietrich River. The caribou season in this area (Unit 26) is liberal, allowing hunting nine months of the year, although with firearms shooting is not permitted within 5 miles of the Dalton Highway, hunting with a bow is allowed with certain restrictions.

The Yukon River area provides access to Kanuti and Yukon Flats National Wildlife refuges. The Yukon River and its tributaries provide popular water recreation use, especially for moose hunters during September, and are of historic interest and importance. Berry-picking and hunting are common activities all along the Dalton Highway during fall.

Recreational use of the area south of the Yukon River to Fairbanks is heavy. Livengood, a gold mining center, offers historical interest. The Tolovana River is popular for canoeing. The area is also popular for road hunters, fishermen, river floating, and berry-picking in the fall.

A popular, undeveloped rock-climbing area known as Grapefruit Rocks exists along the Elliot Highway. The area is also used to some extent for picnicking, overnight camping, and cross-country skiing. Other popular outdoor use areas are the White Mountains National Recreation Area, Wickersham Dome, and the Chena Lakes Recreation Area, which had 98,000 visitors in 1985 (Fairbanks Daily News Miner 1986).

A section of the Chatanika River north of Fairbanks was identified as a potential Wild, Scenic, or Recreational river by the National Wild and Scenic Rivers Act. It is also one of the BLM's Alaska Canoe Trails, as is a stretch of the Chena River from Chena Hot Springs Road downstream to Fairbanks.

Fairbanks offers all the urban necessities as well as tourist points of interest. Along the Richardson Highway south of Fairbanks the Tanana and Salcha rivers are important for recreation, as are several large lakes (Quartz, Birch, and Harding).

Donnelly Dome, a low, rounded hill not far south of Delta Junction, receives considerable use by hikers. The BLM campground on Fielding Lake is heavily used as it is close to the highway. Continuing south on the Richardson Highway, Black Rapids Glacier, and the Isabel Pass area offer scenic views.

Fishing is a popular recreation all over the region, principally because several large lakes (e.g., Paxson and Summit) offer excellent fishing. There is also considerable fly-in fishing to nearby lakes. Portions of Nelchina caribou herd cross the Richardson Highway in the Sourdough area south of Delta during fall migration, and hunters often congregate there in September.

The Gulkana and Delta rivers are designated under the Wild and Scenic Rivers Act but not in the area of the proposed TAGS crossings.

The Tazlina River is used by canoeists who put into the Little Nelchina River from the Glenn Highway and float down the Tazlina River to the Richardson Highway bridge. The Klutna, Tonsina, and Little Tonsina rivers are also used recreationally for fishing and floating. The Tiekel is also a popular fishing stream, but its flow is usually too low for floating.

Squirrel Creek Campground, a state recreation site, is found near the junction of the Richardson and Edgerton highways. Numerous other camping and scenic viewpoints are available between Glennallen and Worthington Glacier National Land Mark. The Wrangell-St. Elias National Park and Preserve lies immediately east of the highway in this area. The Worthington Glacier State Recreation site, within walking distance of the road, has more visitor days than any other site in the Copper River basin.

Nineteen miles east of Valdez on the Richardson Highway and in the Chugach National Forest is Keystone Canyon, a scenic 2.6-mile-long, deep gorge by the Lowe River. The Lowe River through Keystone Canyon is popular with experienced white-water kayakers when the river is high in May, June, and July. Below the canyon, the river becomes a wide, meandering stream.

Recreational services available in Valdez include charter fishing boats, tours of the Solomon Gulch Hatchery and TAPS Marine Terminal, and sightseeing by charter airplanes and boats to Columbia Glacier. There are the major fishing contests in Valdez during the summer.

The Prince William Sound and Port Valdez areas are highly significant outdoor recreation sites, not only because of the availability of numerous scenic and recreational resources, but also due to their proximity to the railbelt area with more than half the state's population. Outstanding natural resources, accessibility from the Anchorage metropolitan area, and availability of high-quality recreation lands within the Chugach National Forest provide a setting favoring continued rapid growth of recreational use.

Additionally, the proposed route traverses four state park areas designated by the federal DOT as 4(f) lands. The parks or recreational areas are Quartz Lake State Recreational Area near Big Delta, Dry Creek State Recreation Site between Gulkana and Copper Center, Worthington Glacier State Recreation Site just north of Thompson Pass near Ptarmigan Creek, and Blueberry Lake State Recreation Site near Thompson Pass 16 miles north of Valdez.

3.2.15.2 Aesthetics

North of the Yukon River, Alaska is a vast wilderness except for the presence of oil production and related transportation facilities. Although man's impact has not been totally absent, it has been localized. The area is typically pristine and natural. South of the Yukon, populated areas, the highway, and the pipeline share the same corridor space. Over the entire route, background views, except for the TAPS and the highway, are relatively untouched by human activity.

Visual resources along the route are outstanding, including vistas of North Slope tundra, limestone hills, and vast river floodplains; the Brooks Range, including Atigun Pass, Sukakpak Mountain, Castle Mountain, and Galbraith Lake. The Alaska Range, including Summit and Paxson lakes; and the Chugach Range, including Thompson Pass, Blueberry Lake SRS, Worthington Glacier, Keystone Canyon, and Prince William Sound, with its infinite variety of fiords, recreation, and wildlife viewing, offer first-class aesthetic resources.

In 1973 Alyeska prepared a comprehensive report on the aesthetics of the TAPS project (APSC 1973). The report presents major aesthetic criteria that have been used to identify aesthetically sensitive areas and discussed how the criteria are applied to prevent and mitigate disturbance of sensitive viewsheds along the route.

Since the proposed TAGS route essentially parallels the TAPS route and also involves large-diameter pipeline construction, the TAPS criteria and aesthetics plan should be generally applicable to both projects. This plan (ASPC 1973) is hereby referenced for a more comprehensive discussion on aesthetics of the proposed route.

Several of the recreational sites mentioned are state 4(f) lands and are eligible for special protection. Possible disturbance of these sites is covered in the environmental consequences section.

3.2.15.3 Wilderness

Public lands north of the 68th parallel associated with the general route of TAGS have been designated by congress as an area that BLM is to evaluate existing wilderness values and to recommend to congress which areas, if any, should be included in the National Wilderness Preservation System. The overall report on this area is being prepared by BLM and will be available for public review and comments during the late spring or early summer 1987.

The BLM evaluated all public lands associated with pending pipeline proposals from Prudhoe Bay. After public review, a decision of June 2, 1980, was issued that certain public lands within the corridor between Prudhoe Bay and Valdez as having no wilderness character. Except in the Valdez TAPS Pump Station No. 3, the preferred TAGS routing is located within areas determined to have no wilderness character.

3.2.16 Cultural Resources

The following discussion provides a brief historical perspective on the territory of the different groups and some of the cultural history of the TAGS corridor.

The proposed TAGS pipeline would pass through the traditional territory of several Alaska Native peoples. In the Valdez Area the coastal fringe and adjacent mountains were home to the Chugachmiut, the southernmost Eskimo group in Alaska. Farther north, across the Copper River basin between Thompson Pass and Isabel Pass, the proposed pipeline route traverses the ancestral territory of the Ahtna, an Athapaskan group. The lands from Isabel Pass north to a point a few miles beyond the Yukon River belonged to the Tanana, another Athapaskan group, while their distant liguistic neighbors, the Kutchin, occupied the territory north of them to at least the Brooks Range divide. Though the Kutchin also hunted and camped beyond the divide in prehistoric and early historic times, the territory from the mountains to the arctic coast was home to the Inupiat (northern Eskimo).

The proposed TAGS route will not only pass by cultural resource sites reflecting the activities of these peoples, but also sites created by their immediate and more distant ancestors and those representing the presence of earlier people who may not have been culturally or genetically related to them. Cultural resources sites located as a result of archaeological surveys testify to at least 11,000 years of human activity in the area to be traversed by the proposed pipeline.

Many archaeological investigations have been conducted in the general vicinity of the pipeline to answer specific research questions, as with Alexander's (1969) work in the Galbraith Lake region. The results were a relatively intensive survey of an area to be crossed by the pipeline. The primary cultural resource site survey of the pipeline route, however, was that associated with construction of TAPS. This route roughly parallels and is very close to the route proposed for TAGS. Investigations along the TAPS route began in the summer of 1970 and extended through the 1971 field season, at which point legal and technical difficulties delayed further work until 1974. The early effort focused on surveying the entire pipeline corridor and excavation of cultural resource sites discovered in locations where disturbance by construction activities seemed certain (Cook 1971). Field activities in 1974 and 1975 concentrated on clearance of construction areas, which involved additional surveys and in some cases excavation (Cook 1977).

The other major survey for cultural resource sites in the vicinity of the proposed TAGS route was that conducted in preparation for construction of the ANGTS (Shinkwin and Aigner 1979). The first field season (1978) was spent on that portion of the proposed route from Delta Junction to the Yukon border, but from 1979 through 1981 archaeological survey efforts were expanded on the portion of the proposed pipeline route paralleling both the TAGS and TAPS routes from Delta Junction north to Prudhoe Bay. Subsequent to the ANGST survey, relatively little archaeological work has been done along the proposed TAGS corridor, though small-scale surveys have been conducted in some localities. (See, for example,(Lobdell 1986) for citations of work in the Prudhoe Bay area) and site-specific clearances have been conducted for DOT/PF by BLM.

Table 3.2.16.1-1 summarizes the results of the various cultural resource site surveys conducted in the vicinity of the corridor. It lists the number of known sites (both prehistoric and historic), as entered in the Alaska Heritage Resource Survey site inventory, by USGS 1:250,000 quadrangle and the total sites known to be present within a 10-mile-wide corridor centering on the TAPS pipeline as constructed. The totals shown must be considered strictly provisional as a wide range of factors affects the accuracy of the actual number listed for this area on the AHRS roster. For example, Cook (1977) reported that 323 sites were located in the northern four construction sections of the TAPS pipeline, but for various reasons only 132 were entered into the AHRS inventory.

Table 3.2.16-1

Cultural Resource Sites Listed on the AHRS Site Inventory for the USGS Quadrangles Traversed by the Proposed TAGS Pipeline

	SITES			
	Total	TAPS	ANGTS	5-Mile Corridor
Beechey Point	36	3	0	2
Sagavanirktok	59	8	3	13
Philip Smith Mountains	325	50	38	94
Chandalar	22	2	11	13
Wiseman	207	9	11	42
Bettles	101	48	15	79
Livengood	171	12	26	112
Fairbanks	225	0	5	11
Big Delta	95	0	2	41
Mount Hayes	329	3	N/A	130
Gulkana	99	5	N/A	32
Valdez	233	28	N/A	75

The great majority of sites discovered during these surveys are shallow scatterings of lithic debris derived from stone tool-manufacturing activities by ancient people. Many did not contain culturally or temporally diagnostic artifacts, but even these sites can provide significant data on land and resource utilization patterns. Stratified sites, sites with culturally and/or temporally identifiable artifacts, sites with good preservation of organic materials, and sites with features (hearths, tent rings, cache pits, etc.) are also known from the corridor. Such sites possess even greater potential for helping to explain the past human history of Alaska.

Several sites either listed or proposed for the National Register are found along or adjacent to the proposed TAGS route. These include the following:

- Gallagher Flint Station - a national historic landmark in the Upper Sagavanirktok River Valley.
- Mosquito Lake Site - Proposed as a national historic register site on the east side of Galbraith Lake.
- Sourdough Lodge - a national historic landmark in the vicinity of Gulkana.
- Gakona Roadhouse - a national historic register site at approximately mile 200 of the Glen Highway.
- Keystone Canyon Rairoad Tunnel - a proposed national historic landmark in Keystone Canyon.

It is difficult to formulate an acceptable cultural historical sequence for the entire corridor or even for specific areas. Broad-scale treatments such as that by Dumond (1977) dealing with Eskimo and Aleut prehistory are far too generalized to allow understanding of the specific cultural events characterizing the human history of the corridor area. Regional syntheses are are invariably based upon the individual researcher's interpretation of the uneven archaeological record.

In northern Alaska the proposed pipeline corridor passes through territory occupied for at least the past 1,500 years, and perhaps as many as 4,500 years, depending on how one reads the archaeological record, by peoples ancestral to the modern Inupiat (Gal and Hall 1982). The more recent representatives of this sequence would be those people exhibiting the complex of cultural characteristics archaeologists refer to as Western Thule (or Late Prehistoric Eskimo) and Birnirk. Moving back in time the Ipiutak, Norton, Choris, and Denbigh complexes also are represented by sites in the area. In late prehistoric times ancestors of the modern Kutchin Athapaskans ranged over the northern flanks of the central Brooks Range. Their distant ancestors may have occupied the region in much earlier times. People represented by the Tuktu complex and at other sites spanning several thousand years in time where the tool inventory includes lancelolate as well as notched projectile points have tentatively been identified as Indian (under the rubric "Northern Archaic Tradition") by some archaeologists. The earliest human occupation of northern Alaska, possibly as early as 11,000 years ago, was by people (American Paleoarctic Tradition and perhaps other complexes) utilizing a tool technology based on the manufacture of lithic blades.

The prehistory of the Interior, from the Brooks Range crest south to Ahtna country, is also poorly understood, primarily because relatively few sites have been located and tested or excavated. Based on the data available in the mid-1970's, Cook (1975) placed known sites from this area into three broad occupational categories: 1) historic or late prehistoric occupations (spanning the Christian Era), rather definitely Athapaskan in nature; 2) an older cultural stratum (dating roughly between the time of Christ and 7000 to 8000 B.C.) which might or might not be early or ancestral Athapaskan but had strong affinities to cultural expressions found further north; and 3) a vaguely defined earlier period about which there was little agreement on the part of archaeologists. Recently Aigner

(1986), reviewing Interior prehistory from the viewpoint of 10 more years data acquisition and a slightly different theoretical perspective, reached substantially the same conclusions. She believes that ancestral Athapaskans arrived in Alaska sometime between 14,000 and 9,000 years ago sustained by a prominent microblade technology, and the subsequent cultural history of the Interior was marked by gradual adaptation to changing climatic conditions and local circumstances. Humans may have entered Alaska earlier, perhaps between 35,000 and 25,000 years ago, but evidence of their presence in the Interior has yet to be found.

Evidence of prehistoric human occupation in the area of the proposed pipeline's southern terminus, in what was historic Chugachmiut country, is even scantier. The few excavations undertaken at sites in the general area suggest that ancestors of the historic Chugachmiut have inhabited the region for at least 2,000 years (de Laguna 1956; Workman 1977).

Thus the known cultural resource sites in the vicinity of the proposed TAGS pipeline corridor offer a glimpse of the human past across a tremendous span of time and space, allowing tentative understanding of the nature of human adaptation over time to the challenges posed by the Alaska environment.

3.2.17 Subsistence

3.2.17.1 Introduction

Subsistence is the harvest of fish, wildlife, vegetation, and other natural resources for noncommercial purposes. It includes activities associated with the harvesting, processing, consumption, and distribution of these resources. Native Alaskans and many non-Native rural residents have traditionally participated in subsistence activities. Subsistence use and the regulations governing it are determined on an area-by-area basis by the State Boards of Fish and Game using specific criteria. The major considerations are whether or not a particular area is rural and has a history of subsistence use of specific fish and wildlife species.

The Native peoples of Alaska have pursued subsistence as a way of life for generations. Subsistence contributes to the economy, social structure, cultural traditions, nutrition, and identity of those who participate in it. The foundation of their sociocultural systems is the utilization of the natural environment and its biological resources. Subsistence foods constitute a significant portion of the diet of Native communities, particularly in smaller villages where imported foods are not readily available or are very expensive. Subsistence and employment contribute to the overall village economy.

Subsistence harvest patterns are seasonal, responding to biological cycles, proximity of resources, environmental conditions, and ease of travel and access. These patterns have a historical basis and have been modified with the establishment of permanent settlements. Most rural communities rely on specific subsistence resources to varying degrees, depending on their abundance, seasonal distribution, and proximity.

The area affected by the proposed TAGS project has been divided into five subregions for the purpose of discussing the distribution of subsistence resources and community harvest activities: 1) the North Slope Borough; 2) the Northern Corridor; 3) the Fairbanks-Delta Junction area; 4) the Glennallen-Copper Center; and 5) Valdez-Tatitlek (Figure 4.2.2-1).

A concept somewhat related to subsistence is "personal use" of fish and wildlife resources, primarily fish. Under state fish and game regulations, certain specific fisheries are opened for "personal use" harvest of fish, usually by dipnet, fishwheel or set gill net. Harvest is limited to a specific number of fish per family member. Some of these popular fisheries are located along the proposed route.

3.2.17.2 North Slope Borough

The portion of the route within the North Slope Borough lies approximately between TAGS MP 0 and 160. Three North Slope Borough communities use this area of the route for subsistence activities--Nuiqsut, Kaktovik, and Anaktuvuk Pass. The Natives in this area are primarily Inupiat Eskimo and their use conincides with traditional Eskimo uses.

3.2.17.2.1 Availability of Subsistence Resources

Because the area around these three North Slope communities encompasses diverse range of terrain that ranges from marine waters to the Brooks Range, residents utilize a variety of subsistence resources (Woodward-Clyde 1984).

Marine mammals are important North Slope Borough subsistence resources and include seal (ringed, bearded, and spotted), walrus, polar bear, and beluga and bowhead whale. Seals are hunted by boat during the summer and on the ice during the winter and spring. Polar bears are usually taken opportunistically, although they can be the specific object of hunting on the ice during the winter and spring. Bowhead whales are hunted by boat with shoulder gun "harpoons" during their spring and fall migrations; belugas are taken opportunistically in conjunction with other activities.

Terrestrial mammals hunted for subsistence include caribou, black bear, moose, brown bear, Dall sheep, and rabbit. Caribou are hunted when present, primarily in the late spring through early winter. Moose are primarily taken in the fall near Nuiqsut and in winter in Kaktovik; Dall sheep are hunted in both spring and fall. Furbearers are hunted and trapped during winter. Access to hunting areas is by boat during open water and snow machine when snow cover permits.

Hunting for seabirds and waterfowl and gathering bird eggs occurs during the late spring, summer, and early fall.

A variety of fish contribute to the subsistence diet, including salmon, char, cisco, grayling, and some species of marine fish. Fish are taken year-round, both in coastal waters by boat and at traditional campsites on rivers and the coast. Gill nets are used both in open water and under the ice; rod and reel is also a popular method.

Various plant resources for food and other needs, including berries, roots, seeds, fuel wood, and construction materials make up the last category of subsistence resources. Harvest of these resources is frequently done in conjunction with other subsistence activities.

The distribution and village proximity of many of these resources is seasonally limited. In particular, caribou, bowhead whales, and specific waterfowl are present only during certain phases of migration. The location of other resources, such as polar bear and fish, depends on seasonal utilization of habitat (e.g., summer ice pack, overwintering areas).

3.2.17.3 Northern Corridor Communities

The northern corridor area runs from TAGS MP 160 to 420 and is used for subsistence activities by ~~six~~ SEVEN communities: Nolan/Wiseman, LIVENGOOD Bettles/Evansville, Allakaket/Alatna, Stevens Village, Rampart, and to a lesser extent Minto. Several of these communities are traditionally Northern Athapaskan; the others are the result of mining activities or highway and TAPS maintenance activities.

3.2.17.3.1 Availability of Subsistence Resources

Five major types of subsistence resources are utilized by northern corridor communities along the proposed route (BLM 1987):

- Hunting for moose, caribou, bear, Dall sheep, rabbit, and variety of waterfowl;

- Fishing for salmon, char, cisco, grayling, and other varieties of fish;

- Trapping various furbearers, including beaver, martin, fox, wolf, wolverine, marmot, and others;

- Collecting various plant resources for food and other needs, including berries, roots, seeds, fuel wood, and construction materials;

- Utilization of water resources for drinking or food processing needs.

Caribou have been historically important to residents of the subregion, although relatively recent shifts in caribou migration patterns have lessened this importance (ADF&G 1986). They are harvested from fall through spring, depending on distribution. Access to harvest areas is provided by boat during open water and snow machine when snow cover permits.

A high percentage of households in the region participate in subsistence moose hunting (ADF&G 1986), harvested from September through March. Access to harvest areas is by boat along rivers, sloughs, and lakes; by snow machine; all-terrain vehicle, and on foot.

Black bear are hunted during May and late summer, usually opportunistically in conjunction with other activities. Up to half the households in some communities participate in bear hunting (ADF&G 1986).

While Dall sheep are still a culturallly preferred food, harvests have been reduced in recent years, partly due to the difficulty of access and time and effort involved. Some Bettles and Allakaket/Alatna residents travel between 130 and 150 miles by riverboat to hunt sheep (ADF&G 1986).

A high percentage of households in the region participate in fishing activities, depending on specific location. Chinook, chum and coho salmon are the most important subsistence fish in this region. They are harvested from June through August, primarily with set gill nets. Fishing is a group activity that takes place at traditional fishing campsites. Whitefish are also a major fish resource, taken in the summer incidentally to salmon, early spring, and late fall with small mesh gill nets, winter under the ice. Inconnu (sheefish), pike, burbot, and grayling are also harvested. Access to fishing sites is by boat and snow machine during the winter.

Waterfowl and small game make an important contribution to subsistence resource consumption. Ducks, geese, grouse, and snowshoe hare are most commonly harvested, often in conjunction with other activities. Waterfowl are harvested in May and September, and hare are hunted year-round.

Nolan/Wiseman

Located on the Koyukuk River along the proposed TAGS route, NOLAN/ Wiseman is a historic mining community. Subsistence uses in the area include trapping along the Koyukuk River and its tributaries and moose hunting, fishing and wood gathering (BLM 1987).

> LIVENGOOD

LIVENGOOD IS A HISTORIC MINING COMMUNITY LOCATED JUST EAST OF THE TAGS ROUTE AT MILEPOST 390. SUBSISTENCE USES ARE PROBABLY SIMILAR TO NOLAN/WISEMAN, AND INCL TRAPPINGS, MOOSE HUNTING, FISHING, AND WOOD GATHERING

Bettles/Evansville

The Bettles/Evansville community (actually two adjacent communities) is a regional transportation and service hub located 30 miles west of the TAGS route; Evansville is predominantly Native, and the majority of Bettles residents are non-Native (Marcotte and Haynes 1985). Participation in employment is greater than in more traditional Native communities. Moose are the largest single source of protein in household diets. Though the availability of caribou has been low in recent years, harvest levels should increase with greater availability. Waterfowl, snowshoe hare, and black bear are also harvested. Fish provide a relatively small, though still important, component of diet than other communities in the subregion. Hunting and trapping activities are common along the Middle and North Forks of the Koyukuk River and its tributaries.

Allakaket/Alatna

Located 190 miles northwest of Fairbanks and west of the TAGS route Allakaket and Alatna are on opposite banks of the Koyukuk River. Fishing is an important subsistence activity. Fish comprise a substantial portion of the diet. Salmon is the major species harvested. As in Bettles/-Evansville, moose is an extremely important source of protein. Sheep hunting is culturally important to residents, despite the distance and effort involved. Caribou and bear are often taken in conjunction with this activity. Near the TAGS route, residents hunt and trap along the Kanuti River and the South Fork of the Koyukuk River. Fishing and hunting also occurs on portions of Fish and Bonanza creeks (BLM 1987).

Stevens Village

Stevens Village is a traditional Athapaskan community located 20 miles up the Yukon River from the TAGS crossing. Important subsistence activities include fishing, moose hunting, hunting for waterfowl and small game, trapping, and berry picking. Fishing occurs primarily at traditional sites such as fish camps. Salmon is an important component of diet, and chinnok, chum, and coho salmon harvested. Portions of the pipeline corridor are used for all of these activities, PARTICULARLY THE RAY RIVER DRAINAGE. (R. KING PERSONAL COMMUNICATION 1987)

Rampart

Located approximately 30 miles down the Yukon River from the TAGS crossing, Rampart is a traditional Athapaskan community. Subsistence patterns are similar to those of Stevens Village. The majority of subsistence uses by residents occur outside the utility corridor area (BLM 1987). Some trapping and moose hunting use may take place along Hess Creek, portions of Isom Creek, and the Yukon River in the vicinity of the crossing.

Minto

Minto is somewhat more distant from the TAGS route than other communities previously discussed, located off of the highway to Manley Hot Springs. The harvest of subsistence resources including northern pike, sheefish, black bear and is heavily used by Fairbanks area residents. Moose, salmon, waterfowl, and small game are an important component of the diet. Residents utilize the Tanana River and its tributaries and the area between the community and the Elliot Highway for subsistence activities.

3.2.17.4 Fairbanks-Delta Junction Communities

This subregion is located between MP 420 and 560 of the TAGS route. Unlike the areas to the north, the Fairbanks-Delta Junction communities are more urban in their orientation, with greater participation in wage employment and the cash economy. They are not CLASSIFIED AS A RURAL SUBSISTENCE USE AREA BY THE STATE BOARDS OF FISHERIES AND GAME AND ARE NOT ~~as~~ economically or culturally tied to pursuit of subsistence-LIKE activites, although some residents participate in subsistence activities and personal use fisheries. This portion of the TAGS route contains three major communities: Fairbanks, North Pole, and Delta Junction. Smaller communities such as Fox and Big Delta are also included in the area discussed.

3.2.17.4.1 Availability of Subsistence Resources and Community Use Patterns

Particular subgroups within the Fairbanks area participate in subsistence activities. In 1980 approximately 3,000 Alaska Natives resided in the Fairbanks North Star Borough (ADF&G 1986). Subsistence salmon fisheries at the Yukon River Bridge and on the Tanana River near Fairbanks are heavily utilized. In 1984 there were 308 subsistence permits issued for this fishery, with a harvest of 8,632 fish.

3.2.17.5 Glennallen-Copper Center Communities

Located between TAGS MP 560 and 760, this subregion contains six communities: Paxson/Sourdough, Gakona, Gulkana, Glennallen, Copper Center, and Upper Tonsina. Similar to the northern corridor subregion, this area is a mix of traditional Ahtna Athapaskan communities, regional service centers and highway/pipeline maintenance camps. Subsistence patterns are further influenced by readily available road access.

In addition to subsistence activities, several of the rivers in the subregion support popular personal use fisheries.

3.2.17.5.1 Availability of Subsistence Resources

Fish harvests are the most important subsistence activity in the subregion. Sockeye salmon constitute the majority of the harvest (ADF&G 1985). Salmon are harvested from June through September using fishwheels, dipnets, and rod and reel. Fishwheels are by far the predominant method, particularly in the southern two-thirds of the subregion. Five major fishwheel sites involving 42 fishwheels are located on the Copper River in the vicinity of the proposed TAGS pipeline (Stratton 1982). Fishwheel sites have been traditional, and entire households participate in the effort, although nonresident participation has been increasing in recent years. Grayling, trout, and burbot are also harvested. Access to subsistence sites is by road and boat.

Moose are highly valued subsistence resources. They are hunted during fall months using highway vehicles, off-road vehicles, airplanes, and boats. Due to ease of highway access there has been significant competition for moose between subsistence and sport hunters. Over the past few years subsistence hunting regulations have been changed to help ensure an adequate subsistence harvest (ADF&G 1985).

Caribou have been a historically important subsistence resource, but population declines in both the Nelchina and Mentasta caribou herds over the last two decades, have restricted hunting to allow for an increase in herd size. Recent increases in caribou populations and changes in subsistence hunting regulations have resulted in a fall caribou subsistence hunt. Access to hunting areas is similar to that discussed above for moose.

Other subsistence resources include small game, waterfowl, grouse, and berries. Spruce and birch are used for firewood and home construction.

3.2.17.5.2 Personal Use Fishery

The Copper River is a very popular personal use dipnet fishery for sockeye, chinook and coho salmon. Nearly 7,000 permits were issued for this fishery in 1983. Individuals are allocated up to 15 fish and households up to 30 fish (ADF&G 1985). Many nonlocals participate in the fishery. Approximately 35 percent of the permits issued in 1983 went to Anchorage residents. Currently, the most popular location for dipnetting is just outside of Chitina to the east of the TAGS route.

3.2.17.5.3 Community Use Patterns

Paxson/Sourdough

Located at approximately MP 610 of the TAGS route, Paxson/Sourdough is a non-Native community with a predominantly wage employment and cash economy. Primary subsistence activities include hunting for moose, caribou, black bear, and sheep; fishing for salmon and other fish; hunting small game and waterfowl; and harvesting plants and berries. Based on Alaska Department of Fish and Game surveys in 1982-83, the harvest of big game contributed 58 percent of the mean household harvest of wild resources, followed by fish (37 percent), small game (8 percent) and plants and berries (5 percent) (ADF&G 1985). Mean household harvest was about 441 pounds.

Gakona

Gakona is located on the Tok Cutoff at the conjunction of the Gakona and Copper rivers. Primary subsistence activities are generally similar to those of Paxson/Sourdough but with greater participation in the subsistence salmon fishery. Based on Alaska Department of Fish and Game surveys in 1982-83, the harvest of fish contributed 69 percent of the mean household harvest of wild resources, followed by big game (24 percent), small game (4 percent), and plants and berries (3 percent) (ADF&G 1985). Mean household harvest was 614 pounds.

Gulkana

Gulkana is located on the Richardson Highway, just south of the Tok Cutoff. It has a mix of the traditional subsistence and cash economy. Primary subsistence activities are similar to those of Paxson/Sourdough. Overall household participation in subsistence is lower than many of the other communities in the subregion. Based on Alaska Department of Fish and Game surveys in 1982-83, the harvest of fish contributed 62 percent of the mean household harvest of wild resources, followed by big game (29 percent), small game (5 percent), and plants and berries (5 percent) (ADF&G 1985). Mean household harvest was about 320 pounds.

Glennallen

Glennallen is the regional service and transportation hub and is predominantly non-Native with a employment and cash economy. Per-household participation in subsistence activities is among the lowest in the subregion. Primary subsistence activities are similar to those in Gulkana. Based on ADF&G surveys in 1982-83, the harvest of fish contributed 54 percent of the mean household harvest of wild resources, followed by big game (40 percent), small game (5 percent), and plants and berries (5 percent) (ADF&G 1985). Mean household harvest was about 305 pounds.

Copper Center

Copper Center is the Native regional center and exhibits a mix of the traditional subsistence and cash economy. Primary subsistence activities are similar to those Gakona but with a higher household participation in the subsistence salmon fishwheel fishery. Based on ADF&G findings, the 1983 harvest of fish contributed 83 percent of the mean household harvest of wild resources, followed by big game (11 percent), plants and berries (5 percent), and small game (2 percent) (ADF&G 1985). Mean household harvest was about 383 pounds.

Upper Tonsina

The Upper Tonsina area includes the community of Tonsina and some scattered residences in its vicinity around Chitina and Kenney Lake. Primary subsistence activities are similar to those of Gulkana.

According to ADF&G the 1983 harvest of fish contributed 58 percent of the mean household harvest of wild resources, followed by big game (31 percent), plants and berries (6 percent) and small game (5 percent) (ADF&G 1985). Mean household harvest was about 305 pounds.

3.2.17.6 Valdez-Tatitlek Communities

The area between MP 760 and the proposed LNG terminal at Anderson Bay (MP 796.5) is sparsely populated and contains only two communities: Valdez and Tatitlek. Valdez has a wage employment and cash economy. Subsistence activities by residents are minimal. Tatitlek is a traditional Chugach Eskimo community that is oriented towards coastal subsistence activities.

3.2.17.5.1 Availability of Subsistence Resources and Community Use Patterns

Tatitlek

Though no detailed subsistence surveys of Tatitlek have been completed, reliance on subsistence resources is similar to those of other corridor areas. A wide variety of subsistence resources is available throughout the year, unlike interior locations. Harvest activities of residents tend to be oriented to use of relatively nearby marine and coastal areas. Access to resources is primarily by boat.

Major subsistence resources include fish, marine mammals, deer, and waterfowl and bird eggs. Salmon are harvested from May through September; marine fish such as herring, halibut, and rockfish are harvested year-round. Invertebrates such as crab and clams are generally available throughout most of the year. Deer are hunted from September through December, and ducks and geese are hunted during the same time period. Seal and sea lions are hunted year-round.

3.3 COOK INLET-BOULDER POINT ALTERNATIVE

3.3.1 Introduction

The following subsections describe the existing environment of the Cook Inlet-Boulder Point alternative to the proposed TAGS project from a point just south of Livengood to the Boulder Point site on the east side of Cook Inlet. The discussion of disciplines is in the same order as found in Subsection 3.2 for the proposed action.

3.3.2 Socioeconomics

3.3.2.1 Regional Socioeconomic Conditions

About 20,000 people live along the proposed Cook Inlet alternative route from Livengood to Boulder Point. North of Cook Inlet the only major developments in this area since 1970 have been: (1) expansion of the highway-oriented business due to the completion of the George Parks Highway between Anchorage and Fairbanks; and (2) expansion of coal-mining activity at the Usibelli Mine near Healy. Most residents live in small rural settlements along the main transportation corridors.

The following section gives a brief overview of existing socioeconomic conditions in three designated regions in the Cook Inlet-Boulder Point alternative corridor: (1) Parks Highway area north of the Matanuska-Susitna Borough, (2) corridor communities in the Matanuska-Susitna Borough, and (3) corridor communities in the Kenai area. Table 3.3.2-1 gives population summaries for each area. Section 3.5.17 describes the environment between Livengood and Nenana.

3.3.2.2 Parks Highway Area

In 1986 the George Parks Highway area between Nenana and Cantwell had a population of about 1,900 persons--about the same as in 1970. During TAPS construction the only

Table 3.3.2-1 Population Summary TAGS Corridor Cook Inlet Alternative

Location Within Alternative Corridor	1970	1980	1986
Parks Highway Area			
Nenana	497	470	552
Anderson	362	517	397
Clear Air Force Station	426	400	378
Healy, Suntrana, Usibelli	469	443	434
McKinley Park	26	60	59
Cantwell	98	89	87
Subtotal	1,878	1,979	1,907
Matanuska-Susitna Borough			
Talkeetna area	216	708	1,100
Montana Creek area	927	1,023	1,700
Willow	38	139	232
Subtotal	1,181	1,870	3,032
Kenai-Peninsula Borough			
Kenai	3,533	4,324	6,546
Soldotna	1,202	2,320	3,668
Nikishka area	2,997	3,747	4,885
Subtotal	7,732	10,391	15,099
TOTAL	10,791	14,240	20,038

Sources: 1970 and 1980 U.S. Census, Alaska Department of Community and Regional Affairs, City of Nenana, City of Anderson, Kenai-Peninsula Borough.

significant impact in this area was increased highway and railroad traffic. Nearly all of the inhabitants in this area live on or within a few miles of the highway or rail line. Nenana and Anderson are the only incorporated municipalities in this area.

Nenana is on the Parks Highway about 55 road miles southwest of Fairbanks. With an estimated 552 residents in 1986, Nenana functions primarily as a transportation and service center for the area south of Fairbanks. Nenana is about 40 percent Native and is the only corridor community with a high percentage of Native residents.

Nenana has a small retail and service sector. Residents rely on Fairbanks for most goods and services. A 1981 study found that Nenana residents drove to Fairbanks an average of five times per month during summer and about twice per month during winter.

In addition to highway connections to the state's primary population centers, Nenana also has rail and barge service. Most rail freight to Nenana is petroleum products, which are barged from Nenana to interior villages along the Yukon and Tanana rivers. Nenana is one of only four permanent dry cargo loading and unloading facilities on the Yukon/Tanana rivers system. The Interior's largest barge operator is located in Nenana, and approximately 32,000 tons of freight crosses the Nenana dock annually bound for villages. The community's major employers are the barge company and the Yukon-Koyukuk School District headquarters, which administers schools in 10 interior communities.

Anderson, 21 miles south of Nenana, is adjacent to the Clear Air Force Station (AFS)--an early warning missile site. A 1986 city census enumerated 397 residents in the community and 378 at Clear AFS for a total population of 775. In 1986 Clear AFS accounted for nearly 75 percent of the community's employment.

The Healy area, about 56 miles south of Nenana, estimated 434 residents in 1986 residing in Healy, Suntrana, or Usibelli. The mainstay of the local economy is the Usibelli Coal Mine, which ships coal on the Alaska Railroad to Fairbanks and to Seward for export to South Korea. Other major employers in the Healy area are the Golden Valley Electric Association coal-fired generating plant and the Railbelt School District.

About 60 persons, primarily National Park Service employees and their families, live at Denali National Park and Preserve. Most of these people depend on tourism for their cash income. Cantwell, a highway service community with a 1986 population of 87, is located about 30 miles south of Denali Park near the juncture of the Denali and Parks highways.

3.3.2.3 Matanuska-Susitna Borough

About 3,000 people live along the proposed route in the northern Matanuska-Susitna Borough. There are no incorporated cities in this area, but there are numerous small settlements. The largest is Talkeetna, which had an estimated 441 residents in 1986. The Talkeetna area population is estimated at 1,100. About 1,700 people live south of Talkeetna near Montana Creek, and about 232 people live in Willow.

3.3.2.4 Kenai Area

The last 50 miles of the corridor is in the Kenai Peninsula Borough. There are three governments in the Kenai area portion of the corridor--the Kenai Peninsula Borough, the City of Soldotna, and the City of Kenai. In 1986 an estimated 15,099 persons lived in the Kenai/Soldotna/Nikishki area, which accounts for about a third of the population within the borough.

In contrast to other portions of the corridor the Kenai area has a diversified economic base with a well-developed retail and service sector. As shown in Table 3.3.2-2, between 1980 and 1986 total employment in the borough rose from 8,550 to 11,141, an increase of 30 percent.

In addition to petroleum, the major employers in the Kenai area are local government, retail trade, and service businesses. All sectors have grown more than 60 percent since 1980. The Kenai area economy is very oriented toward the oil and gas industry, not only because of Cook Inlet petroleum exploration and development, but also because a significant percentage of the local labor force have worked on Alyeska pipeline and North Slope petroleum projects. Many oil field services businesses are also located in Kenai.

Tourism and fishing-related businesses are also important contributors to the local economy during the summer months from May to September. The Kenai River and several other rivers on the peninsula are extremely heavily used by sport fishermen and recreationists from all over the world. They fish for salmon, steelhead, and halibut offshore and use the locally accessible beaches for some of the finest clamming in the world. Some weekends as many as 10,000 people may pass through Soldotna pursuing recreation on the peninsula.

Commercial set-net operations on the eastern side of the inlet also contribute millions of dollars to the local economy.

3.3.3 Land Use

The pipeline route to Cook Inlet would be constructed primarily on federal and state lands in the more remote areas such as from Livengood to Nenana and Willow to Boulder Point. However, along much of the Parks Highway, regional, borough, and private landholdings are interspersed among the federal and state holdings. Clear Air Force Station would be traversed adjacent to the highway. Homesteading and numerous state land sales to Alaska residents have occurred in this area. Some of these would be crossed or closely approached by the pipeline and the compressor stations.

In the Minto Flats area south of Livengood, subsistence hunting and fishing are the primary land uses. From Nenana to Willow the route would be adjacent to the Parks Highway and the Alaska Railroad corridor, the primary transportation arteries to the Interior of Alaska. This route borders the most highly developed industrial lands in the state. Known as the Alaska Railbelt, the corridor from Fairbanks to the Anchorage area has three major existing facilities within it. These are the Alaska Railroad, the Parks Highway, and the Anchorage-Fairbanks electrical intertie.

The route traverses sparsely developed lands with a number of peripheral roads and other developments, including several gold and gravel mining operations. Just north of the Alaska Range, the route would pass near Alaska's only operating coal mine, owned by the Usibelli Company. This strip mine provides the fuel for coal-fired electric generating plant in Fairbanks and another at Clear AFS and is the only coal exporting operation in Alaska. In addition, there is ongoing production of gold, lead, silver, zinc, and antimony in areas in and around Denali Park.

South of the Alaska Range the volume of oil and gas produced in fields in Cook Inlet and the Swanson River fields far exceeds other minerals in value. Coal is present near tidewater in the Matanuska, Beluga, and Kenai fields. The total coal resource is estimated to be approximately 2.5 billion short tons, but none of this is presently being mined. An EIS for strip-mining in this area is in its final stages of completion.

The prevailing land uses typify those of a major transportation route through a thinly populated region. Fishing and hunting are still important uses in this region, but many towns and highway stops depend on visitors to Denali National Park and Preserve for their cash income. Many are closed in the winter. In addition to Denali attractions, there are numerous other recreational areas, including the huge

Table 3.3.2-2 Kenai Peninsula Borough Employment by Industry
1980 and 1986 Comparisons

Industry	1980	1986*	% Change 1980-86
Mining	800	1,001	25
Construction	600	762	27
Manufacturing	1,800	1,095	-39*
Trans. Comm. & Util.	700	761	9
Wholesale Trade	250	376	50
Retail Trade	1,100	1,846	68
Finance, Ins. & RE	200	394	97
Services & Misc.	1,200	1,959	63
Federal Govt.	200	217	9
State Govt.	550	825	50
Local Govt.	1,150	1,905	66
TOTAL	8,550	11,141	30

* Based on the first six months of 1986. Thus, it is likely that average annual employment in manufacturing, which is primarily fish processing during the summer, will be somewhat higher.

Source: Alaska Department of Labor, Statistical Quarterly, various issues.

Denali State Park, as well as activities such as hunting, fishing, boating, and trapping throughout the corridor.

A forestry potential exists along the route but is presently of limited value and only locally important. Present usage includes logs for homes, outbuildings, corrals, and heating, plus some applications in mining. The heavier stands of commercial forest occur surrounding the Cook Inlet area. The prime timber species in the Susitna lowlands and Cook Inlet areas includes cottonwood and white spruce. There are extensive stands of cottonwood and paper birch in the middle Susitna Valley.

The Alaska Division of Lands regularly conducts timber sales for harvest of these renewable resources in areas adjacent to the route. Principal sale areas are between Fairbanks and Nenana, in the Susitna River valley, and on the Kenai Peninsula.

The Forest Service timber harvest program is primarily in areas away from the route. The U.S. Fish and Wildlife Service occasionally burns or sells timber from the Kenai Moose Range as a result of habitat enhancement programs.

Land use and management plans exist for much of the region, including a Nenana Comprehensive Planning study, Matanuska-Susitna Borough Comprehensive Development Plan, and the Kenai Borough Comprehensive Plan. There is also a DNR Land Use and Resource Report published in 1978. These plans would have to be complied with or modified in areas where a gas pipeline would conflict with presently specified uses.

The primary industry of the Cook Inlet area is oil and gas production. The petroleum products industry has produced billions of dollars worth of oil and gas since 1959. There are four major petroleum facilities at Nikiski just south of the Boulder Point site.

The Susitna River mouth and delta is a part of the Susitna Flats State Wildlife Refuge and is set aside for wildlife. Due to availability of transportation, centers such as ship docks, a highway terminal, and an international airport. The entire region traversed by the route is the primary center for the state's third largest industry--tourism and recreation. This is especially true of the Parks Highway near the Denali National Park and Preserve, Denali State Park, Nancy Lake State Recreation Area, and Captain Cook State Park.

Agriculture is a dominant commercial land use of the eastern side of the Susitna lowlands near Cook Inlet, with hay farms and several dairies being the primary activities.

Fish resources in Cook Inlet include anadromous species such as salmon and smelt and resident species such as flounder and halibut. Species such as halibut, while not anadromous, may be considered migratory, coming into shallower water at certain times of the year. All five species of Pacific salmon, including sockeye, chum, pink coho, and chinook inhabit upper Cook Inlet in that order of abundance. Of these, the pink and chum contribute most of the commerical catch. Sockeye, halibut, and coho are also important.

3.3.4 Transportation

The region traversed by the alternative route has a relatively complex transportation system in comparison with other parts of Alaska. It has a relatively good paved road network, most of the railroad infrastructure in the state, several large seaports and airports, and existing oil and gas pipelines in the Cook Inlet area. This area is one of the few parts of Alaska with significant competition among the various kinds of transportation. These factors result in an effective network for public transportation and commerce in the Railbelt, which the alternate route parallels for much of its distance.

The Parks Highway extends from Anchorage to Fairbanks and provides commercial and public vehicular access to the Interior of Alaska. Daily traffic on the highway varies, depending on the number of tourists visiting the Denali National Park and Preserve and recreational traffic traveling to fishing, hunting, and boating sites along the route. Denali National Park and Preserve recorded a daily average of about 25,000 visitors during the 1986 summer season. During the June fishing season and the September hunting season, traffic is often stop-and-go on Sunday afternoons from Wasilla to Anchorage, a distance of about 50 miles.

The Alaska Railroad, with approximately 650 miles of track connecting Fairbanks to Anchorate and Anchorage to Seward, carried more than 8 million tons of cargo during fiscal year 1984 (DOT/PF 1984) and numerous passengers between Anchorage, Denali Park, and Fairbanks. The railroad also serves as a unique supply, passenger, and mail delivery service for residents of otherwise inaccessible areas between Anchorage and Fairbanks.

There are four major ports in the region: Anchorage, Nikiski/Drift River, Homer, and Kenai on Cook Inlet and Seward and Whittier. There is considerable small-boat traffic along the Susitna River and its major tributaries, and the area is heavily used by small planes, especially during hunting and fishing season. Since North Kenai/Nikiski Road is a dead end, it is seldom used at or near its capacity.

3.3.5 Noise

Since most of the proposed Cook Inlet alternatives route would be built along or near an existing transportation system, i.e., the Parks Highway and the Alaska Railroad, there would be considerable ambient noise derived from train and vehicular traffic, small aircraft, jet and air boats, and shooting, as described in Subsection 3.2.5.

Both humans and wildlife have habituated to a certain extent to this ambient noise level.

3.3.6 Meteorology/Air Quality

The climate along the regional Cook Inlet-Boulder Point alternative route is classified in the four major climatic zones as discussed: the Arctic, the Continental Interior, the Transition, and the Maritime. The Arctic Zone extends south from the Beaufort Sea coast through the northern part of the Brooks Range. The southern portion of the Brooks Range down through the middle Susitna River basin (near Talkeetna) comprises the Continental Zone. The Transition zone (from continental to maritime climate) includes primarily the lower Susitna River basin. Generally, the area around Cook Inlet is in the Maritime Zone, although there is some modification due to the mountain barrier surrounding the inlet.

The climatic condition for most of the route to the area north of the Alaska Range is similar to that discussed in Subsection 3.2.6. The mean annual temperature in the area north of the Alaska Range is from about 24°F to 29°F. South of the Alaska Range the mean annual temperature is about 29°F in the more northerly part and 38°F in the Cook Inlet area.

Extremes range from lower than -60° to nearly 100°F north of the Alaska Range. South of the range extremes range from about -40° to 85°F.

Precipitation in the area north of the Alaska Range has an annual range of from about 8 to nearly 24 inches per year. South of the Alaska Range the average annual precipitation is from 12 to 24 inches per year at lower elevations.

Winds are generally calm in the area north of the Alaska Range with high winds usually less than 50 miles per hour. South of the Alaska Range winds are generally light, although winds in excess of 50 miles per hour have been noted at several places along the route.

In the area north of the Alaska Range, ice fog, other fog, and blowing snow cause hazardous conditions along portions of the route at certain times of the year. South of the Alaska Range ice fog is less common and less persistent. Blowing snow and severe wind conditions in some of the passes through the Alaska Range, such as Broad Pass, constitute a hazard at certain times of the year, especially in late winter.

Air quality along most of the route is generally considered to be very good and characteristic of rural areas due to minimal human habitation and industrial development. A coal-fired generating facility at Healy burns 180,000 tons of coal per year and another coal-fired plant at Clear AFS burns about 85,000 tons of coal per year. Natural, localized sources of emissions include traffic, wind-generated dust, and forest fires which contribute to temporary increases in air pollution.

3.3.7 Solid Wastes, Hazardous Materials, and Sanitation

Railbelt communities dispose of solid waste in a variety of ways. The primary disposal means are through landfill and both legal and illegal dumping. Due to the low population and small quantity of solid wastes, disposal is not a problem in most areas.

Hazardous materials are presently generated by several entities along the route, the major sources being the railroad, highway department, schools, and small generators such as filling stations and cleaners. Currently there is no mechanism for storage or disposal of toxic or hazardous material in Alaska, and all such materials must be transported and disposed of in the Lower 48.

Sanitary wastes are generated all along the proposed route by the people and facilities there. Due to the fairly low population, disposal of sanitary wastes is not a problem except on a local level. Problems occur especially in areas which are wetlands or have a high water table and leach fields don't work properly.

There are virtually no common sewage disposal sites or systems along the Cook Inlet route. Therefore, each dwelling, business, or shopping center is left with the problem of disposing of their own liquid wastes. Most use leach fields or package sewage treatment plants, although leach fields don't work in the winter due to the frozen ground. Waste concentrations in surface waters are high in the spring due to a winters accumulation of wastes, but generally water levels are sufficiently high during breakup to dilute waste concentrations down to acceptable levels.

3.3.8 Physiography, Geology, Soils and Permafrost

Between Livengood and Boulder Point the Cook Inlet-Boulder Point route alternative passes through five physiographic provinces as shown on Figure 3.3.8-1:

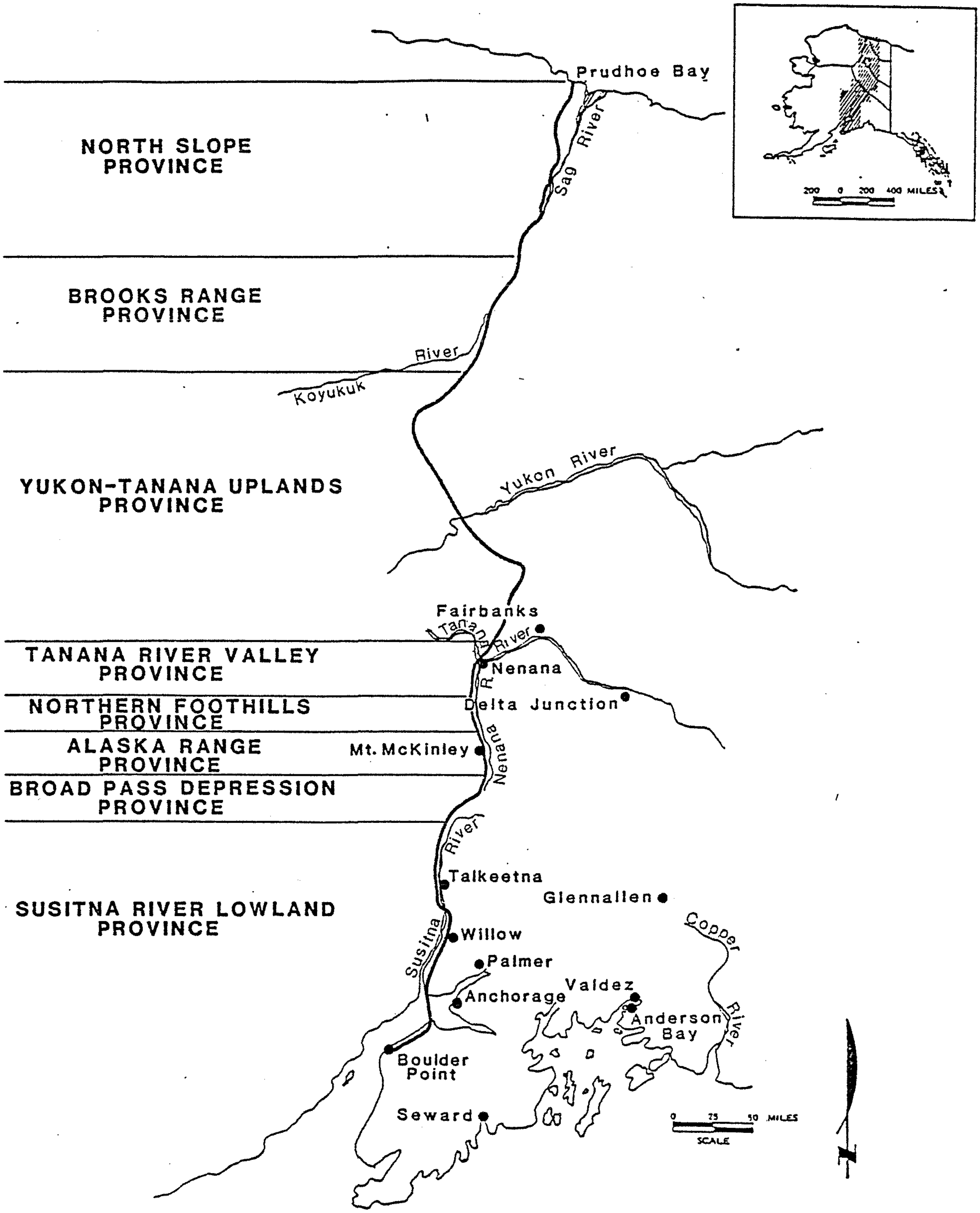
- Yukon-Tanana Uplands
- Tanana River Valley
- Northern Foothills
- Alaska Range
- Broad Pass Depression
- Susitna Lowlands

The discussion for the Yukon-Tanana Uplands, Tanana River Valley, and the Alaska Range are similar to that found in Subsection 3.2.8-Affected Environment. Discussion for the remaining three provinces follows.

3.3.8.1 Northern Foothills

This region of the Alaska Range includes east-west trending ridges 2,000 to 4,000 feet in elevation with wide intervening valleys. The foothills are largely unglaciated.

The Cook Inlet pipeline alternative route enters the foothills on the north via the Nenana River and parallels the Parks Highway to Healy. Bedrock exposures in this section of the route should allow construction due to the solid foundation.



NOTE: Physiographic Provinces after Warhaftig, 1965

Figure 3.3.8-1 Physiographic Provinces Along the Cook Inlet Boulder Point Alternative

3.3.8.2 Broad Pass Depression

The Broad Pass Depression, 1,000 to 2,500 feet in altitude and 5 miles wide, is a trough with a glacially deposited floor. It opens on the east to a broad glaciated lowland with rolling morainal topography and central outwash flats. The bounding mountain walls of the trough are several thousand feet high. Long, narrow hills in the trough trend parallel to its axis, and the main streams in Broad Pass are in deep gorges. The trough opens to the south toward the Susitna Lowlands.

The divide between the Bering Sea and Pacific Ocean drainages crosses this depression in two places and is marked by nearly imperceptible passes. The southwestern part of the depression drains from the Chulitna River into the Susitna; the central part through the Nenana River north to the Yukon; and the eastern part by the headwaters of the Susitna. Most streams which head in Broad Pass and in the surrounding mountains are of glacial origin and are swift, turbid, and have braided beds.

Near Summit, several long, narrow lakes lie in the central parts of the trough. Moraine and thaw lakes are common in the eastern part of the depression. Most of the depression is underlain by permafrost.

3.3.8.3 Susitna Lowlands

The Susitna Lowlands are a glaciated area containing ground moraine and stagnant ice topography, drumlins, eskers, and outwash plains. Most of the area is less than 500 feet above sea level and has low local relief. Rolling uplands near the bordering Talkeetna Mountains and the Alaska Range rise to about 3,000 feet. Isolated mountains, such as Mount Susitna, rise from the central part of the lowland. The Susitna Lowlands contain a major population center and most of the developed agricultural land in Alaska.

The lowlands are drained by the Susitna River and other streams that flow directly into Cook Inlet. Most of these streams on the east side head in glaciers in the surrounding Talkeetna Mountains.

Dozens of irregular-shaped shallow lakes and ponds occur, primarily in morainal areas. Muskeg ponds are common in poorly drained areas.

3.3.8.4 Geology

Most of the bedrock in the Broad Pass area consists of deformed, slightly metamorphosed Paleozoic and Mesozoic rocks that are also exposed in the surrounding mountains. Moraine covers the floor of the depression.

The Cook Inlet-Susitna Lowlands consist mainly of poorly consolidated, coal-bearing rocks of Tertiary age comprising the bedrock. This rock is covered by glacial moraine and outwash and deposits from former lakes and oceans. The boundaries of the lowlands consist of: a) abrupt mountain fronts that are probably fault lines and b) rolling hills of hard pre-Tertiary rocks that slope gently toward the lowlands. The uplands are probably uplifted parts of the surface on which the Tertiary rocks were deposited. The edge of the lowland generally marks the edge of the Tertiary cover, which dips gently away from the mountains. The individual mountains in the center of the Susitna Lowlands are made up of metamorphic and granitic rocks of Mesozoic age.

3.3.8.5 Mineral Resources

Large deposits of subbituminous and lignite coals occur both north and south of the Alaska Range, particularly along the west side of Cook Inlet in the Beluga River area and to a lesser extent on the east side.

The only active coal mine currently in Alaska is at Healy along this route. Prior to discovery of Cook Inlet oil and gas supplies, large amounts of coal for the Anchorage area were mined near Palmer.

The route also traverses numerous mineralized zones. Though the route crosses little unexplored areas, the potential for new discoveries of gold, copper, zinc, and lead along the route is only fair.

3.3.8.6 Soils

Bedrock underlying the Cook Inlet route is generally covered by surficial deposits. The route consists chiefly of schist, claystone, siltstone, sandstone, conglomerate, shale, slate, argillite, graywacke, greenstone, and andesite. The sedimentary rocks vary from poorly to well-indurated, from thinly bedded to massive and have joint systems with spacing of from a few inches to several feet.

Deposits of surface material underlying the corridor are extremely varied. The northern section of the route is underlain by ice-rich silt, sand, gravel, and colluvium. In the Nenana-Clear area, unconsolidated sediments consist of silt, sand and gravel, dune sand, and muskeg deposits.

From Nenana to Talkeetna the route is generally composed by glacial outwash gravel, glacial moraine, clay, silt, and gravel.

The segment of the Cook Inlet route from near Talkeetna south is underlain by glacial outwash consisting of ground moraine, floodplain silt, sand and gravel, muskeg, and shallow lakes.

3.3.8.7 Permafrost

In the area south of Livengood in the highlands adjacent to the Tanana River continuous permafrost is encountered. The Tanana Valley contains isolated ice masses in silty alluvium. Intermittent permafrost is encountered through the Alaska Range, including the foothills both north and south. The Susitna River valley is generally free of permafrost but frozen soil may be found under patches of muskeg.

3.3.8.8 Seismicity

The Cook Inlet route is seismically active and associated with the northeast extension of the Aleutian seismic belt. In addition to the 1964 earthquake (magnitude 8.5), epicenters of several shocks of magnitude 7.0 and larger have occurred within 100 miles of the route during this century.

The earthquake potential along the TAGS corridor may be specified in terms of maximum expectable earthquakes, as shown in Table 3.3.8-1. The maximum expected earthquake is the largest earthquake that can reasonably be expected to occur, based on existing knowledge. It exceeds the largest known historic earthquake. The zonation of the route might be refined if more complete geologic and geophysical data were available.

Table 3.3.8-1
Maximum Expectable Earthquakes

Segment	Magnitude
Livengood to Clear	7.5
Clear to Broad Pass	8.0
Broad Pass to Willow	7.5
Willow to Boulder Point	8.5

Source: FPC 1976a

Depths of earthquakes along the corridor range from shallow crustal to subcrustal depths in excess of 75 miles. Two major active faults which intersect the corridor include the McKinley strand of the Denali Fault near Cantwell and the Castle Mountain Fault just west of Wasilla. An earthquake of magnitude 8 accompanied by ground breaking of at least 20 feet may occur near the McKinley strand of the Denali Fault whereas the magnitude and vertical offset on the Castle Mountain Fault would be about 7.5 and 10 feet, respectively. A delineation of earthquake epicenters (Gedney et al., 1972) indicates a seismically active fault that intersects the corridor in the vicinity of Healy.

3.3.9 Surface and Ground Water

3.3.9.1 Livengood to the Nenana River

The Cook Inlet alternate route departs the preferred route south of the Tolovana River crossing and follows the Tolovana Valley downstream to Minto Flats and then along the edge of the flats to the Tanana River.

The route crosses many small clear-water, gravel-bed streams draining into Minto Flats. Minto Flats is a low, poorly drained area consisting of muskeg lakes and marsh connected by sluggish meandering streams.

Major floods on small streams occur mainly as the result of late summer rainstorms. Icing occurs on most stream valleys in winter as the result of groundwater discharge from fractured bedrock sources and from shallow alluvium. There are no glaciers tributary to the route in this area, and water quality is good.

The Tanana River is crossed about 3 miles downstream of Nenana, which provides a terminal connecting the Alaska Railroad to the barge traffic of the Tanana and Yukon rivers. The Tanana River is a large, silty, braided-channel glacial river, which tends toward rapid channel changes during floods. The Nenana is also a large, silty, braided-channel river, which splits into several distributaries at its junction with the Tanana. The primary distributary of the Nenana River is crossed about 2 miles upstream from Nenana. Streambeds and banks of both rivers are extremely low and unstable in this area. The area floods frequently, and the main channel of the Nenana River could easily divert through another of the existing distributaries to the Tanana.

3.3.9.2 Nenana River to Summit

This 95-mile portion of the route follows the broad Nenana River valley, paralleling either the Alaska Railroad or the Parks Highway to the summit of the Alaska Range. The Nenana and its major tributaries are braided, glacial rivers which drain the northern flank of the Alaska Range. Although the Nenana and its major tributaries are glacial, there are no known glacier-dammed lakes. Major floods can result from fall rainstorms combined with glacier melt. Occasionally the Parks Highway is blocked. Soils in the northern portion of this section tend to be easily eroded. Moderately hard water of the calcium-carbonate type is readily available.

3.3.9.3 Summit to Cook Inlet

From Summit the route follows either the Alaska Railroad or the Parks Highway through Broad Pass and down the wide glaciated valleys of the Chulitna and Susitna rivers. The northern 50 miles of this section is located on a high terrace in the 5-mile-wide glaciated floor of the Chulitna River valley. Tributaries crossed tend to be small and incised deeply into bedrock, and floodplains are narrow; most are relatively clear, draining the Talkeetna Mountains and the southern slopes of the Alaska Range.

The lower 75 miles of this portion follows the Parks Highway through the Susitna Lowlands to Willow. This is glaciated lowland containing many small lakes separated by drumlins and eskers. In this section there are crossings of the Chulitna and several other significant streams. The Chulitna is a steep, gravel-bed river affected by large glacial outburst floods.

The streams crossed south of the Susitna River crossing are less active and tend to be meandering or split channel with gravel beds. Water quality of many of these streams is excellent. Those draining the

Talkeetna Mountains tend to be slightly glacial. There is no permafrost in this area, and erosion potential is minimal. Ground water is readily available and is of the calcium bicarbonate type.

This 55-mile portion of the route leaves the highway north of the village of Willow and follows a route more or less on the divide between the Susitna and Little Susitna rivers to the north shore of Cook Inlet. Only one major stream, Willow Creek, is crossed. However, the route crosses many small streams and is in wetlands for much of the distance. All streams crossed are relatively clear, meandering, and have gravel beds. Water quality is good and ground water is readily available, although there are few springs in that area.

3.3.9.4 Cook Inlet to Boulder Point

At the point it would be crossed, Cook Inlet is a 15-mile wide, shallow estuary. During winter, ice floes drift with the tide. The bed consists of silts and clays over glacial gravel deposits. The bed scours easily to the gravel in response to tidal currents.

From the Cook Inlet crossing the route follows an existing gas pipeline southwesterly for about 50 miles along the coast to the terminal site at Boulder Point. Six small, low-gradient, clear-water streams draining lake basins are crossed, as well as the Swanson River, a coastal stream of some significance. Water quality of these streams is good and groundwater is readily available.

3.3.10 Marine Biology and Oceanography

3.3.10.1 Oceanography

The affected marine environment would consist of the area of upper Cook Inlet near the LNG facilities, the marine terminal, and the marine pipeline crossing. The proposed pipeline across Cook Inlet to Boulder Point would be in an area of variable and constantly changing bathymetry, strong currents, very high tidal exchange, and floating ice during much of the winter. Currents in this area are driven more by tides than wind, and bore tides form in the area near the proposed crossing. Winds are more severe in this area than in the surrounding terrestrial area due to the funneling effect of the mountains on either side of Turnagain Arm and strong glacial winds occur during the summer.

Sedimentation is highly variable, and changes occur constantly in the area's shoals and bathymetry. Major rivers entering the inlet are all highly turbid from glacial flour, and the 3 to 6 m/sec currents generated by extreme tidal exchanges scour the shallow bottom and redeposit the clay/silt sediments constantly.

Ice from the tidal rivers in the area sometimes covers 10 to 80 percent of the inlet during severe cold spells. This pan ice, though usually only 1 or 2 feet thick, is dangerous to ships without reinforced hulls and to any structures placed in the water. Upper Cook Inlet can freeze for brief periods during extremely cold periods with calm winds.

Water quality is good with respect to most parameters except for turbidity, which is very high. Potential sources of pollution which could be exacerbated by the TAGS project include the Port Woronzof municipal waste discharge where primary treated sewage from Anchorage enters upper Cook Inlet, the mouth of the Kenai River where the City of Kenai discharges wastes, and from several industrial sources near Nikiski.

3.3.10.2 Marine Biology

A variety of seabirds, marine mammals such as seals and sea lions, and fish are present in upper Cook Inlet, but in low numbers, probably due to the extreme tides and turbid water and also to the low primary and secondary production in the upper inlet.

There is a large school of beluga whales that uses the upper inlet as a feeding ground during the summer when salmon mill at the mouth of 20 Mile River, Susitna, Portage Creek, and many other west side streams.

Fish species of interest in the upper inlet include all five species of Pacific salmon, which are present when returning to spawn in tributaries, rivers and streams or during outmigration of young smolt, Pacific cod, halibut, and sole, plus a few smelt and hooligan (candlefish). Most are present in small numbers and only during periods of migration or seasonal movement. Excellent razor clam beaches lie just south of the proposed terminal area.

3.3.11 Fish

The fish resources of the proposed route were discussed in Subsection 3.2.11. Most of that discussion holds true for the Cook Inlet-Boulder Point route. Physical characteristics of surface waters in both areas, including glacially turbid major rivers fed by clear tributaries, are similar, and the species typically present also vary little. Approximately 100 rivers and streams are crossed by the Cook Inlet alternative route. (See Table 3.3.11-1) In all five species of Pacific salmon are present, as discussed in Subsection 3.2.11. The fish resources are under more fishing pressure along the alternative route. Several primarily saltwater species are present in the lower Susitna, including hooligan (candlefish), smelt, and coast range sculpin. Also, there is little personal-use fish netting on streams crossed by the Cook Inlet route.

The pipeline would be buried at most river and stream crossings but would be elevated at some along the Cook Inlet-Boulder Point route, including Tanana, Nenana, Hurricane Gulch, and Montana Creek. The route would parallel existing facilities, and a major highway, a railroad, and a high-voltage transmission line would parallel the Cook Inlet-Boulder Point route

Table 3.3.11-1 River or Stream Crossing From Livengood to Boulder Point by the Cook Inlet Alternative Route

Winter Creek
Fourth of July Creek
Eagle Creek
East Fork of the Chulitna River
No Name Creek
Hardage Creek
No Name Creek
Antimony Creek
No Name Lake Tributary
Honolulu Creek
No Name Lake Tributary
Hurricane Gulch
No Name Tolovana Tributary
Granite Creek
No Name Tolovana Tributary
Pass Creek
Tatalina River (2 crossings)
Little Coal Creek
Washington Creek
No Name Tributary to Chilitna
Chatanika River
Byers Creek
No Name Tributaries to Minto
No Name Tributary to Chulitna Lake and Flats
Troublesome Creek
Gold Stream Creek
Chulitna River
Little Gold Stream Creek
5 No Name Tributaries to Chulitna
Tanana River
Trapper Creek
East Middle River
Rabideux Creek and Slough
Little Nenana
Susitna River
Nenana River
No Name Tributary to House Lake
Julius Creek and 2 Tributaries
Montana Creek
Glacier Creek
Goose Creek
Nenana River
Sheep Creek
No Name Tributary to Nenana
Caswell Creek
Birch Creek
Kashwitna River
Bear Creek
196-Mile Creek
2 No Name Tributaries to Nenana
Little Willow Creek
Rock Creek
Willow Creek
Perry Creek
Polly Creek
Little Panguingue Creek
No Name Tributary to Red Shirt Lake
Panguingue Creek
Fish Creek
Dry Creek
Tributary to Flathorn Lake
6 No Name Creeks
Miller Creek
Riley Creek
Seven Egg Creek
Nenana River
Otter Creek
Carlo Creek
No Name Tributary from Scamp Lake
Slime Creek
Swanson River
Nenana River
No Name Tributary from Gooseneck Lake
Jack River
Cantwell Creek

for most of the way. There are very few streams crossed after the Cook Inlet-Boulder Point route leaves the highway system near Willow.

Among the more important streams to be crossed would be Willow Creek, which has all five species of salmon present and is heavily used by sport fishermen; the Swanson River, which has a highly vulnerable run of silver salmon; and Montana Creek, which has large runs of pink and chum and a major rainbow trout population. Montana Creek receives very heavy fishing pressure because of its accessibility. Due to the lack of existing infrastructure in the lower Susitna River part of the route, access road construction would be substantial all the way to the mouth of the Susitna River.

3.3.12 Vegetation and Wetlands

The vegetation and wetlands traversed by the proposed TAGS route south to the point of divergence (TAGS Milepost 395 near Livengood) has already been described in Subsection 3.2.12. Except for coastal sedge marsh in the Susitna Flats, no new vegetation types would be transected by the Cook Inlet-Boulder Point route. However, the relative proportions of vegetation types traversed would differ from those along the Prince William Sound alternative. Vegetation types occurring along the proposed Cook Inlet-Boulder Point alternative route are described under Interior Taiga (Subsection 4.12). Even in the lower Susitna River valley and Kenai Peninsula portions of the route, vegetation types more closely resemble those of the interior region than of the south coastal region.

Five broad vegetation types would be affected by the Cook Inlet alternative south of Livengood. In order of estimated occurrence these types are: lowland spurce-hardwood forest (approximately 39 percent); upland spruce-hardwood forest (35 percent); bottomland spruce-poplar forest (15 percent); alpine tundra (7 percent); and high shrub thickets (4 percent) (DOI 1976). Although coastal sedge marsh was not specifically treated by the DOI (1976), the proportion of this type along the proposed alternative route would be on the order of one to two percent.

Lowland spruce-hardwood forest is found along the route in the Minto Flats and Tanana Flats north of the Alaska Range, along the lower Susitna River, and on the Kenai Peninsula portions of the route. Upland spruce-hardwood forest occurs primarily in the upper Nenana and Chulitna river valleys along the route and is locally interspersed in the lowland forest type on better-drained sites. Bottomland spruce-poplar forest is found immediately adjacent to major rivers, most notably the Tanana, Chulitna, and lower Susitna. Alpine tundra is found in the passes through the Alaska Range and locally along floodplains. Coastal sedge marsh borders upper Cook Inlet, mostly in the Susitna Flats.

The major wetland areas crossed by the proposed alternative route are lowland spruce-hardwood forest and lowland bogs and marshes in the Minto Flats, Tanana Flats, lower Susitna River valley, northwestern Kenai Peninsula. Additional minor wetland areas include shrub thickets, moist tundra above treeline in the Alaska Range, and shrub thickets on floodplains, and coastal marshes in upper Cook Inlet, especially the Susitna Flats.

3.3.13 Wildlife

The species of large terrestrial mammals found along the proposed Cook Inlet alternative route south of Livengood are the same as those described in Subsection 3.2.13, with two exceptions--bison and mountain goats do not occur along this route.

The proposed route passes through important winter concentration areas for moose, including major riparian habitats in a number of sections along its length (ADFG 1973, 1985). Most moose populations of southcentral Alaska are subjected to heavy hunting pressure, both legal and illegal, as a result of the proximity of major centers of human population. The route skirts the western edges of the ranges of the Delta, Yanert, and Nelchina caribou herds and the eastern edge of the range of the Denali caribou herd as shown in Figure 3.2.13-1. Only a very small portion of the Nelchina herd would be expected to contact the route, primarily in fall and winter. Dall sheep occur adjacent to the route in the Alaska Range, most notably in the Windy Pass area. Compressor Station No. 8A would be only a few miles from winter sheep range on Mount Healy but should have negligible noise impact due to the distance.

Black bears are abundant along much of the proposed alternative, especially in the Tolovana River/Minto Flats area, the Chulitna and lower Susitna river valleys, and the Kenai Peninsula lowlands. Brown bears occur in moderate densities in the Alaska Range and Kenai Peninsula portions of the proposed route and in lower densities elsewhere along the route (ADFG 1976a, b). Wolves occur along the entire proposed route and are subjected to heavy trapping and hunting pressure in areas near human population centers, particularly on the Kenai Peninsula.

The species composition of the avifauna along the proposed Cook Inlet alternative route south of Livengood is essentially the same as described for the Yukon and Copper river drainages under Subsection 3.2.13, with the addition of a number of marine-oriented species in the upper Cook Inlet region.

The most important habitats that would be affected by the proposed alternative route are the prime waterfowl nesting and staging areas along the eastern Minto Flats, lower Susitna River valley (especially the Susitna Flats), and the Kenai Peninsula lowlands. Coastal sedge-marsh habitat in the upper Cook Inlet region hosts breeding densities of up to 60 ducks/square mile, and the Susitna Flats and Minto Flats are considered to be "especially sensitive and important from the standpoint of maintaining undisturbed habitat" (ADFG 1976b). The impacts would be considered moderate.

The proposed alternative route would traverse nesting habitats of several raptor species. Bald eagles nest in lowland areas and river valleys (except in the Alaska Range); the species is a common nester along the lower Susitna River. Low numbers of golden eagles nest near the route in the Alaska Range, but the amount of habitat for cliff-nesting raptors is very limited elsewhere along the route. There are records of peregrine falcons nesting near the proposed route south of Livengood (USFWS 1982). Low to moderate nesting densities of several hawk and owl species occur in forested habitats along the route.

3.3.14 Endangered or Threatened Species

The threatened or endangered species of concern for either route are listed in Table 3.2.14-1. Peregrine falcon have been sighted along the Nenana and Susitna rivers, but no nest sites have been reported in this area. There are reports of historic peregrine falcon nesting near the proposed route just south of Livengood (NSFNS 1982).

Seasonably large concentrations of bald eagles gather along the lower Susitna River, and there are several nest sites along the Tanana and Susitna rivers and the coast of the Kenai Peninsula. Eagles gather to feed on hooligan in the lower Susitna in May and June and may occur in concentrations of 50 or more in one small stretch of the river. Eagles also congregate at the mouths of upper Cook Inlet rivers to feed on fish scraps, especially at locations where fish are cleaned by sports fishermen.

There are two threatened plant species candidates listed along the Cook Inlet route. These are the Smelowskia borealis and the pink dandelion (Taraxacum carneocoloratum). Both species are found in high passes in the Alaska Range.

3.3.15 Recreation, Aesthetics, and Wildlife

Recreational use of much of this region is high, and there are many high-quality recreation areas available. Most of the state's population is concentrated near the route, and requirements for recreation are intensive.

Recreational opportunities in the vicinity of the Cook Inlet-Boulder Point route include seasonal and year-round activities such as hiking, hunting, sport fishing, camping, sight-seeing, boating, cross-country skiing, snowmobiling, dog mushing, cycling, wildlife viewing, ice-skating, berry picking, and recreational mining. Outdoor activities depend on weather, time of year, and access. Since the route parallels a year-round highway and railroad system most of the way, access to the area is generally good. However, lack of roads and developed infrastructure, private land, and extensive muskeg hinder more extensive use especially in summer. Aircraft, boats, and all-terrain vehicles offer considerable off-road access during certain times of the year. Such use is very heavy all along the route during the September hunting season and in certain locations during the winter.

The Denali National Park and Preserve lies roughly midway between Anchorage and Fairbanks adjacent to this route. It is a scenic area of national and international importance with Mount McKinley, the highest North American peak, surrounding mountains nearly as high, rolling alpine tundra vistas, and wildlife resources such as grizzly bear and caribou available to viewers nearly every day of the summer.

In 1984 approximately 400,000 recreational visits were recorded in Denali National Park and Preserve, accounting for a total of almost 200,000 overnight stays. This number of visitors doubled over the previous 10-year period. Visitors engage in wildlife viewing, photography, camping, hiking, and mountain climbing. Facilities in the park are available for motorhomes, trailers, and tents at specific locations along the park road. Shuttle busses are available during the summer to take visitors along the park road to Eielson Visitor Center and to Wonder Lake on an hourly basis. The busses operate as wildlife tours also. Visitors can drive personal vehicles into the park before June and after the first of September each year.

The state has developed several high-quality recreational areas along the Parks Highway. Following is a list of most important recreational areas administered by the State of Alaska, Division of Parks, near the Cook Inlet corridor. Recreational uses, size, and locations are given.

- Denali State Park - Cantwell, 282,000 acres, various acccess points for camping, canoeing, fishing; Byers Lake is the largest and most heavily used campground

- Nancy Lake Recreation Area - Willow, 22,685 acres camping, picnicking, canoeing, and fishing

- Willow Creek Wayside - Willow, 40 acres camping and fishing

- Little Susitna Wayside - Houston, 25 acres, camping, picnicking, swimming, fishing, and boating

- Bernice Lake Wayside - Kenai, 7 acres camping, boating, canoeing, fishing, and swimming

- Captain Cook Recreation Area - Kenai, 3,620 acres camping, boating, canoeing, fishing, and swimming

The Cook Inlet-Boulder Point alternative route traverses or has the potential to traverse several state or local parks and recreation and wildlife areas designated as 4(f) sites by the DOT. These include: the Susitna Flats State Game Refuge; Denali

State Park; Nancy Lake State Recreational Area; the Kenai National Moose Refuge, and the Captain Cook State Recreation Area. The route traverses 8 miles of military reservation at the Clear AFS.

Northern Cook Inlet salmon are an important recreational resources. Most sport fishing for salmon in the area is in freshwater streams.

Chinook, sockeye, pink, chum, and coho salmon are found in varying combinations and abundances in major tributaries of the Susitna River and most other streams which enter Cook Inlet.

Hooligan spawn in the early spring in several of the rivers on the east side of Cook Inlet, including 20-mile River and the Susitna and Kenai rivers and provide sport and subsistence fishing opportunities at that time.

A major sport fishery has developed for salmon during the summer in many of the Susitna tributaries. Those flowing into the Susitna River from the east, such as the Willow, Kantishna, Sheep Creek, Goose Creek, and Montana Creek, would be crossed by this pipeline right-of-way. These rivers are major recreational resources during the summer months and receive extremely heavy usage on weekends in June and July.

Hunting is an extremely popular activity on or near the Susitna and Swanson rivers and the Parks Highway during September. There is also considerable spring bear hunting along the Susitna River.

3.3.16 Cultural

Subsection 3.2.16 summarizes the affected environment for cultural resources for the Cook Inlet alternative route north of the Alaska Range.

In southcentral Alaska the relationship between the early Athapaskans and the people known to have occupied southcentral Alaska at an earlier date is not well understood (Cook 1975). It is known that by 500 A.D. Athapaskans occupied interior Alaska and utilized a subsistence strategy similar to that assumed for the people of earlier periods.

Linguistic studies by Kari and Krauss (1980) indicate that the Cook Inlet alternative route area was occupied in recent history by Athapaskan-speaking people. In general the southern portion of the project near Cook Inlet was occupied by Tanaina and the northern portion of the route was dominated by the Ahtna Indians. The origin of either group is not well understood, but it appears the Ahtna may have occupied the interior area for a considerable time (Workman 1977). The Tanaina probably are recent arrivals to the upper Cook Inlet area (Osgood 1966, Reger 1977).

The first recorded European contacts were related to the exploration of Captain James Cook, who sailed into the inlet in 1778. A Russian trader with the Zaikov expedition had established trade links with the Ahtna Indians by trading through the coastal Chugach Eskimos in the early 1700s (de Laguna 1972).

By 1783 trading camps established along Cook Inlet later became staging areas from which military and geological survey parties explored and mapped interior Alaska during the late nineteenth century (Eldridge 1900; Learnard 1900). By the late 1800s, gold prospectors were searching much of the Susitna River basin. In 1903 gold was discovered on Galina Creek, later renamed Valdez Creek, which became the center of Susitna basin gold mining. Overland trails and supply routes developed. Most of these routes utilized the Richardson Trail, which originates in Valdez, since there was no convenient unloading facility on Cook Inlet. Consequently, the movement of men, supplies, gold, and furs to and from the Alaska Interior was primarily east of the Talkeetna Mountains.

It was not until around 1915 that there was renewed interest in transportation routes to the middle and lower reaches of the Susitna Valley. Congress authorized construction of the Alaska Railroad and a northern route was selected which eventually paralleled the Susitna River for much of the way to Fairbanks. The railroad was completed in 1923 (Fitch 1967). Roadhouses were built simultaneously with the construction of the railroad. At one time, up to 50 roadhouses existed along this route. Of these, only the Wasilla Roadhouse near Knik is on the National Register. It wasn't until 1973 that the Parks Highway was completed. Until then, the only access to the Fairbanks area and to Cantwell-Denali National Park was via the Richardson and the Denali highways. The Denali Highway between Paxson and Cantwell is still a gravel road.

3.3.17 Subsistence

The area affected by the proposed Cook Inlet alternatives has been divided into three subregions for the purpose of discussing the distribution of subsistence resources and community harvest activities. These communities are: Nenana, upper Cook Inlet, and the Anchorage/Kenai Peninsula.

3.3.17.1 Nenana Corridor Communities

The Nenana Corridor begins approximately at Livengood and ends at Denali National Park and Preserve. Five potentially affected communities are located in the corridor--Minto, Nenana, Anderson-Clear, Healy-Sultrana, and McKinley Village. Of these communities, Minto is a predominantly traditional Athapaskan village; Nenana has a mixed population of Native and non-Native residents; and the remainder have small non-Native communities with economics that revolve around the military, mining, and service-tourism.

3.3.17.2 Availability of Subsistence Resources

Four major types of subsistence resources are utilized by Nenana Corridor communities.

- Hunting for moose, caribou, bear, sheep, rabbits, and a variety of birds and waterfowl.

- Fishing for salmon, char, cisco, grayling, and other species.

- Trapping various furbearers, including beaver, martin, fox, muskrat, wolf, wolverine, marmot, and lynx.

- Collecting various plant resources for food and other needs, including berries, roots, seeds, fuel wood, and construction materials.

Moose are the most important subsistence resource of this area. In Nenana, 95 percent of surveyed households reported participating in moose hunting during a 12-month period of 1981-82 (ADFG 1986). Moose hunting takes place along rivers and off the road systems, primarily in the fall, but it may continue into the winter months. Important use areas include the Minto Flats; the Tanana, Teklinika, Tolovana, Chatanika, and Wood rivers; and along the Parks Highway as far south as Cantwell. Boats and all-terrain and highway vehicles are commonly used during the fall for hunting access; snowmobiles are used in winter when snow cover permits.

Compared to moose, caribou, bear, and Dall sheep are less important, and hunting is more likely to take place further away from the TAGS corridor. Increased expense and effort, competition with sport hunters, and concerns about depleting the resource are mentioned as reasons for low hunting effort for these species (Shinkwin and Case 1984). Hunting for these animals mostly takes place in the fall, although bear are also hunted in spring. Though they may not represent a large portion of subsistence harvest, many households participate in hunting for small game, birds, and waterfowl. In Nenana a recent survey showed that household participation was 82 percent for hare, 77 percent for waterfowl, and 73 percent for ptarmigan and grouse (Shinkwin and Case 1984). Peak waterfowl hunting occurs in September along rivers, lakes, and sloughs, particularly in the Minto Flats and the Linden Lakes areas. Upland game birds and rabbits are harvested throughout the year.

Fish are another important subsistence resource, particularly for the community of Nenana, which harvests chinook, chum, and other salmon on the Nenana and Tanana rivers. Fishwheels and set nets are used to harvest salmon. Most fishwheel and set net sites are concentrated along the Tanana River within 6 miles up and downstream from Nenana. Communities to the south of these river systems tend to be less dependent on salmon and harvest other fish resources. Salmon fishing takes place in summer. Fishing for other species, such as cisco, grayling, and char, occurs during winter using set gill nets deployed under the ice.

Game Management Unit (GMU) 20, which includes this segment of the TAGS alternative route, is one of the most heavily used trapping areas in the Interior (ADFG 1986). The area's population and road access contribute to this high use. Activities are concentrated along the Parks Highway and side roads and along the river systems. Trapping provides an important supplementary source of cash and products for local handicrafts. Snowmachines are the most commonly used means of access to trapping areas, although dog sleds and aircraft are also used.

3.3.17.3 Community Use Patterns

Minto is a traditional Native community with road access to the Elliott Highway. Moose, salmon, waterfowl, and small game are important components of the diet. Residents utilize the Tanana River and its tributaries and the area between the community and the Elliott Highway for subsistence activities. Additional information on subsistence characteristics of Minto is presented in Subsection 3.2.17.

Of the other communities in this area, Nenana is the only one with a significant Native population; 46 percent in 1980 (ADFG 1986). The economy is a mix of traditional subsistence and wage employment. Moose and salmon are among the most important subsistence resources, and household participation in hunting for waterfowl, upland game birds, and small game animals is also high. Harvest activites are concentrated along the waterways accessed by boat (rivers, sloughs, and lakes) and along the Parks Highway and secondary roads.

The remaining three communities are predominantly non-Native and are wage employment oriented, although subsistence contributes to their economies. Subsistence activities are oriented towards hunting of moose, waterfowl, upland game birds, sheep, and small game animals and trapping. Subsistence activities are focused along the Parks Highway and adjacent areas where access is available.

3.3.17.4 Upper Cook Inlet Communities

The upper Cook Inlet section of the route stretches from just south of Denali Park and Preserve along the Parks Highway to Houston. The area includes six communities: Cantwell, Summit, Talkeetna, Montana Creek, Willow, and Houston. These communities are primarily non-Native and have wage based economies with some contributions by subsistence.

Considered part of the Railbelt area, the nature of subsistence activities of these communities is a mix of rural and urban, unlike traditional Native communities. Because of their location and road access, they do not meet the present state definition for subsistence users, and their harvest of fish and wildlife is considered to be recreational. In addition, several more rural communities located off the Parks Highway may use the proposed route area for subsistence purposes, including Petersville, Peters Creek, and Trapper Creek.

3.3.17.5 Availability of Subsistence Resources

Resources used for subsistence by these communities are similar to those of the Nenana Corridor and include moose, caribou, bear, Dall sheep, salmon and other fish, waterfowl and upland game birds, small mammals, furbearers, and berries and edible plants. Harvest periods are also similar to that of the Nenana Corridor. Moose are hunted during the fall months along the Parks and Denali highways and the various systems connected to them by boat along the Susitna and Chulitna rivers and their tributaries. Access is sometimes by airplane. Salmon are harvested by rod and reel from June through September. Access is usually by boat and the road systems. Harvest of nonsalmonids occurs year-round. Waterfowl are also harvested during fall, along with small game into the winter. Trapping begins in November and continues into April and May except during warm springs (ADFG). Access is along the road system, by boat, and by snowmachine.

3.3.17.6 Community Use Patterns

The small and rural communities along the TAGS alternative route in upper Cook Inlet area have wage employment economies although harvest of fish and wildlife and trapping contribute to the economy. Though specific data are not readily available on household participation in fish and wildlife harvest, it appears that moose is the most important subsistence resource, followed by salmon. Many households are likely to participate in hunting for waterfowl and small game and to a lesser extent sheep and caribou, which are less accessible and require greater effort. Trapping contributes to cash income in most of the smaller communities.

3.3.17.7 Anchorage-Kenai Peninsula Communities

This segment of the alternative route runs from Wasilla to the Boulder Point LNG terminal site on the Kenai Peninsula. The affected communities include Big Lake, Anchorage, Nikiski, Kenai, and Soldotna. As was the case for the upper Cook Inlet communities, they are connected to Anchorage by the Railbelt transportation system and are not legal subsistence hunting and fishing areas. Specific subgroups in all of these communities participate in subsistence activities, particularly Natives on the Kenai Peninsula.

3.3.17.8 Availability of Subsistence Resources and Community Participation

As for the upper Cook Inlet communities, fishing and moose hunting are popular subsistence and recreation activities. Salmon fishing occurs from May to October in streams in the Mat-Su Valley and in streams along the coast of the Kenai Peninsula. The Susitna and Little Susitna rivers, located near the alternative route, are popular rivers for salmon fishing. Rod and reel is the primary method of harvest, although a personal use set-net salmon fishery is often opened in certain areas along the route. Access to fishing areas is by road, boat, and airplane. A random sample of households in the Anchorage and Palmer/Wasilla showed that 1978-79 household participation ranged from 28.6 to 39.9 percent for freshwater fishing (ADFG 1985). Fishing for rainbow trout, grayling, burbot, and other freshwater species occurs throughout the year along the area's rivers, lakes, and streams.

Though not quite as popular as fishing, the Alaska Public Survey of Anchorage and Palmer/Wasilla showed that 1978-79 household participation in moose hunting ranged from 13.2 to 21.4 percent. Popular moose hunting areas include GMU's 16 A and B along the

Susitna River, 14 A-C to the east, and 15 B and C on the northern Kenai Peninsula. Hunting takes place primarily during the month of September. Access is by road, boat, snowmobile, and airplane.

Other important subsistence/recreation activities include hunting for waterfowl along coastal flats and wetlands (with seven percent household participation) during September and October and hunting for small game (8 to 11 percent household participation). Popular waterfowl hunting areas along the alternative route include the Susitna Flats and the Chickaloon Flats on the Kenai Peninsula.

SECTION 4
ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

SECTION 4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND ALTERNATIVES

4.1 INTRODUCTION

This section analyzes and discusses potential environmental consequences from activities associated with the proposed TAGS project and the Cook Inlet-Boulder Point alternative. The alternative route is discussed in Section 1.0. The actual project might differ somewhat from the scenario presented in Section 2.0 in that minor changes in routing, compressor station locations, stream crossings, and other modifications would be expected; however, the types and magnitude of the potential effects of such modifications should be reasonably comparable. Required permit applications such as those for stream crossings, air and water emission discharges, and land use would require considerable additional site-specific information and discussion of impacts.

This section tiers on existing EIS consequences sections such as those found in the TAPS, ANGTS, and the El Paso EIS's previously discussed in Subsection 3.1 and are incorporated herein by reference wherever applicable. It includes appropriate discussions as well as updated information on each subsection.

Discussion considers the applicant's proposed mitigation measures, described in Section 2.8 as project features that would be implemented. In addition, the impact assessment section considers environmental, social, and engineering stipulations included in the TAPS Grant of Right-of-Way dated January 23, 1974 and the ANGTS Grant of Right-of-Way dated December 1, 1980 (see Appendices E and F respectively.) Table 4.1-1 defines the significance level of environmental effects terminology used throughout this section.

4.2 PROPOSED TAG PROJECT TO ANDERSON BAY

4.2.1 Introduction

The following subsections describe the environmental consequences for the proposed route from Prudhoe to Anderson Bay. The topics result from issues derived at scoping meetings and agency comments. In all cases the identification of consequences begins at the northern end of the route and proceeds southward, unless there is a statewide description. The technical sections are grouped into similar or related topics whenever possible.

4.2.2 Socioeconomics

4.2.2.1 Statewide TAGS Impacts

4.2.2.1.1 Population and Employment

The most significant socioeconomic impact of the TAGS project during preconstruction and construction phases would be increased population and employment. The preconstruction phase would last about three years and require about 375 personnel in Anchorage to work on design definition and permitting. During the five-year detailed design and construction phase, average annual TAGS employment would peak at more than 7,200 people (Table 4.2.2-1). By comparison, employment on the TAPS pipeline peaked at an annual average of nearly 22,000 people.

During the five-year construction phase an average 950 project management, administration, and related support staff would be based in Anchorage. During the first two years of the construction period there would be very little construction craft employment along the pipeline corridor. One exception is that about 1,500 personnel would be working on the liquified natural gas (LNG) plant and marine terminal facilities in Valdez.

During peak construction about 80 percent of the direct project employment would be in craft positions. A major problem during the Alyeska project was a shortage of skilled, experienced workers in certain crafts. To evaluate the potential availability of craft workers, TAGS construction craft requirements were

Table 4.1-1 Definitions of Environmental Impacts

EFFECT LEVEL	DEFINITION
Physical Resources:	
Major	Widespread modification of considerable severity in land forms, surface appearance, or contamination of surface resources lasting more than 20 years.
Moderate	Local modification of considerable severity in land forms, contamination of physical resources lasting more than 20 years or widespread modifications lasting less than 20 years.
Minor	Localized, relatively isolated change lasting less than 10 years with no observable modification in surface appearance.
Negligible	Little or no change in surface appearances.
Biological Resources:	
Major	Widespread, long-term change in habitat quality, abundance, or distribution of species.
Moderate	Widespread, short-term modification or local long-term modification
Minor	Short-term local change
Negligible	Nondetectable change in habitat, etc.
Social/Cultural Resources:	
Major	Substantial change in government policy and planning or likely to have long-term effect on residents social or cultural resources.
Moderate	Some modification of policy, or has short-term effect on local residents.
Minor	Minor modification in government policy required, predictably marginal or barely detectable effect.
Negligible	Has nondetectable effect on social/cultural resources of area residents.

Note: Long-term is defined as 20 or more years
Short-term is defined as less than 20 years

Table 4.2.2-1 TAGS Projected Employment
by Job Type
Construction Phase

JOB TYPE	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5
Construction Managers	18	29	162	167	134
Admin. Managers	4	7	40	50	46
Purchase Agents	4	6	33	31	31
Accountants	6	9	49	47	38
Computers Techs/Progs	6	9	49	47	38
Engineers	28	46	253	241	172
Attorneys	1	1	8	9	11
Life & Physical Scientist	1	2	12	12	8
Public Relations	1	1	7	9	6
Personnell/Labor Relation	3	4	24	30	31
Engineering Techs.	45	72	396	504	459
Secretaries	5	8	46	47	42
Bookkeepers	5	8	46	47	42
Office Machine Opers	5	8	46	47	42
Clerks	14	23	125	132	107
Carpenters	3	5	26	43	34
Caterers	19	31	171	201	191
Concrete Workers	0	0	0	3	2
Electricians	6	10	54	127	266
Sheet Metal Workers	8	13	73	67	44
Laborers	74	119	661	1395	1187
Operating Engineers	148	237	1310	1887	1606
Painters	0	1	3	6	48
Pipe Fitters	10	17	93	638	457
Welders	6	10	55	139	186
Teamsters	98	158	872	1276	674
TOTAL	520	834	4612	7202	5902

Source: Yukon Pacific Corporation

compared with peak Alyeska employment, union membership, and union unemployment. The results of this analysis, summarized in Table 4.2.2-2, show that the number of unemployed in most crafts exceeds the number of workers in that craft who might be needed during construction of TAGS.

Since the welders union is not based in Alaska, many of these workers would be imported from the Lower 48. The TAGS project would require a peak annual average of less than 600 welders compared to nearly 1,400 on the Alyeska project.

Much of the negative impact associated with the Alyeska project resulted from the need to import workers with pipeline-related construction experience. At that time most of the contractors were also new to Alaska. Today, most of the major contractors who would likely bid on the TAGS project have extensive Alaska experience and have developed a cadre of Alaska workers who have the skills and experience to work on the TAGS project. Certain management and technical personnel and some highly skilled crafts personnel would still have to be brought in, but most positions probably could be filled from within the state. It should be noted, however, that the state labor market, particularly the availability of craft workers, could decrease dramatically between now and when TAGS is built due to outmigration and shifts to other employment.

In addition to direct employment of about 7,200 people the TAGS project would create about 3,400 indirect jobs during construction (Table 4.2.2-3). These statistics do not include the conditioning plant, additional North Slope field development, or state and local government employment.

During the operations phase TAGS would employ about 550 people in Alaska: 100 in Valdez, 150 in Anchorage, 100 in Fairbanks, and 200 (in two-weeks-on/one-week-off shifts) at the 10 compressor stations. As shown in Tables 4.2.2-4 and 4.2.2-5, the project would also generate indirect employment of about 1,250 jobs during the operation phase.

Table 4.2.2-6 estimates the overall population gain (workers and families), during the five-year TAGS construction period at about 10,600 persons. During construction most population impacts would be concentrated in the communities along the corridor. In the two years following project completion, however, most of this population gain would be lost. As Table 4.2.2-4 shows, by the fifth year of TAGS operation the total statewide population gain as a result of the TAGS project would be about 2,000.

4.2.2.1.2 Infrastructure and Social Impacts

The long lead time available to plan for the TAGS project and the surplus of facilities and services currently available should help relieve infrastructure impacts of the project. For the most part Anchorage and the communities along the proposed TAGS route could accommodate most anticipated impacts without building new facilities. During the Alyeska project housing shortages were the primary cause of the rapid inflation. Today, however, housing surpluses are the rule in Anchorage and in nearly all the communities along the proposed TAGS route. In fact surplus capacity exists throughout the public and private sectors due to the billions of dollars in state-funded construction for new schools, airports, highways, hospitals, roads, fire departments, government offices, libraries, community centers, and other public facilities.

This growth was matched by vast expansion of the state's banking industry, retail trade, service sectors, and other infrastructure. Most of the state's utility providers have substantial excess capacity, and vacancy rates are high for all types of retail, commercial, and industrial space. Services such as trucking would need to expand, but this can readily be accomplished without negatively affecting existing customers. The extent to which the state's infrastructure would still have a surplus when TAGS is constructed depends on future

Table 4.2.2-2 TAGS Peak Craft Employment Compared To Alyeska

Craft	Alyeska Peak Employment	Current Union Members	Union Unemployment	TAGS Peak Unemployment
Carpenters	509	2,547	724	43
Caterers	1,254	2,811	979	201
Electricians	761	570	380	127
Laborers	3,323	1,981	1,169	1,395
Operators	4,593	2,800	924	1,887
Plumb/Pipe Fit.	946	1,560	208	638
Welders	1,379	NA	NA	139
Teamsters	3,224	8,776	2,721	1,276
Other	1,533	NA	NA	76
Sub Total	17,522	21,045	7,105	5,782

Source: Alaska Department of Labor, Research and Analysis Section "Union Membership and Percent Out-of-work," Juneau, Alaska, 1980-1985 and "Community Information Quarterly," Fairbanks North Star Borough, Volume I, No. 1, February 1978.

Table 4.2.2-3 Trans-Alaska Gas System
Construction Phase Increases
Alaska Nonagricultural Employment

	Year-1	Year-2	Year-3	Year-4	Year-5
Mining	80	79	84	10	7
Oil & Gas	0	0	0	0	0
Other Mining	84	79	84	10	7
Construction	716	1221	5150	8063	6758
TAGS	520	834	4612	7202	5902
Other	196	387	538	861	856
Manufacturing	10	14	64	99	82
Logging	0	0	0	0	0
Sawmills	0	0	0	0	0
Pulp & Paper	0	0	0	0	0
Seafood Processing	0	0	0	0	0
Other Manufacturing	10	14	64	99	82
Transportation, Comm., & Public Utilities	189	189	310	515	638
Trucking	60	52	80	112	118
Water Transportation	114	94	91	111	121
Air Transportation	11	20	78	134	133
Other Transportation	1	6	18	46	87
Communications	2	13	32	84	141
Public Utilities	1	5	11	28	39
Wholesale Trade	28	56	294	506	480
Motor Vehs. & Parts	1	4	9	23	27
Constr. Matls., Elec. & H'Ware	2	5	15	32	30
Building Matls. & H'Ware	3	9	21	51	59
Other Retail Trade	7	38	91	242	368
Services	147	198	422	719	849
Health, Legal & Membership Orgs.	6	28	78	188	308
Other Services	141	169	344	531	541
Finance, Insur. & Real Estate	7	39	97	252	408
Banking	2	13	33	86	142
Other	5	26	64	166	266
Government	0	0	0	0	0
Federal	0	0	0	0	0
State	0	0	0	0	0
Local	0	0	0	0	0
Miscellaneous	0	0	0	0	0
Total	1103	1764	6427	10437	9662

Source: Yukon Pacific Corporation

Table 4.2.2.4 Trans-Alaska System
Operating Phase Increases
Alaska NonAgricultural Employment

	Year-1	Year-2	Year-3	Year-4	Year-5
Mining	0	0	0	0	0
Oil & Gas	0	0	0	0	0
Other Mining	0	0	0	0	0
Construction	8	27	31	29	26
Manufacturing	7	7	7	7	7
Logging	0	0	0	0	0
Sawmills	0	0	0	0	0
Pulp & Paper	0	0	0	0	0
Seafood Processing	0	0	0	0	0
Other Manufacturing	7	7	7	7	7
Transportation, Comm., & Public Utilities	703	739	762	773	778
Trucking	2	5	8	9	9
Water Transportation	2	7	7	7	7
Air Transportation	2	7	9	10	10
Other Transportation	551	558	566	570	572
Communications	3	16	25	29	32
Public Utilities	142	146	147	147	147
Wholesale Trade	63	73	78	79	79
Motor Vehs. & Parts	1	3	3	3	3
Constr. Matls, Elec & H'ware	0	2	2	2	2
Other Wholesale Trade	62	68	72	74	74
Retail Trade	12	48	61	64	65
Motor Vhs. & Parts	2	7	12	14	14
Building Matls & H'ware	3	8	6	6	6
Other Retail Trade	8	32	42	44	45
Services	700	741	765	770	773
Health, Legal & Membership Orgs.	9	36	57	62	65
Other Services	691	705	708	709	709
Finance, Insur. & Real Estate	35	75	97	106	110
Banking	3	17	24	27	29
Other	32	59	73	79	82
Government	0	0	0	0	0
Federal	0	0	0	0	0
State	0	0	0	0	0
Local	0	0	0	0	0
Miscellaneous	0	0	0	0	0
Total	1528	1711	1799	1828	1838

Source: Yukon Pacific Corporation

Table 4.2.2-5 Trans-Alaska Gas Project
Selected Local Area Impacts
Operation Phase

Local Area	Year 1	Year 2	Year 3	Year 4	Year 5
Direct and Indirect Employment (Jobs)					
Statewide	1528	1711	1799	1828	1838
Anchorage	743	832	874	889	893
N'Slope Borough	79	88	93	94	95
F'Banks Borough	291	325	342	348	350
Valdez City	25	28	29	30	30
G'Allen/Copper Center	60	67	71	72	72
Direct and Indirect Resident Personal Income (Millions 1986$)					
Statewide	71.3	84.7	91.8	95.9	100.0
Anchorage	35.9	42.6	46.2	48.2	50.3
N'Slope Borough	1.0	1.2	1.3	1.3	1.4
F'Banks Borough	12.5	14.9	16.1	16.8	17.6
Valdez City	1.2	1.4	1.6	1.6	1.7
G'Allen/Copper Center	1.0	1.0	1.0	1.0	1.0
Retail Sales (Millions 1986$)					
Statewide	29.9	35.5	38.5	40.2	42.0
Anchorage	15.0	17.8	19.4	20.2	21.1
N'Slope Borough	.4	.5	.5	.5	.5
F'Banks Borough	5.2	6.2	6.7	7.0	7.3
Valdez City	.5	.5	.6	.6	.7
G'Allen/Copper Center	.4	.4	.4	.4	.4

TAGS Property (Millions 1986$)

Statewide	$ 9,400
Anchorage (Offices and Storage Facilities)	$ 25
N'Slope Borough (2 Comp. Stations; 175 miles pipe)	$ 1,380
F'Banks Borough (2 Comp. Stations; 85 miles pipe; office/storage)	$ 810
Valdez City (20 miles pipe)	$ 2,030
G'Allen/Copper Center (1 Comp. Station; 22 mile pipe)	$ 165

Other Property Value Increases (Millions 1986$)

Statewide	$ 22
Anchorage	$ 11
N'Slope Borough	(small)
F'Banks Borough	$ 4
Valdez City	$ 1
G'Allen/Copper Center	(small)

Notes:
(1) Compressor Stations in North Slope Borough (2), Fairbanks Borough (2), and Glennallen/ Copper Center Area (1). Two other compressor stations located outside localities listed here.
(2) Employment is on a place of work basis. These are jobs in the local area and may or may not be filled by residents.
(3) Personal Income and retail sales are on a resident basis, in the case of personal income, regardless of where earned.

Source: Yukon Pacific Corportation

Table 4.2.2-6 Trans-Alaska Gas System
Construction Phase
Selected Alaska Economic Impacts

	Year 1	Year 2	Year 3	Year 4	Year 5
Cumulative Population Gain	651	1526	4578	9045	10570
Employment Due To	1103	1764	6427	10437	9662
Resident Personal Income Due To	43.7	68.9	273.0	468.8	445.2
Cumulative Housing Units Auth.	71	183	563	1279	1728
Bank Deposits Due To	3.8	17.1	45.3	118.4	177.7

Note:
(1) Personal Income and Bank Deposits in Millions of Constant 1986 Dollars.
(2) Population Gain includes TAGS Workers in Camps.
(3) Housing Units excludes TAGS Workcamps.

Source: Yukon Pacific Corporation

Alaska economic trends and when construction begins.

Concern about the social effects of the Alaska pipeline was second only to environmental concerns. The project caused a flood of jobseekers to come to the state, and in some communities along the corridor, the supply of housing, facilities, and services were totally inadequate to meet the demand. Many that do not find employment would be dependent on state social services and would strain existing social support programs. All the communities in the TAGS corridor experienced the effects of the Alyeska project, which should greatly help them to anticipate and plan for potential TAGS impacts. These communities have also experienced postconstruction economic downturns and should be better able to differentiate between short-term impacts and long-term community and economic development needs.

4.2.2.1.3 Government Revenues and Expenditures

About two-thirds of the proposed TAGS right-of-way would be located in areas without local governments. This creates problems for the project, government officials, and project contractors because it is difficult to determine who really represents the community. Planning for and effectively dealing with impact requires that local residents work together to assess potential problems and develop mitigation methods.

During the construction phase additional expenditures for some government services are likely, particularly for public safety and highway maintenance. Areas without local governments cannot raise additional tax revenues to pay for such service increases and would probably request state assistance to deal with anticipated impacts.

During the operations phase the TAGS project would add an estimated $188 million annually in property taxes, $64 million in state severence taxes, and $125 million in royalty payments. In addition approximately $100 million in corporate income tax would be realized. These revenues would greatly exceed any imaginable costs state government would incur dealing with socioeconomic impacts of the project. Additionally, TAGS revenues would help to supplant declines in state petroleum revenues due to the depreciation of TAPS and potential reductions of Prudhoe Bay oil production. The State of Alaska owns 12.5 percent of the total volume of natural gas to be produced at Prudhoe Bay.

4.2.2.2 Regional TAGS Impacts

A major impact along the entire length of the TAGS corridor would be increased highway traffic from transporting thousands of truckloads of 80-foot, double-jointed pipe during a 15-month period. This increased traffic and the long, heavy loads would be expected to create significant safety hazards and require increased road maintenance.

Interest in construction employment would undoubtedly be high among corridor residents. All except those living in Anchorage or Fairbanks would have to travel to Anchorage or Fairbanks to seek employment. During construction some corridor residents would work on the pipeline, since many village and urban residents now have construction experience. One consequence of falling construction employment opportunities in recent years is that many workers, especially village residents, have not maintained their union status.

In rural areas pipeline employment could conflict with some subsistence pursuits and BLM fire-fighting jobs. A more serious concern would be that highly skilled workers now maintaining village utility systems and other facilities might be attracted to higher-paying pipeline jobs. The loss of such workers could jeopardize village facilities if adequately trained personnel were not available to replace them.

During the operations phase the only employment opportunities along the corridor would be 20 workers at each compressor station, 100 at the Fairbanks maintenance facility, and 100 at the Valdez terminal and LNG plant. The following sections detail specific impacts in six regions along the proposed corridor.

4.2.2.2.1 North Slope Borough

TAGS construction in the North Slope Borough (NSB) would include 175 miles of pipeline and two compressor stations. About 200 personnel would be housed in existing facilities at Prudhoe Bay and a total of 2,200 additional beds would be available (although not all at the same time) at construction camps to be located at Franklin Bluffs, Happy Valley, Galbraith Lake, and Compressor Stations No. 1 and No. 2.

Since none of the NSB Native villages are located near the proposed TAGS right-of-way, no direct impacts on village populations or community services are anticipated. Average annual TAGS employment in the region would peak at nearly 600 (Table 4.2.2-7).

The most significant effect of the project to the NSB would be increased property tax revenues from the pipeline and compressor stations in the borough, which would have a combined value of $1.4 billion. This figure does not include an estimated $1.5 billion for the Prudhoe Bay conditioning plant and millions of dollars in field development required to deliver gas to the conditioning plant. The TAGS project and conditioning plant would add $2.9 billion to the NSB's assessed valuation, which stood at $13.6 billion in 1986.

4.2.2.2.2 South Dalton Highway Area

In the Dalton Highway area south of the North Slope Borough, the TAGS project would have construction camps at Chandalar, Dietrich, Coldfoot, Oldman, Five Mile, Livengood, and Compressor Stations Nos. 3, 4, 5, and 6, which would have a total bed capacity of 5,700. (Note: Not all these camps would be operated simultaneously or at full capacity.) The pipeline construction worker population would exceed the entire resident population along the corridor and adjacent villages several times over.

The primary impact of the TAGS project in this region would be increased traffic on the Elliott and Dalton highways. In summer 1986 northbound and southbound traffic on the Dalton Highway averaged only 74 vehicles daily, compared to a peak of 275 vehicles per day in 1976 during the peak of Alyeska construction. The Dalton Highway was originally built and maintained by Alyeska as a private road.

Since October 1978, when the state assumed ownership and maintenance of the highway, the roadway has been resurfaced and topped by 6 inches of crushed gravel. This provides an excellent driving surface which could be damaged by up to 10,000 truckloads of double-jointed pipe that would have to be transported from Fairbanks over the Elliott and Dalton highways.

During construction of the oil pipeline the only two inhabited settlements on the route directly affected were Wiseman and Livengood, both historical mining towns with only a handful of inhabitants. Although no municipalities or large settlements have arisen along the corridor, there has been a substantial amount of settlement, particularly along the Elliott Highway near Fairbanks.

Beginning in 1980, DOT/PF established highway maintenance camps at seven locations along the highway. The northernmost of these camps is located at the Chandalar Shelf. Vehicles are not allowed to travel north of this point without a special permit. The Chandalar Shelf and Sagavanirktok River maintenance camps are staffed by two rotating (one week-on/one-week-off) six-person crews of DOT/PF personnel who live in a dormitory.

Table 4.2.2-7 Trans-Alaska Gas Project
Selected Local Area Impacts
Construction Phase

Local Areas	Year 1	Year 2	Year 3	Year 4	Year 5
Direct and Indirect Employment (Jobs)					
Statewide	1103	1764	6427	10437	9662
Anchorage	412	659	2400	3898	3609
N'Slope Borough	92	147	595	483	268
F'Banks Borough	216	345	1258	2044	1892
Valdez City	20	125	455	830	854
Glennallen/Copper Center	25	41	165	134	74
Direct and Indirect Resident Personal Income (Millions 1986$)					
Statewide	43.7	68.9	273.0	468.8	445.2
Anchorage	20.3	32.1	127.2	218.5	207.5
N'Slope Borough	.3	.5	2.4	2.0	1.1
F'Banks Borough	9.4	14.8	58.9	101.2	96.1
Valdez City	.4	3.0	12.1	23.4	24.7
Glennallen/Copper Center	(small)	(small)	1.0	1.0	(small)
Retail Sales (Millions 1986$)					
Statewide	18.3	28.9	114.9	196.8	186.9
Anchorage	8.5	13.4	53.4	91.7	87.1
N'Slope Borough	.1	.2	1.0	.8	.4
F'Banks Borough	3.9	6.2	24.7	42.7	40.3
Valdez City	.1	1.2	5.0	9.8	10.3
Glennallen/Copper Center	(small)	(small)	.4	.4	(small)

Notes:
(1) Employment is on a place-of-work basis. These are jobs in the local area and may or may not be filled by local residents.

(2) Personal Income and Retail Sales are on a resident basis. Thus income earned by local area residents working elsewhere is included in local area resident personal income.

Source: Yukon Pacific Corporation

There are four other DOT/PF maintenance stations between the Sagavanirktok River and Livengood staffed by five to eight personnel each. Most state workers at these latter sites are accompanied by their families. The construction of TAGS would result in an expansion of services provided by DOT/PF at these locations on a temporary basis. In addition to the DOT/PF camps there are "truck stops" at the Yukon River Crossing and Coldfoot that include workers and their families, and they would be affected by increased use of the Dalton Highway.

Along with additional road maintenance, increased traffic also creates potential for more accidents and state trooper patrols. Most pipeline construction personnel would likely be transported to remote camps in this area by air, which would also increase the requirement for airport maintenance at some airports in the region.

With the exception of Minto, most of the travel to and from the villages (Allakaket/Alatna, Bettles/Evansville, Stevens Village, and Rampart) in the Dalton Highway region is by air. However, some Stevens Village and Rampart residents travel by boat to the Yukon River crossing and then by truck to Fairbanks. There is a 29-mile winter road from Bettles/Evansville which local residents use to travel to Fairbanks. Recently a state highway worker reported that the Bettles winter access road was in such good condition that he was able to drive to the community from the Dalton Highway in about 45 minutes. Thus, to some degree, village residents and others living along the highway could be affected by increased traffic along the road. A DOT/PF worker noted that during construction of TAPS the increased traffic caused highway dust in the settlement of Wiseman. Minto residents probably would be the most affected by increased highway traffic since villagers frequently travel to Fairbanks

Since there are no local governments with jurisdiction over any part of the proposed TAGS corridor between the Fairbanks North Slope Borough and the Fairbanks North Star Borough, no local taxes would be levied or available to local residents to directly offset any impacts which might occur.

4.2.2.2.3 Fairbanks North Star Borough

During TAGS construction a 1,000-bed construction camp and a 400-bed construction camp adjacent to Compressor Station No. 7 would be located within the Fairbanks North Star Borough. Fairbanks would also be the primary storage site for pipe to be shipped north and south along the highway. During the TAPS project, pipe was double-jointed and coated in Fairbanks; however, on the TAGS project the coating and double-jointing would be done at the factory.

Increased traffic and demands for truck, rail, and air transportation services would likely be the primary impacts in the Fairbanks area. Existing and planned improvements in the Alaska Railroad should be able to accommodate increasing demand for rail service, and the Fairbanks International Airport, which has undergone two major expansions in the last decade, should easily be able to handle any increases in service demands. The completion of a major highway which routes truck traffic around rather than through the city greatly lessens potential problems with increased truck traffic in the urban area.

Impacts of TAGS would be fewer and of lesser magnitude than those generated by the TAPS project because:

- Peak average annual direct and indirect Fairbanks employment on TAGS line would be 7,500 compared to 15,000 during the TAGS project.

- Most of the management personnel would be based in Anchorage and would not affect the housing supply.

- In contrast to a housing shortage, overloaded utilities, and underdeveloped commercial sector which preceded the TAPS project, Fairbanks now has a surplus of housing, excess utility capacity, numerous industrial sites, and an oversupply of retail and service businesses. Some of this surplus would likely be absorbed due the anticipated influx of military personnel over the next two years. However, if the state's economic problems persist, much of the surplus will probably not be absorbed.

- Much of the local work force has construction and oil industry experience, both working on the TAPS project and on other North Slope petroleum developments.

- The Fairbanks North Star Borough's Community Research Center, which was established in 1974 as the Pipeline Impact Information Center, has the information and staff to enable the community to both anticipate and manage potential impacts.

Access to recreation areas and potential state land disposals has been a major issue in some areas along the present TAPS right-of-way. State Division of Land personnel noted that access problems were typically the most difficult impacts to resolve. The need for future access was not anticipated during TAPS construction. Similar impacts would result with TAGS due primarily to the need for safety of system operations.

Although Fairbanks would likely experience some negative impacts during TAGS construction, local officials believe that most would be largely offset by the employment, economic development, and tax benefits TAGS would provide.

During the operations phase of the project, about 100 workers would be employed at the Fairbanks maintenance center and 20 workers at Compressor Station No. 7. Additionally, the 85 miles of pipeline and Compressor Station Nos. 6 and 7 would add an estimated $810 million to the Fairbanks North Star Borough's tax base, which totalled $4.7 billion in 1986. The addition of TAGS to the Fairbanks tax base would help to offset the anticipated decline in the value of the Alyeska pipeline due to depreciation.

4.2.2.2.4 <u>Delta Area</u>

During construction, an 800-bed construction camp would be located in the city of Delta Junction, and a 400-bed construction camp would be located adjacent to Compressor Station No. 8 about 40 miles south of the community. Given that the area population is about 5,000 people, the project would temporarily increase the local population by about 20 percent.

The local infrastructure of facilities and services developed since the TAPS project has greatly enhanced the community's ability to meet most potential impacts of the TAGS project. Additionally, Delta Junction is only about 75 highway miles from Fairbanks, which would be available to meet any impact demands which Delta cannot accommodate.

Due to the present slump in the local economy, Delta Junction officials predicted that most residents would welcome the increased employment and economic opportunities another pipeline construction project could provide. During the operations phase the only potential local employment in the area from the project would be about 20 jobs at the Compressor Station No. 8. Delta Junction, which is the only government in the area, does not assess any local sales or property taxes. Thus, the local residents would not be able to benefit directly from TAGS tax revenues.

4.2.2.2.5 <u>Glennallen/Copper Center Area</u>

Of all the regions along the TAGS corridor, the Glennallen/Copper Center area would likely experience the highest relative negative impacts and the lowest relative benefits. The 2,000 bed spaces in the construction and compressor station camps exceed the area's population. About half the residents live in Glennallen; the remainder are scattered in several small communities. Most of the area's communities are adjacent to the proposed TAGS corridor and would directly experience increased traffic and other strains on local facilities and services.

Although employment and population impacts were greater during the TAPS project than they would be during TAGS, the local infrastructure is similar to that existing during the oil pipeline period. Since there is good highway access to Anchorage, the Glennallen/Copper Center area might attract pipeline worker families requiring such services as schools, medical, and public safety. During the TAPS project numerous families lived in motor homes and small trailers in the Glennallen area, overloading the area's ability to provide needed services. One indicator of the transportation and population impacts the region experienced during TAPS was that 21 Alaska State Troopers were stationed in Glennallen in 1976, compared to only three in 1986.

Despite potential negative impacts many, if not most Glennallen/Copper Center area residents probably would welcome the large, though short-lived, boost the TAGS project would give to the local economy. One indicator of the desperate conditions in the area is that the Copper River School District filed for bankruptcy in December 1986. Numerous local businesses have closed, and most have cut employees.

A significant problem in the Glennallen/Copper Center area is that there are no local municipalities or regional government, although some villages have Native councils. As a result, it could be difficult for the communities to plan for socioeconomic impacts, even though facilities exist to provide needed services. The lack of local governments also means that area residents cannot receive direct gas property tax revenues from the TAGS project. In the operations phase the only direct local employment opportunities would be 20 persons each at Compressor Station Nos. 9 and 10.

4.2.2.2.6 Valdez

Valdez would likely experience the largest relative impacts of any region along the proposed TAGS corridor during both construction and operation phases. In Valdez the construction period would last five years, compared to only three years for the remainder of the corridor. During the peak year of TAGS construction the project would create an estimated 830 additional direct and indirect jobs in Valdez. Most of this employment would be associated with construction of the LNG plant and the marine terminal. Other employment would be related to the pipeline storage yard, pipeline construction, and other facilities.

TAGS employment would represent a 45 percent increase over the 1985 average of 1,850 jobs in the community. However, even at the peak of TAGS construction, Valdez employment would be substantially below the record 4,600 peak employment experienced during the Alyeska construction period.

Due to the current slump in the Valdez economy there is presently a housing surplus, excess capacity in community facilities such as schools and hospitals, and an abundance of retail and service businesses. Much of this excess capacity would be absorbed if a proposed $900 million refinery is built in Valdez. Refinery construction, which would peak at 1,500 workers, could begin as early as late 1987. Construction is expected to take two years, and when completed the refinery would employ approximately 250 persons.

The population of Valdez today is three times the size it was prior to the TAPS project. The local infrastructure of facilities and services would be much better able to accommodate the needs of the TAGS project. Planning would be required to ensure that the community does not overbuild to accommodate construction phase employment since during the operation phase TAGS employment would be reduced to 100 workers.

In addition to long-term employment, the 20 miles of pipeline and the LNG plant and terminal facilities would add about $2 billion to the Valdez tax base, which in 1986 totalled $1.7 billion. By the time of TAGS completion the present Valdez tax base is expected to have eroded substantially due to depreciation in the value of the Alyeska facilities and TAGS would make up for the tax loss, although this decline might be offset if the proposed $900 million refinery is built.

4.2.2.3 National and International

The TAGS project would generate approximately $2.5 billion a year in gas sales, assuming that 14 million tons of gas a year is sold at $4 per thousand cubic feet.

Although gas sales contracts are not yet complete, a reasonable breakdown of gas volumes by customer could be:

Japan	7 million tons/year
Korea	6 million tons/year
Taiwan	1 million tons/year

ERA will provide a discussion of national economics.

4.2.2.4 Summary

The most significant socioeconomic impact of the TAGS project during preconstruction and construction phases would be increased population and employment. Direct employment on the project, however, would be only about a third of that experienced during TAPS construction. If the project were being built now, most of the required work force could be drawn from a large pool of unemployed construction craft workers in the state. Unfortunately, by the time TAGS would be built, these workers might not be available because they left the state or found other employment.

Interest in construction employment would undoubtedly be high statewide, particularly among corridor community residents; however, all except those living in Fairbanks would have to travel to Anchorage or Fairbanks to seek employment. Pipeline employment could create some labor shortages in both rural and urban areas. In rural areas pipeline employment could conflict with some subsistence pursuits, but a more serious concern would be that highly skilled workers now maintaining village utility systems and other facilities might be attracted to higher-paying pipeline jobs. During the three-year pipeline construction period the most serious negative socioeconomic impacts relates to increased highway traffic, which could increase potential for safety hazards and damage to the highways.

At the present time Fairbanks would be able to accommodate TAGS-induced growth. However, the community's surplus housing and other infrastructure could be absorbed by the time the project would be built due to an influx of military personnel expected in the next two years. The Glennallen/Copper Center area, where the construction work force could outnumber local residents, would likely experience the highest relative negative impacts and the lowest relative benefits. The five-year construction period in Valdez would strain the local housing supply and the infrastructure of community services, especially if a proposed $900 million refinery is built prior to or during TAGS construction. Otherwise, Valdez impacts would be minimal.

During the operations phase, statewide employment would total only 550 people. The largest relative long-term employment impact would be in Valdez, where 100 people would be employed at the marine terminal and LNG plant. By far the largest impact of the TAGS operations phase would be increased state government revenues from property taxes, severance taxes, and royalties. There would be no direct tax benefits in the Dalton Highway, Delta Junction, or Glennallen/Copper Center areas because they do not assess local property taxes. TAGS would provide a substantial boost to North Slope Borough, Fairbanks North Star Borough, and City of Valdez property tax revenues, which would largely or wholly supplant the decline in TAPS tax revenues.

4.2.3 Land Use

4.2.3.1 Introduction

The TAGS transportation system starts in the Prudhoe Bay area within the oil development and transportation zone, follows the federal-state utility corridor from its point of inception to an area south of Thompson Pass in the Chugach Mountains through Keystone Canyon, and then proceeds to an LNG plant at Anderson Bay in Port Valdez.

The route of this proposed facility would change unimproved land to pipeline right-of-way for the duration of the project. It would cross the alignment of the TAPS, authorized ANGTS, and various highway rights-of-way in a number of places. Table 4.2.3-1 provides an estimate of the area disturbed by the combined TAGS facilities.

Table 4.2.3-1
Estimate of Disturbed Area

Development Component	Phase: Construction (Acres)	Phase: Operation (Acres)
Pipeline	14,473	5,114
Ten compressor stations	278	200
Access roads	430	430
Temporary camps, storage yards	730	255
Airstrips	144	0
River crossings (extra work space)	55	20
Spoil areas	700	80
Construction materials	5,800	1,740
LNG facility	300	280
Total area disturbed	22,910	8,119

4.2.3.2 Project Impacts

An initial pipeline construction requirement would exist for approximately 22,910 acres of land, of which 8,119 acres would be required for the life of the project. Within the boundary of the Chugach National Forest the approximately 1,300 acres for the terminal and LNG facility buffer zone would require a special use permit for long-term duration of project operations.

Most of the route passes through relatively undeveloped areas along the TAPS utility corridor and existing road system. There are a few towns and villages along the route and only three incorporated cities--Fairbanks, North Pole, and Valdez. Within a mile or so on either side of the proposed corridor the area is virtually inaccessible except by walking, horseback, or all-terrain vehicle. Access is easier in winter, and cross-country skiers and snowmobilers use the existing access road system and the frozen major river systems as transportation corridors for hunting, trapping, access to winter cabins, and ice fishing. Impacts to these uses would be moderate but short term.

The major temporary land requirements necessary for project construction include a 120-foot-wide strip 796 miles long, new access roads, material sites, and construction camps. Upon completion of construction, a 53-foot-wide permanent right-of-way would be required. The remainder would revert back to the present landowner.

The 53-foot permanent right-of-way for pipeline plus the material sites, construction camps, and compressor stations would remain cleared and withdrawn from other compatible uses. Impacts to the corridor would be moderate.

Much of the area would naturally revegetate with grasses and low-growing shrubs which would be allowed to remain on the right-of-way. This regrowth would prevent erosion and provide some wildlife habitat. Materials sites would include reopening some of the existing TAPS borrow pits. Except for those sites required for maintenance, all material sites would be restored and allowed to revegetate; other land uses would then occur. The TAGS project gravel requirements would result in remove all ofabout 4,000 acres from other uses temporarily and the removal of 33 million cubic yards of mineral material for construction. The impact of the total amount of borrow pit acres would be moderate since most of these areas would eventually be returned to preconstruction use after restoration. The other major land use changes would consist of new access roads, dump sites, compressor stations, surplus equipment disposal areas, and construction camps, occupying a total of about 7,938 acres.

Construction camps would be closed upon completion of construction and facilities removed. Since these camps are presently unused, there would be no additional loss due to these pads. Construction pads, even after revegetation, would be of limited value to wildlife for many years. The compressor stations and most access roads would be maintained and withdrawn from other land uses for the life of the project.

The possibly increased public access and use through new access roads and increased use of the existing highway system could result in increasing demand on lands adjacent to the corridor for such activities as mining, homesites, trapping, hunting, fishing, and sight-seeing during both winter and the warmer months.

The influx of workers in the larger communities of Fairbanks and Valdez also would result in changes of present land uses. Workers would purchase land, use it more for recreational pursuits, and require development of presently undeveloped property.

The state has assumed management and maintenance of the Dalton Highway, and pressure is increasing for the state to allow full public access on this highway. Access is already open all the way to the Chandalar Shelf area. If unrestricted access were to become available to the public, the pressure on lands adjacent to the TAGS corridor would increase and land uses would change, perhaps dramatically. There is no indication, however, that TAGS construction or operation would result in a change to the existing conditions.

All of these potential changes in land use would have to conform with land-use planning documents presently in effect. These documents were produced by the North Slope Borough, the Fairbanks North Star Borough, and the Valdez City Planning Commission. Project design criteria and location of the various facilities would also have to conform with various existing state and federal land use restrictions, including:

- U.S. Coast Guard reviews construction of facilities seaward of the last manifold of the marine terminal.

- 49 CFR 193 must be complied with as to exclusion zones for thermal radiation and vapor-gas dispersion zones.

- Several military reservations would be crossed. Therefore, present land use of the construction area and possibly the pipeline route would be changed.

- Moose Creek Dam across the Chena River in Fairbanks is a USACE structure and federal stipulations for its use would have to be met.

- ADF&G requirements would be met for any wildlife refuges, stream crossings, sensitive habitats, or wildlife sanctuaries.

- ADNR requirements for use of any state parks or state land leasing, including tidelands, would have to be met.

The direct impacts to present land uses along the corridor would involve clearing and brushing along construction areas, grading around compressor stations and communications sites, and excavation and refilling the pipeline trench. Some of the land to be cleared contains potentially marketable timber stands. This is especially true in the area just south of Fairbanks, the Glennallen area, and in the area from Thompson Pass to near Valdez. Though the potential for some timber harvest is there, the area has slow regrowth potential and the timber is relatively small. Therefore, it is not presently competitive with West Coast timber in either quality or price, and there seems to be little likelihood of the timber being marketed in the forseeable future. Increased access could result in establishment of new local logging enterprises. Impacts would be negligible.

The proposed route also passes through some presently used and potential agriculture land. This farming, ranching, and dairy land is located around and north of the Fairbanks area and near Delta Junction. Some of this land, would be temporarily lost to production during construction, but overall impacts would be minor.

In some areas, notably Atigun Pass, Sukakpak Mountain, and Keystone Canyon, there would not be enough room for a fourth pipeline, so some future options would be foreclosed. Likewise at Phelan Creek once the TAPS pipeline was installed, future options would be foreclosed.

The proposed route would pass near industrial development centers at Prudhoe Bay, Fairbanks, and Valdez. There should be little impact to those areas except for increased traffic during construction. Impacts would be negligible. The route also crosses military reservations. There are no known restrictions on military land uses that would offset military missions in Alaska.

Mineral extraction patterns might be changed somewhat. Some gold claims might be crossed, the flow pattern changed, or ice bulb formation might cause the loss of some marginal mineral claims. On the other hand the increased number of access roads might allow better access and therefore increase mining in some of areas. In any event the impacts to mining, with the exception of gravel, are expected to be minor.

The presence of the TAGS LNG facility and marine terminal might cause a virtually permanent change in the present use of Anderson Bay since much of the recreational pursuits would be restricted for the life of the project. The Anderson Bay access to the Chugach would be reduced due to the access restrictions placed on the buffer zone around the LNG plant.

4.2.3.3 Potential Areas of Critical Environmental Concern (ACEC)

Discussion of prospective ACEC's have been grouped with other special areas associated with the proposed TAGS project in Subsection 4.2.19.

4.2.3.4 Summary

The pipeline route, LNG plant, and marine terminal would change or influence land uses on 22,900 acres. Other land use changes would be on a local basis, mostly very near the existing TAPS corridor. Land use of the corridor itself would be relatively unchanged. Although the route crosses two military reservations, this would not compromise the military's mission on these lands. Total impacts to existing land use would be moderate to minor.

4.2.4 Transportation

4.2.4.1 Introduction

The discussion of transportation impacts is divided into marine, air, and land transportation and considers both long- and short-term changes and the significance of potential impacts.

4.2.4.2 Marine Transportation System

In the Prudhoe Bay area, marine transportation or sealift is confined to a brief period, usually August, when the pack ice recedes enough to allow non-ice-breaking ships to pass along the Beaufort Sea nearshore area. Typically during this period a sealift of tugs and barges carrying large component sections of equipment and buildings arrives at Prudhoe and is unloaded on one of the four causeway docks. The project would add a considerable number of barges to one or two years of sealift. This would increase the traffic from associated marine vessels, including workboats, lightering vessels, and possibly dredging operations.

Increased marine traffic would cause localized traffic conflicts and perhaps increase the incidence of minor collisions, but since the Prudhoe Bay, Kuparuk, and Endicott sealifts would be essentially completed prior to TAGS project startup, the net result would probably be a continuation of similar traffic to what presently occurs. Such an increase would, of course, boost Alaska and Seattle/Portland barge operators since it would extend their involvement in North Slope sealifts for a few years.

Prince William Sound marine traffic proceeds year-round and includes TAPS supertankers, fishing vessels, ferries, and charter and sports boats. This traffic is controlled by the U.S. Coast Guard in Valdez by use of a Vessel Traffic Service (VTS) designed for constricted areas to lessen the probability of collisions. The major control points to Anderson Bay are the Hinchenbrook Entrance and the Valdez Narrows.

The additional five or six tankers per week from TAGS, plus the terminal support vessels and the ferry from Valdez to the marine terminal, would have to be integrated into the VTS. The U.S. Coast Guard has indicated the additional TAPS project tankers would not have any impact on the VTS since existing vessel traffic movement is low. The chance of collisions and major or minor oil spills would increase. Weather in Prince William Sound can be severe and has caused tankers to be delayed in getting to the Alyeska terminal. Overall, the impacts from marine traffic would be negligible due to the VTS and in 10 years of operations experience at the Alyeska Marine Terminal, no tanker incidents have occurred.

Marine terminals at Anchorage, Whittier, and Seward will also experience increased usage but all can handle increased shipping volumes.

4.2.4.3 Air Transportation

Potential impacts on air transportation would primarily be evidenced in Prudhoe Bay and Valdez during the construction phase of the project, although some increase in scheduled airline and charter service would occur throughout the operation of the project. In the Prudhoe to Fairbanks area there would be a significant increase in scheduled airline traffic and both fixed- and rotary-wing charter service during the major construction phase and some increase during the preconstruction permitting phase. This would have significant positive effects on the airlines and the air-charter services in these regions. Counterbalancing this, however, the increase in traffic would also increase the chance of collisions, accidents, and disturbance by low-flying aircraft on wildlife and birds during sensitive periods. Additional air traffic would be a moderate impact to existing guided hunts in the Galbraith or Sagwon areas. Overall impacts would most likely be minor during construction and negligible during operations phases.

The two primary airports, Anchorage International and Merrill Field, would experience some level of increased traffic but with negligible impacts.

Construction of the proposed route between Fairbanks and Valdez also be affected to a lesser extent. Mostly, the need for charter air service for fixed- and rotary-wing aircraft would be increased. This would also increase the noise and disturbance factor to humans and wildlife to a degree, especially during the fall hunting season. The spinoff effects on the aircraft charter business would be more people in the area and increased demand for fishing and hunting charters. The latter impacts would be very positive to this industry. Some restrictions as to altitude and restricted zones might be instigated during project construction. It is also possible that some traffic control might be added at the two state airports and public use might be temporarily affected. Overall impacts for this region would most likely be minor during construction and negligible during operational phases of the project.

4.2.4.4 Land Transportation

The Prudhoe Bay area would be moderately affected by increased car and truck traffic during construcion of the proposed project. The result would be longer waits at crossroads, security checkpoints, and during sealift; increased dust loading from many associated roads in the area; and increased chance of accidents and potential minor oil spills. Traffic delays would be kept to a minimum. The road system is gravel, and increased usage would necessitate increased maintenance of affected sections. Overall impacts would most likely be moderate during construction and negligible during operation.

Impacts to the area between Prudhoe and Fairbanks would be especially evident on the Dalton Highway, or "haul road." This gravel road from the Yukon River to Prudhoe Bay can carry up to 600 vehicles per day instead of its present rate of approximately 150 per day, but there would be corresponding increase in accidents, requirement for road maintenance and repair, and dust. Some traffic delays at Atigun Pass would be expected during the two summer seasons of construction. YPC expects these delays to be of short duration and of minor consequences during construction.

Since construction would include crossing the Dalton and Richardson highways in several places and connecting access roads to the existing structures, there would be isolated instances of delay to all traffic using the highway system. In such instances traffic control would be maintained for the short term of such activities. Again, YPC does not intend to delay traffic. Other possible impacts would be increased collisions with moose and other wildlife. More extensive road repair would be required, especially since some of the vehicles carrying TAGS equipment would be oversize during construction.

There could be serious delays should there be the necessity for extensive highway repairs during TAGS construction. It could also be a problem if such construction changed the existing highway alignment. Areas subject to change lie between Delta and Summit and in the Paxson, Gakona, and Copper Center area. The Phelan Creek construction area would probably be the only location where traffic delay impacts would occur. No impacts would be evident from operation of the pipeline.

The overall impacts to the more populated interior areas along the Richardson Highway from Fairbanks to Glennallen would probably be moderate during construction and negligible during operations.

A good highway system exists in the Valdez area, but in some places this system is quite constricted, such as in Keystone Canyon. In these areas there would be delays necessitated by blasting and excavation of the pipeline trench near the existing highways. The increase in project-related traffic, especially by oversized loads, would also slow down traffic, particularly in the summer during the tourist season. These delays would be coordinated with the DOT/PF. There would be some increased possibility of accidents and oil spills in sensitive habitats.

The present capacity of 1,700 vehicles per day on the lower Richardson Highway would probably not be exceeded, but project traffic would result in increased damage to the highway, especially during freeze/thaw periods. Traffic would increase considerably on Dayville Road between Valdez and the Alyeska terminal during construction of the pipeline.The overall impacts would probably be moderate during construction. There would be considerable economic benefit to local trucking and shipping firms during construction.

Statewide, there would be an increase to rail and highway traffic in the Railbelt and Fairbanks area during construction. This impact would be minor during construction and negligible during operation. The state may require YPC to enter into some sort of agreement to repair portions of the existing highway adversely impacted. This would reduce construction impacts.

4.2.4.5 Summary

Overall, the existing transportation could handle the increased traffic in all areas quite well. There would be delays along the entire highway system during the construction period which would affect tourist and local traffic. These impacts would be moderate during construction and negligible during operation of the project.

4.2.5 Noise

4.2.5.1 Introduction

This subsection presents a discussion of the interaction between the proposed project and the noise consequences to the environment. Construction noise would be considered short term and transient, but operations noise would be long term and continuous.

4.2.5.2 Construction Phase

Construction of the proposed TAGS would result in indirect noise due to additional road traffic and aircraft and direct construction site noise from heavy equipment. Noise effects to the environment from construction of the project are a function of the noise generated by construction equipment, the location and sensitivity of nearby land uses, and the timing and duration of the noise-generating activity and are all of short-term duration. Road traffic due to hauling operations, personnel transporation, and aircraft flights to airfields located along the route would be expected to create the largest indirect impacts during the construction operation.

Construction of a project of this magnitude involves various types of earth-moving and other heavy equipment--most of it noisy--working in tandem to get the job done as quickly as possible. Typical decibel levels (in dBA at 50 feet) of noisiest construction equipment are: front-end loaders, 72 to 85 dBA; backhoes 72 to 94 dBA; tractors, 72 to 95 dBA; scrapers and graders, 76 to 94 dBA; and trucks, 68 to 96 dBA. Welding equipment noise would be between 75 and 86 dBA. These ranges represent typical equipment used on pipeline construction sites, most of it diesel powered. Noise decays at a rate of 6 dBA per doubling of distance, which is a worst-case assumption that does not include additional attenuation caused by atmospheric absorption, terrain, and meteorological conditions. If higher attenuation rates were assumed, the estimated impacts would be less.

Blasting operations during the construction phase would produce direct impacts. Drilling and blasting would be required where trenching through rock could not be accomplished by ripping and removing the loose material with a backhoe. The detonation of explosive materials induces transient motion in the rock which is then transmitted through transient motion into the surrounding rock and through any overlying or underlying strata. It is this motion, referred to as ground motion, that produces noise and stress levels. In some areas the impact would result in a startled response from wildlife for greater distances than during typical construction activities.

Construction of the compressor stations would require only small amounts of grading; most of the activity would entail hauling of materials and construction of the buildings. Those activities should be of short duration, including installing the compressors. Little impact would be predicted since no residences would be located within audibility of the proposed compressor station locations.

At Anderson Bay the pile driver used in offshore construction would be the noisiest piece of construction equipment on the project, producing an average level of about 65 dBA at 1,000 feet during its use. At the closest receptors to this noise source, almost 3.5 miles to the east at the Alyeska terminal, pile-driving levels would be about 45 dBA, which would not be disturbing. Noise levels from other sources, including construction of LNG plant, berth, and metering facilities, would generally not exceed 61 dBA at a distance of 1,000 feet. Noise levels at 2 miles would be well below ambient conditions and would not be disturbing.

All construction noise has the potential to temporarily affect wildlife near construction activity. When an activity begins in an area, wildlife initially react adversely but over a period of time begin to habituate to constant noise levels. Sudden changes in sound, such as during blasting, would create a startled response and, depending on the timing, could result in significant impacts to wildlife. Normally, the TAGS proposed timing mitigation constraints and those expected from the FWS for the more sensitive species should eliminate any major impacts. Studies indicate that the most probable effect of noise would be to reduce utilization of affected habitat areas. This effect should be short-term and likely varies between species. The bald eagle nesting site at Anderson Bay could be affected by the several years of construction activity and the noise created by such activities, as identified in Subsection 5.13.

4.2.5.3 Operations Phase

Noise potentials of significance during the operational phase of the project would be the compressor stations, which are long-term, continuous, and fixed sources. The estimated distance at which stations would affect residences with normalized day-night sound levels is 6,000 to 7,000 feet (FPC 1976a). YPC estimates the expected noise levels from a single turbine/compressor unit for gas compression, would produce levels less than 59 dBA at a distance of 400 feet from the equipment. The proposed TAGS turbine/compressor units would be fully enclosed and would be equipped with exhaust silencers. Applying the generalization that the distance between point noise sources and a receptor in the far field is doubled with the sound level decreasing by 6 dBA's, sound levels are expected to be below background noise levels at a distance of 3,000 to 4,000 feet from the compressor station for normal operating conditions. As identified in Subsection 4.5, outdoor ambient noise levels range from 15 to 45 dBA's.

Periodic venting (blowdown) of high-pressure gas from the pipeline and at compressor stations would cause temporary but severe increases in sound levels. Maintenance checks on the emergency blowdown system normally occurs annually unless an emergency triggers a blowdown which could

Particulate (dust) emissions would be generated during various construction activities, such as grading, filling, and clearing of land at the 300-acre plant and terminal site. Assuming that construction activities would be limited to 75 acres during any one month, and using the emission factor (1.2 tons per acre per month) (EPA 1975), particulate emissions are estimated at 90 tons per month. The particle size distribution of fugitive dust from construction activities generally indicates larger-diameter particles than from many industrial sources, including particles greater than those captured by a high-volume sampler (30 microns) and particles greater than the respirable fraction (less than approximately 10 microns). These larger particles from earth-moving activities settle to the ground quickly; therefore, excessive particulate concentrations are more common at locations close to construction activity.

The likelihood that fugitive particles from construction activities at this site would have a potentially major impact on the City of Valdez would be slight. The extent of the impact would be major only if (1) soil moisture content were low, (2) winds were blowing from the west-southwest, (3) wind speed greater than 12 miles per hour (this results in greater entrainment of particles at the source and reduced settling), or (4) wind stability classification were neutral (D wind Classification - Note that more stable wind classes E and F do not occur at elevated wind speeds).

4.2.6.3 Operation Emissions

4.2.6.3.1 Compressor Station

Gaseous pollutants from compressor stations along the route consist of combustion products from the gas-fired engines, mainly nitrogen oxide and hydrocarbons. Intermittent emissions of hydrocarbons could be expected occasionally, particularly methane as a result of leaks, venting, and other accidental emissions. Sulfur oxide, carbon monoxide, and particulate emissions are shown in Table 4.2.6-2 and are compared to federal standards and EPA significant impact level. Since these values are within applicable limits, no significant long-term air quality impacts would result from the operation of the compressor stations. These emission levels are similar to those for the authorized ANGTS and the previously proposed El Paso.

4.2.6.3.2 LNG Plant

The location of the LNG plant near Valdez is advantageous with respect to minimizing the operational air quality impacts of the plant on human receptors. The city is normally upwind of the proposed plant location, as winds are generally easterly. Additionally, the plant is 5.5 miles away from the townsite, a distance which allows much more dispersion of any source emissions than would normally be encountered in a more urban setting.

Exhaust emission sources at the LNG plant would include the following.

4 LNG liquefaction trains, each using five natural gas-fired turbines

3 vaporizers

4 25-Megawatt gas-fired generators

1 solid waste incinerator

1 reactivation heater

1 process flare

Additionally, minor emissions would originate from other small pieces of equipment and vehicles.

Emissions from all of the sources itemized above (except for vehicles and the solid waste incinerator) would be generated

Table 4.2.6-2 Modeling for Typical Compressor Station

Pollutant	Averaging Time	Maximum Concentration (Microgram per cubic meter)	National Ambient Air Quality Standards (Microgram per cubic meter)	EPA Significant Impact Level (Microgram per cubic meter)
NO_2	Annual	32.7	100	N/A
SO_2	3-hr	1	1,300	25
	24-hr	1	365	5
	Annual	1	80	1
CO	1-hr	19.7	40,000	N/A
	8-hr	13.8	10,000	N/A
Particulate Matter	24-hr	1	150	5
	Annual	1	60	1

* Data used for General Electric Frame 5 Turbine with source emissions of 95.6 lb/hr of NO_x, 0.11 lb/hr of SO_2 and 5.36 lb/hr of CO.

Source: Dames and Moore, 1986

Table 4.2.6-3 Dispersion Modeling for the LNG Plant Site Emissions

Pollutant	Single Turbine Emission Rate (lb./hr.)	Averaging Time	Calculated Concentration (Micrograms per Cubic Meter)	NAAQS Standard (Micrograms per Cubic Meter)	Significant Impact Level (Micrograms per Cubic Meter)
Carbon Monoxide	40.07	1 hour	2800	40,000	--
		8 hours	2000	10,000	--
Sulfur Dioxide	0.15	3 hours	9.3	1300	25
		24 hours	4.1	365	5
		Annual	0.1	80	1
Nitrogen Dioxide	107.03	Annual	76	100	1

Source: Dames and Moore, 1986

from the combustion of boil-off natural gas as plant fuel. Prior to liquefaction, this gas had passed through driers and scrubbers for removal of particulate matter, lubricant oils, hydrogen sulfides, and mercury. Therefore, combustion of this natural gas would result in minimal emissions of all contaminants, such as sulfur dioxide.

The 20 gas turbines used in the four LNG liquefaction trains and the four gas-fired generators were judged to represent the greatest potential source of air contamination. This is due to the greater consumption of natural gas by these sources and the combustion in internal combustion engines, which inherently results in greater emission of nitrogen oxides and carbon monoxide compared with emissions from external combustion sources.

Exhaust gas data for these 24 gas turbines were introduced into the COMPLEX I dispersion model. This model was chosen because it can accommodate the mountainous terrain near the LNG plant and can quantify the ground-level concentrations at receptor points at elevations greater than that of the adjusted plume height. Additionally, the elevations (altitude) of nearby receptors were put into a polar-coordinate system. The maximum short-term receptor concentrations and the maximum long-term receptor concentrations were both found to be located within 2 miles of the plant; therefore, all receptors in this model were located within this radius.

A hypothetical set of worst-case meteorological data was used in the short-term model, and one year of meteorological data collected at the Jackson Point and Valdez stations were introduced into the long-term model. Additionally, options were selected which followed those recommended in the EPA User's Guide or which would result in maximum receptor concentrations. Table 4.2.6-3 presents results of this dispersion model.

Use of these conservative modeling assumptions resulted in calculated ground-level ambient air concentrations which were less than the National Ambient Air Quality Standards (NAAQS) and also less than significant impact levels specified in EPA's Prevention of Significant Deterioration (PSD) Regulations. Therefore, these major sources at the LNG plant would not significantly affect air quality. YPC is aware of the ADEC's air quality monitoring requirements, which could be accomplished within the currently projected project schedule.

The Port Valdez area naturally experiences fog especially during winter months in morning hours when moist air masses from the southwest result in overcast skies and neutral or stable vertical mixing conditions. The introduction of additional water vapor to such an atmosphere could exacerbate this fog condition.

The LNG plant includes several previously identified sources that emit water vapor as a product of natural gas combustion. Typically, the moisture content of such exhaust gases is less than 20 percent by volume.

The effect of the emission of water vapor to the atmosphere from the LNG plant is reduced by the heat released, which occurs in two forms 1) elevated exhaust gas temperatures from the combustion of fuel (stack gas temperatures from turbine engines are 891°F) and 2) air-cooled condensor coils used in the gas liquefaction system. A synergistic effect from the various exhaust points and from the released cooling load would yield a greater plume rise, longer transport, and greater dispersion of the moist exhaust gases than would be expected from each individual stack.

4.2.6.3.3 LNG Terminal

Identified sources of emission to the atmosphere from the operation of the LNG terminal would include: 1) tanker engine emission and 2) fugitive leaks in the LNG marine tanks and loading lines. Although the engines may have an option to operate on bunker fuel, tanker engines are assumed to operate on natural gas fuel which is boil-off from the LNG tanks while in port.

The capacity of the LNG loading lines would allow simultaneous loading of two tankers in a 12-hour period. Due to the time required for idling and docking, limited worst-case 24-hour emissions would occur when the terminal services three LNG tankers of 125,000 cubic meter capacity in one day.

Emission of nitrogen oxides, particulate, hydrocarbons, and sulfur oxides are expected from the tankers' internal combustion engines. Nitrogen oxide emissions from these natural-gas-fired engines are expected to be greater than emissions of sulfur oxides, particulate, or hydrocarbons. The extent of these emissions is expected to be of minor concern at receptors at the Alyeska Terminal and in Valdez.

Should the engines operate with the optional bunker fuel, or a combination of natural gas boil-off and bunker fuel as is occurring in Cook Inlet, emissions of nitrogen oxides, particulate, and carbon monoxide would be similar to those outlined above. Emission of sulfur dioxide would be greater than with natural gas fuel. At the Cook Inlet facility, LNG tankers normally use a mix of 94 percent LNG boil-off and 6 percent bunker fuel (pers. comm., USCG). The extent of sulfur dioxide emission with this fuel mix would not be expected to exceed national standards.

Fugitive leaks of LNG or of natural gas from storage tanks on the tankers and from loading lines represent emissions of nonmethane hydrocarbons as well as emission of methane. The anticipated feed gas composition includes 17.86 percent by weight of nonmethane hydrocarbons. Unlike the emission of methane, the emission of nonmethane hydrocarbons to the atmosphere contributes to the formation of ozone and photochemical smog. The extent of these emissions to the atmosphere, however, would be carefully controlled to reduce fire hazard and product losses as well as to reduce emissions to the atmosphere using the following measures.

- Control of the pressure of marine storage tanks and loading lines. Boil-off would be used for fuel gas for plant operation and for tanker engines.
- Maintain all LNG storage tanks and loading facilities at a cold condition at all times.
- Insultate loading lines between storage tanks and loading platforms to minimize LNG boil-off.
- A vapor return line that would allow tanker boil-off to return to onshore vapor recovery facilities for use in LNG plant operation.
- Automatic shut-off valve for each loading arm as well as the main LNG line to prevent spills.

These measures should ensure that nonmethane hydrocarbon emissions are of minimal concern.

4.2.6.3.4 Summary

Construction and operation of the compressor stations, LNG plant, and marine terminal would result in some degradation of air quality. Various sources of emission were identified during both construction and operation of the facilities. The sources judged to have the greatest potential impact are the gas turbines used for liquefying the pipeline gas and gas turbine generators. A dispersion modeling analysis of these emissions indicated that the LNG plant would be well within the national ambient air quality standards and should have a negligible effect on air quality in the Valdez area.

4.2.7 Liquid, Solid, and Hazardous Wastes

4.2.7.1 Introduction

Three categories of wastes would be generated by the proposed TAGS project facilities during construction and operations--all of which are strictly controlled by Alaska Department of Environmental Conservation (ADEC) or EPA. These wastes, including their source and their disposition, are the subjects of the following subsections.

4.2.7.2 Liquid Wastes

Wastes from all facilities would not significantly degrade the surface and subsurface water quality beyond the approved mixing zone. Wastes from compressor stations could be collected and emptied at offsite approved treatment plants. Impacts of wastewater discharge would be minor unless an unexpected condition were to arise which would require special mediation unique to each individual situation.

Liquid wastes from hydrostatic testing may or may not contain contaminants which would require a state discharge permit prior to release. ADEC regulations will be complied with in any event.

Equipment washdown at construction camps and compressor stations would occur as necessary and would constitute about 15 percent of the volume of wastewater generated. These wastes would be collected in a sump or other device run through an oil-water separator. The remaining water would be routed through a settling basin to remove sediment. This water would then be discharged along with the wastewater to dilute waste concentration. Wastes from the settling basin would be disposed of in an approved solid waste disposal site.

Surface water runoff from each workpad, construction laydown area, and full storage area would depend on local precipitation, but each site would be designed to retain a large runoff in a short period of time. The retention facilities would be installed to collect the runoff, which could then be run through an oil-water separator and/or a settling basin.

Industrial liquid wastes would be generated primarily by vehicle maintenance and repair. Oily waste would be collected in sumps. Mixing would be avoided whenever possible. Wastes would be stored in approved containers until they could be properly disposed of either at a recycling center or a hazardous waste facility if they are classified as toxic or hazardous. Impacts should be negligible unless an accident occurred during transportation and transshipment of the material. The resulting environmental impacts would depend on the location of the occurrence and the sensitivity of the area.

4.2.7.3 Solid Wastes

Solid wastes would be generated primarily at the construction camps at the rate of about 8 pounds per person per day. This waste would consist of paper, cans, bottles, cooking scraps and wastes, repair scraps, and used pallets and broken lumber. Combustible wastes would be burned as permitted by the ADEC, and the remaining materials plus noncombustibles would be placed in an approved landfill or at a local solid waste facility. Impacts to local air quality would be minor. Incineration rather than storing food scraps and wastes would avoid attracting bears and other wildlife and reduce creation and destruction of nuisance animals. Proper landfilling would result in negligible impacts.

4.2.7.4 Hazardous Wastes

Hazardous and toxic materials would be used on site and would include at least the following: pressurized gases; solvents; chlorinated hydrocarbons; explosive gases; flammables such as gasoline and diesel; and corrosive materials, pesticides, herbicides, paints, etc. as identified in Appendix G.

These materials would not become hazardous wastes until there is a need to dispose of them after use. When that occurs, the generator would have 90 days to collect, consolidate (not mix), properly package, place into approved DOT overpack containers, and ship these wastes to an approved out of state incinerator or landfill facility in accordance with applicable state and federal regulations. Any special permits required for transportation of hazardous substances would be obtained from the proper authorities.

If properly handled, accidental spills and contamination could be avoided, and impacts due to these wastes would be negligible. The major potential for impact would be during shipment to a disposal site.

4.2.8 Geologic Environment

4.2.8.1 Introduction

The proposed TAGS system would interact with the geologic environment in a number of ways during construction and operation. Impacts arising from construction and operation could result in modifications to the topography, physiography, resources, and permafrost along the proposed route. Geologic processes at work in the natural environment include frost heave, erosion, and mass wasting. Conversely, the geologic environment could directly affect the pipeline. For example, the pipeline would not affect the seismicity along the route; however, ground displacement along an active fault as a result of an earthquake could cause the pipeline to rupture if undetected and not considered in design.

YPC has proposed mitigation, as identified in Subsection 2.8, which should ameliorate most of the concerns regarding pipeline-geologic environment interaction. Many of the mitigation measures proposed by YPC were used successfully during construction and operation of TAPS, which has resulted in minimal impacts.

The potential interactions between the pipeline and the geologic environment are discussed in Subsections 4.2.8.2 to 4.2.8.7. Section 4.2.8.8 presents a systematic description of pipeline/geologic environment interaction.

4.2.8.2 Topography and Physiography

Topographic and physiographic impacts resulting from the development of the TAGS pipeline would be primarily the result of excavation necessary for the construction of the pipeline. The working surface clearing, grading, and trench excavation and the development of new or expansion of existing borrow sites would modify existing landforms over the short-term construction phase and would leave permanent scars in the terrain in areas where the pipeline route traverses bedrock or where borrow pits or quarry sites have been developed. These impacts are principally visual changes of the landforms. Alterations of existing drainage features might also cause minor but permanent changes.

Maintenance of the pipeline could result in local changes in terrain similar to those during initial construction. These impacts would probably be localized and of minor importance.

4.2.8.3 Resources

4.2.8.3.1 General Statement

The primary resources that could be affected by construction and operation of the proposed TAGS pipeline are petroleum and aggregate (sand, gravel, and quarry rock). Potential impacts to these resources are discussed in more detail in the following sections.

The impact of the proposed pipeline on coal and heavy metal resources would be negligible.

4.2.8.3.2 Petroleum Resources

Experience in petroleum-producing provinces elsewhere in the world indicates that construction and operation of the infrastructure required to support a large field often leads to extension of the field and possibly to discovery of additional fields nearby. To date, the development of the Prudhoe Bay field has lead to the discovery and development of the Kuparuk, Lisburne, and Endicott fields. Continuing expansion of oil-producing operations on the North Slope and the continental shelf underlying the Arctic Ocean is to be expected except as curtailed by economic factors or restricted by governmental regulation, classification, or other policies. Operation of the TAGS pipeline, providing access for North Slope gas to markets, would be expected to lead to discovery, extraction, transportation, and use of additional quantities of oil and gas on the North Slope in excess of presently proven reserves.

Other potential petroleum provinces that are crossed by or are near the proposed pipeline route include Yukon Flats, the Copper River basin, and the northwestern end of the Yukon-Koyukuk (FPC 1976a). Petroleum potential offshore in the Gulf of Alaska has also generated considerable interest in the past. Operation of the LNG plant/marine terminal at the southern end of the pipeline would provide a processing and export facility for natural gas from the offshore area in the Gulf of Alaska and from the onshore areas along the pipeline route.

4.2.8.3.3 Mineral Materials

Construction of the TAGS pipeline and its associated workpad would require large quantities of aggregate for right-of-way preparation, access roads, foundations, and specialized ditch backfill. Preliminary estimates indicate 33 million cubic yards of aggregate may be required for completion of the TAGS project.

The applicant proposes, wherever possible, to reuse construction areas where gravel pads remain after TAPS construction uses were finished, such as construction camps, and to use some existing TAPS access roads. This accounts for an estimate for TAGS some 8 million cubic yards of mineral materials less than used for TAPS construction. Most, if not all, TAGS mineral material sites would be uplands. Table 2.3.1-2 shows the estimated mineral material requirements by construction spread. Generally, mineral material resources appear adequate to meet the estimated volumes needed for the TAGS project.

There are two areas where existing developed mineral resources appear limited in abilities to expand beyond immediate requirements for TAPS and the state highway net: Construction Spread 1 (North Slope) and Construction Spread 5 (in the Copper River drainage). In both cases TAGS would be located beyond areas previously explored for mineral material resources. In Construction Spread 1 the initial focus for TAPS and Dalton Highway sources were in the Sagavanirktok River and adjacent lands. This area of state administration is no longer using the active floodplains of rivers for material sites. This area also has potential to use snow and/or ice construction pads as a means to reduce the overall mineral material requirements for TAGS. In Construction Spread 5, it is unlikely that snow and/or ice workpad construction techniques would reduce significantly the mineral material requirements for TAGS. Overall, it appears the identified 33 million cubic yards of mineral materials needed to construct TAGS is available. Whether they are located in the quantities and qualities desired is unknown.

In addition to the traditional fluvial sources of mineral material, the applicant indicates mineral materials of acceptable quality could be created by mining and crushing bedrock. The applicant has not identified the extent, if any, bedrock that is exposed and/or excavated during right-of-way preparation could be used to meet part of the 33 million cubic yards for construction. The applicant further proposes that snow or ice workpads would be evaluated as a means to reduce the total amount of mineral materials needed for TAGS.

New borrow sources as identified by the applicant would be developed chiefly in inactive floodplains and terraces of rivers and from alluvial fans, glacial drift, and bedrock. Where these upland deposits are incorporated in or underlain by permafrost, their excavation causes the permafrost to thaw.

Upland material sources would be visible for a substantial number of years. The exact duration would depend upon whether permafrost is present, length of growing season, extent and type of soil terrain, and vegetation in the surrounding area. Upland sites would have more dirt included within gravel, and therefore screening or washing procedures would be necessary. The applicant would investigate prospective mineral material sources in Phase II of project development and develop detailed mining plans showing how the site would be mined, access, and stabilization-revegetation proposals. This would be similar to the process successfully used for TAPS and would be submitted to appropriate interagency review and comment prior to approval.

Impacts from extraction of 33 million cubic yards of mineral materials for TAGS would be similar to those for TAPS and for the state highway system. A major exception is that the applicant has not proposed to use river- or streambed sources. The overall impact to scenic resources would be minor to moderate north of the Yukon River and minor to the south. This difference reflects both flatter topography and shorter vegetation on the North Slope. Impacts to supplies of mineral materials in Construction Spreads 1 and 5 would be negligible to moderate. In some cases available supplies would be used faster and therefore have a potentially moderate adverse effect; conversely, actions associated with exploring mineral sources in areas not now available would create moderately beneficial effects to the extent new supplies exceed TAGS needs and there is access to existing and authorized transportation utility systems.

4.2.8.4 Seismicity

The applicant recognizes that a major design criterion for TAGS would be the ability of the system to withstand the anticipated effects of earthquakes. The earthquake potential along the various segments of the route has been expressed in terms of the maximum expectable earthquake (DOI 1974). The TAPS project indicates that earthquakes characteristic of these seismic zones can be accommodated by facilities design and construction. The applicant has proposed specific designs for fault crossings and has proposed to develop additional data to evaluate slope stability, liquefaction, and strains in buried pipe. Developing and applying these criteria correctly would result in a pipeline system capable of withstanding earthquakes while producing no major impacts to the environment.

Three major active fault zones are traversed by the TAPS route between Delta Junction (Milepost 533) and Summit Lake (Milepost 600). Specifically, these are the Donnelly Dome, Denali, and McGinnis Glacier faults. The Denali Fault, displayed significant evidence of offset in the last 10,000 years (Richter and Matson 1971).

The following four distinct but interrelated seismic phenomena constitute potential impacts to the proposed pipeline.

- Soil liquefaction and ground breakage

- Ground motion

- Differential movement along a fault
- Water inundation by earthquake-generated waves (tsunamis)

Liquefaction, the earthquake-induced transformation of a stable granular materials such as silt and sands into a fluid-like state, can occur during long duration and significant seismic events. Due to a general lack of cohesion, the relatively common deposits of uniform silts and fine sandy silts found in and beneath some stream valleys in Alaska are susceptible to seismic liquefaction. In addition, zones of fine-grained sediments in these valleys would be susceptible to liquefaction.

YPC recognizes that liquefaction and strong ground motion are significant geotechnical constraints to siting and designing the proposed system. The potential impacts of these phenomena can be reduced by avoiding potentially liquefiable areas or, in areas where alignment changes are not feasible, by applying construction techniques to mitigate liquefaction-related problems.

The occurrence of large earthquakes is a potentially serious hazard to the integrity of the pipeline system. Seismic shaking or surface faulting accompanying a large shock could deform the pipeline directly or cause failure in the foundation material that could lead to deformation. Excessive pipeline deformation could result in rupture where the route crosses active faults. The applicant has proposed to traverse the fault in the above-ground mode on steel beams at grade or on vertical support members (VSM) similar to TAPS. Proper design of the above-ground fault crossings would result in a system that would accommodate differential pipeline movement from earthquake-induced horizontal and/or vertical displacement. Large earthquakes could trigger landslides and sea waves that could affect the integrity of the loading dock and tankers.

The pipeline and LNG plant are located at an elevation higher than that of the highest recorded run-up wave, and no major impacts to these onshore structures would be anticipated.

4.2.8.5 Permafrost

Impacts to permafrost occur where there are changes in its delicate heat balance. The applicant proposes to maintain mean pipeline operating temperatures between 0°F and 32°F in permafrost areas. Compression and refrigeration of the gas would take place at regular intervals along the pipeline in order to prevent large-scale and long-term degradation of the permafrost. Water bodies raise the effective average temperature at the ground surface, and removal of surface water lowers the average ground surface temperature. As proposed, the pipeline operation would have minor impacts on the permafrost regime.

The most significant impacts on permafrost would be realized as a result of disturbing the natural ground surface during construction. Changes can occur as the result of any activity that reduces the surficial material or changes surficial heating characteristics. Reducing the insulating qualities of the surface material through compaction or removal of material would increase surface heat input to permafrost during summer.

All disturbances in permafrost areas would have long-term perhaps irreversible, effects on the permafrost regime. Construction activities that could affect the permafrost include the placement of gravel workpads and structures and ditch excavation. The thickness and general insulating qualities of the organic layer and the ice content of the uppermost permafrost layers are probably most critical in determining specific impacts. The applicant has proposed thermal modeling as a means to assess the effects of thermal disturbance caused by clearing, workpads, and ditching.

Removal or in situ use of the present ground surface materials would have impacts during construction and operation, especially if the exposed soil is ice rich. Exposure of the ice-rich soil to solar radiation results in thermal melting. If the exposed ice-rich soil is brought into contact with running water, thermal erosion takes place as the water not only melts the interstitial ice, but also carries away the soil particles. If a high-ice content area is involved, subsidence of the soil surface, gullying, and establishment of new drainage patterns could occur.

Mitigative measures proposed by the applicant to prevent permafrost melting and erosion include construction scheduling, specialized construction zone grading, and erosion control monitoring. Construction of TAPS has shown that if these measures are properly applied, pipeline construction would have only minor, localized impacts on the permafrost regime.

Portions of the pipeline could be buried as long as two and a-half years before the introduction of chilled gas. Impacts of the pipeline to the permafrost would occur in the time period from the initial disturbance until the startup of chilled operation. Pipe backfill materials could become saturated, increasing the bouyancy of the pipe.

In sloping terrain the pipeline trench could divert and capture local surface drainage, causing erosion of natural surface soils and removal of pipe supporting materials by virtue of becoming a channel of reduced resistance to water flow (FPC 1976a). The use of ditch plugs, surface protection, select backfill, and erosion control monitoring has been proposed by the applicant to mitigate impacts occurring as a result of local drainage capture and modification. Erosion-control monitoring would be a continual mitigation effort to minimize potential occurrences during preoperation and operational conditions.

Numerous studies, field data, and full-scale tests indicate that the operation of a chilled gas pipeline would result in creation of a permanent frost bulb. The direct impact of decreasing the temperature of existing permafrost is negligible. However, the creation of a permanently frozen frost bulb in formerly unfrozen zones could have major impacts on the surrounding environment and nearby facilities. Frost bulb growth beneath streams and across subsurface drainage zones could result in lowered water temperatures for overwintering fish and an increase in the occurrence and severity of aufeis development.

The applicant understands these impacts could be major and has proposed to investigate design measures to mitigate the impact of frost bulb growth on subsurface flow and to adjacent facilities.

4.2.8.6 Frost Heave

Much research has been devoted to developing an understanding of the mechanism of frost heave and to developing models for qualification and quantification of frost heave. In addition, large amounts of laboratory and full-scale frost heave data have been developed and reported by public and private institutions. The applicant recognizes frost heave as a major design consideration for the proposed system and has proposed to obtain additional field and laboratory data in order to predict the behavior of frost susceptible soils as they affect the pipeline and related facilities.

A chilled gas pipeline passing through initially thawed soils would cause a "bulb" of frost to develop with time. Frost heave or upward expansion of the overlying soil mass results from the development of segregated ice lenses due to freezing of soil water at the freezing front and to a lesser extent the expansion due to freezing of the pore water within the frozen bulb. Frost heave would be possible anywhere with freezing temperatures, a source of water, and frost-susceptible soils. To mitigate these effects, TAGS would use select granular material in areas where this potential exists.

The impact of frost heave upon the pipeline would depend on the severity of the heaving. Uplift of the pipe gradually through a broad region, such as a floodplain or riverbed, could result in its becoming uncovered and exposed to erosion. Differential uplift on the pipeline would place increased stress on the pipe and is one of the most important geotechnical concerns, especially in permafrost transition zones with adjacent areas of frost-susceptible and nonfrost-susceptible soils. The applicant proposes to mitigate the effects of developed pipe stress by incorporating thicker wall pipe in those areas where frost heave forces are anticipated. In either case the primary environmental impacts could be the need to repair or replace the pipe. Impacts from these activities would normally be minor unless the action occurs in an environmentally sensitive area or during a time period which doesn't optimize weather conditions. In those cases impacts would be more severe.

Uplifting of the pipe due to frost heave could cause ponding of surface water on the upstream side of the pipeline and redirection of surface water flow. Impacts on surface water flow could be moderate where uplift occurs over long distances across the preexisting drainage direction. Diversion of surface water could result in increased erosion of surface soils and greater heave in thawed soils then in adjacent permafrost soils. These impacts would tend to be localized and minor. Erosion control monitoring and use of surface protection as proposed by the applicant would greatly reduce the severity and occurrence of those conditions.

Aside from uncontrolled removal of pipe cover material, ponding or drainage changes could occur. The impacts of frost heave effects on surface water would be negligible.

4.2.8.7 Erosion and Mass Wasting

Erosion and mass movement are geological processes that operate using the force of gravity, the former with water or wind as the principal medium and the latter with the entire body of soil and rock debris (water-saturated) as the medium. Consequently, the severity of these processes increases as the slope of the land surface increases. The proposed pipeline route passes through some of the most rugged topography in Alaska, traversing many steep slopes along the route in the Brooks Range, the Alaska Range, and the Chugach Mountains as well as in some foothills and plateau regions.

The construction of TAPS and the Dalton Highway has provided an understanding of how the slopes along the proposed TAGS alignment might be expected to react to construction disturbance. The applicant proposes to use knowledge gained in constructing these projects in conjunction with advances that have been made in understanding potential slope instability to perform the initial route evaluation and preliminary design.

The planned TAGS route corridor has avoided areas marked by surface indicators of naturally occurring slope instabilities. These include extensive deposits of colluvial and talus materials, slopes patterned with solifluction lobes, bimodal failure scars on permafrost slopes, conventional landslide and rockslide areas, and progressive failures of river- or streambank cut slopes. Routing and design would be used to minimize or eliminate the potential.

Thawing of permafrost caused by construction or maintenance activities could result in slope failure, especially where fine-grained, ice-rich soils are encountered. As melting of interstitial ice and drainage of meltwater take place, the volume of the thawing soil profile is reduced.

Avoiding areas of sloping, ice-rich permafrost would minimize impacts to these areas. Stabilization techniques available to the applicant in the event ice-rich areas are unavoidable include winter construction and insulated workpad. These techniques were used successfully in constructing TAPS. If used properly, impacts to the environment as a consequence of the TAGS system would be minor.

4.2.8.8 Pipeline/Geology Interaction Segment

The route from Prudhoe Bay to near Galbraith Lake parallels and would normally be located 1 to 4.5 miles from the Dalton Highway. Moderate impacts along this segment would be the result of surface disturbance during construction. The large amounts of gravel needed for contruction would impact the supplies available along this segment. Development of new borrow sources and expansion of existing sources could result in short-term minor impacts to water quality and fisheries resources if borrow activities were to occur adjacent to active stream channels. Gravel workpad construction could impede surface water drainage, accelerating thermal degradation and erosion of the ice-rich permafrost.

Use of snow or ice pads would reduce the gravel requirements for workpad construction and the impacts associated with workpads and borrow site development.

During the period between pipeline installation and startup of chilled gas operation, thermal degradation and subsequent erosion and mass wasting could cause loss of cover and backfill. These impacts would occur primarily in the northern foothills of the Brooks Range where the route crosses ice-rich soils underlying moderate slopes.

From Galbraith Lake to the South Fork Koyukuk River, the route closely parallels the existing TAPS pipeline and Dalton Highway. Accelerated erosion could result in minor impacts in this segment. Construction activities would locally cause minor stream siltation and thawing of the ice-rich layers and lenses in permafrost.

South of the Yukon through the Tanana Uplands the route crosses a wide range of soil types and permafrost conditions. Impacts would occur from preparing construction pads, trenching, and borrow pits. Terrain modification from these activities would be moderate.

The potential for minor impacts due to thermal degradation of the relatively warm permafrost south of the Yukon River exists during the construction to chilled gas operation period. Frost heave impacts to the pipeline after chilled gas startup would probably be a significant consideration for pipeline design and modeling. The fine-grained soils exposed as a result of surface disturbance would be susceptible to erosion from surface runoff resulting in gullying and minor water quality impacts.

Surface erosion and its subsequent impact on water quality could be controlled with techniques proposed by the applicant.

The main potential impact within the Tanana Valley would be from degradation of locally ice-rich frozen silts and alluvial gravels underlying the Shaw Creek Flats and the frozen loess overlying bedrock in the upland areas south of Quartz Lake. Alluvial gravels along the Delta River from Big Delta to the southern end of this segment are generally permafrost free.

From Donnelly to Summit Lake the route closely parallels the existing TAPS pipeline and the Richardson Highway. Along this segment there would be minor terrain modification from trenching across discontinuously frozen glacial deposits. Degradation of locally ice-rich soil could develop as a result of construction activity.

Between Donnelly Dome and Paxson the route crosses the Donnelly Dome, McGinnis Glacier, and Denali faults. An earthquake as large as magnitude 8, accompanied by fault offsets of at least 20 feet, could be expected along this fault zone (FPC 1975a).

The most significant impact consideration for this segment of the pipeline route is differential movement along the Denali Fault. Loss of pipeline integrity due to fault displacement and subsequent pipeline deformation is of primary concern. Consequently, a special elevated construction mode to accommodate potential fault displacement would be installed at these three fault crossing zones, thus reducing the potential impact to the pipeline from fault displacement.

Other impact considerations are ground motions and subsequent liquefaction of saturated alluvial material in the active floodplains of both Miller and Castner creeks along the McGinnis Glacier Fault.

The most significant potential impact of the segment through the Chugach Mountains is related to earthquake hazards. Damaging earthquakes, as demonstrated by the 1964 earthquake (magnitude 8.5), can and do occur. Impacts to the pipeline as a result of seismic activity could include impacts to pipeline integrity as a result of ground failure in the saturated alluvial soils found in the floodplains of the numerous stream crossings and, along the Lowe River, due to strong ground motion. No major impacts to pipeline integrity would be anticipated if structures are designed proper seismic using criteria.

4.2.8.8 Summary

Construction of TAGS would cause a wide range of impacts to the geologic environment along the route. Conversely, the geologic environment could directly impact pipeline integrity. Impacts to the geologic environment would occur mainly during construction and would consist of changes in topography, thermal effects on permafrost, and increased erosion. Impacts to the pipeline system would be realized primarily during operation as a result of the differential heave, erosion, and seismicity of the proposed route. All of these impacts would be minimized by application of the mitigating measures described in the Project Description (Subsection 2.8) and by special conditions which may be contained in various required permits issued by regulatory agencies.

Impacts caused by TAGS construction would be very similar to and frequently cumulative with those created during TAPS construction. Overall, impacts would be moderate during construction and operation.

4.2.9 Surface Water and Ground Water

4.2.9.1 Introduction

Construction and operation of TAGS would involve construction in and across the floodplains of rivers and streams along the route. These activities have potential for causing both long- and short-term impacts on the riparian habitat and upon property both up- and downstream of the route. Additionally, thermal effects of construction, both in and out of the floodplain, can affect ground-water movement and alter surface drainage. The impact of the pipeline on the existing water resources and on the fluvial environment depends the specific design, the construction and maintenance procedures used, and upon the scheduling of activities. These activities are to a large extent controlled by stipulations and conditions of the various specific permits and the mitigation efforts described in the Project Description, Section 2.8.

Subsection 4.2.9.2 describes the general types of surface-water processes which would be affected as a result of pipeline construction and operation and identifies resulting impacts to the hydrologic environment. Subsection 4.2.9.3 describes impacts to ground water. These general processes may occur at any point on the pipeline route. Specific processes which are of concern for particular pipeline segments are described in Subsection 4.2.9.4.

4.2.9.2 General Surface-Water Impacts

Hydrologic processes are systematically interrelated--an impact to one process will in time effect change in other processes (Curry 1972). If sufficient care is exercised during design, construction, and operation of the TAGS pipeline, these impacts would be minimized; however, some impact is inevitable.

Alteration of stream hydraulics includes changes in existing velocity, stage, or water-quality patterns directly by construction of instream works or by inducing natural changes such as icings or deposition of sediment. Flow alterations could be caused by roads, pads, river training works, bridges, culverts, or ice. These changes could directly affect other resource values, such as restricting passage of fish through a culvert. They could also effect other changes in stream hydraulics that in turn affect resource values. For example, deposition of sediment in an existing channel might cause diversion of a stream.

Scour, the lowering of a streambed, occurs naturally in response to passage of a flood hydrograph. Construction-related increases in scour could be caused by a constriction or impingement of flow in either the channel or floodplain. Scour could expose the foundation of hydraulic structures and cause them to fail. Scour also causes a local increase in suspended sediment downstream of the scouring area and creates deep holes in the stream bed, thus increase stream-bottom diversity.

Bank erosion is the lateral migration of riverbanks in response to erosion by impinging flow. Migration is a natural ongoing process on the outside of bends in any alluvial river; however, it can be accelerated by either natural or man-made changes in stream geometry or an increase in flow intensity. Icings or depositions of sediment change flow patterns. Erosion may also be accelerated by instream activities such as gravel mining, which disrupt the natural supply of sediment from upstream. Bank erosion is the chief source of suspended sediment in most nonglacial streams. If allowed to continue, bank erosion can undermine and destroy riparian property.

Diversion is the removing of water from one drainage channel to another (ASCE 1962). Diverson is a natural process occurring frequently in braided river channels, in deltas, on alluvial fans, and, less frequently, in meandering rivers. The usual natural cause of diversion in rivers is blockage of an existing active channel by deposited sediment, icings, or ice jams. Diversions may be temporary, as usually occurs with icings, or long lasting, as occurs with sediment blockages. Although diversions are a natural occurrence, their frequency and severity could be increased by any activity which increases erosion or sediment deposition, restricts channels, or creates new channels. Particular concerns created by the TAGS in cold regions would be the creation of icings by thermal or ground-water discharge changes and creation of new channels by thermal degradation of ice-rich soils. Diversions could cause rapid destruction of property and could destroy road access to facilities. Diversions could also disturb or isolate sensitive habitat areas. The potential for diversion would be minimized by application of the mitigating measures provided by YPC.

Aggradation is the rise in bed level of a stream at a specific site in response to deposition of sediment (ASCE 1962). During construction, aggradation could be caused by a downstream flow constriction, such as a culvert, or by increased production of sediment upstream, such as in a disturbed area. Aggradation could also cause diversion. Aggradation would alter the character of the streambed in the aggrading area to a finer, less permeable bed because the finer material deposited clogs the interstitial spaces in the original bed. Aggradation at one point in a stream could remove sediment and would result in cleaner flow and possible degradation of the downstream bed. A source of aggradation, unique to cold regions, is raising of the ground level because of the accumulation and expansion of subsurface ice, such as might occur around a cold pipe. To minimie this process, TAGS would insulate where necessary.

Icings, sometimes called aufeis, naleds, or glaciers, form by successive freezing of sheets of water that seep from the ground, a river, or a spring (USGS 1976). Icings may form naturally in thick sheets on floodplains, as the result of surfacing stream flow, or as hillside icings formed below springs. Icings often are formed because local thermal characteristics are altered by construction, allowing frost to penetrate blocking aquifers and stream channels and causing water to surface.

The TAGS pipeline could alter surface thermal characteristics because of construction of roads or pads. The buried pipeline could alter subsurface temperatures either by freezing areas normally thawed or by thawing areas normally frozen. Either process could create icings by altering ground-water flow patterns and causing water to surface. Icings could divert streamflow during breakup, or they might inundate roads or other facilities. The TAGS proposed to avoid areas of regular formation of icings. However, control of icings which are not avoided would be handled during operation using standard approach such as ice fences.

Erosion is wearing away of lands or structures by running water or wind (ASCE 1962). Erosion would be caused by construction activities which concentrate water flow or which loosen soil surfaces. Erosion rates would be accelerated when ice-rich soils are thermaly disturbed. The chief environmental impacts of erosion are contribution of sediment to streams and the loss of soil from uplands. Secondary impacts to streams would be increases in turbidity and sedimentation of beds. Erosion, particularly in ice-rich sands and silts, could rapidly concentrate stream flow and create new drainages. Standard methods for controlling erosion in the Arctic would be used by TAGS to provide control of erosion, sediment production, transport, and deposition. Erosion control mitigation would be considered in all phases of design development, construction activities, and operation maintenance.

Surface-water resources could be contaminated by improperly treated wastewater from camps, from accidental spills of fuels or lubricants, by chemicals used during construction or operation activities, by release of contaminated hydrostatic test water, by fertilizer used for rehabilitation, as a by-product of gas conditioning, or by sediment from erosion.

Available winter surface water supply could be seriously depleted by use at camps, fire supression, or other use along some portions of the pipeline route. During construction winter surface water supply could also be depleted by diversion of either surface or ground water, or by creation of icings. Depletion of winter water supply could seriously affect aquatic resources, so these uses are regulated by the Alaska DNR water use permit system.

4.2.9.3 General Ground-water Impacts

Impacts on ground water ultimately result in impacts to surface water. The most common influence to ground water in frozen soil results from disturbance of flow in the shallow active zone overlaying permafrost. This zone can be rendered impermeable by either compaction or by frost penetration. Frost can penetrate because of alteration of surface thermal characteristics or because of operation of the pipe at below-freezing temperatures. Diversion of an aquifer would create a new ground-water flow pattern which could surface and result in an icing, accelerated erosion or diversion of surface flow. These alterations may in turn further affect the thermal regime and cause more thermal degradation.

Excavation for pipeline features such as ditches and material sites could intercept shallow ground-water flow. Thawing of permfrost by a buried warm pipe could also provide new aquifers, as could permeate bedding material in pipe ditches. These activities could create new subsurface drainage paths and dewater existing springs. They may also contribute to formation of surface icings. These same pipeline features could intercept surface flow and recharge ground-water aquifers.

Impacts to ground water would be minimized by application of the mitigating measuring proposed by TAGS.

Along much of the route, winter ground-water availability would be nonexistent or limited to unfrozen alluvium underlying major streams. Volume in the alluvium would be low, and there is no recharge during winter. Water use during construction and operation could deplete available supplies; however, use is controlled by state permits.

Shallow ground water could be contaminated by accidental spills or leaks of fuel oils and other chemicals. Water quality could also be affected by leakage from sewage collection and treatment facilities.

4.2.9.4 Other Direct Impacts

Between Prudhoe Bay and Slope Mountain the major potential effect on surface water would be disruption of natural drainage paths in the Putuligayuk and Little Putuligayuk river basins by the workpad. Major impacts, consisting of accelerated beach erosion, would result from mining gravel from the Prudhoe Bay beach. Gravel mines proposed for the Sagavanirktok River terraces could, in concert with existing works, adversely alter surface-water flow and endanger TAPS river crossings and river training structures if not carefully located.

Relatively small hillside icings occur along Slope Mountain, and small stream icings occur on many of the streams crossed along the pipeline route. Icing sizes are limited by availability of ground water. Thermal disturbances could alter present icing patterns. Minor impacts to access roads for existing pipelines may occur. Other surface water impacts would be relatively minimal.

A steep-sided slope of active alluvial fans runs from the West Fork Atigun River to the base of Chandalar Shelf. Such fans are subject to frequent channel diversions during floods as a result of rapid aggradation. Channels on the fan scour as they adjust their bed to new grade as the result of erosion of the toe of the fan by receiving waters. Pad and pipeline design must be carefully coordinated with adjacent structures to prevent either excessive erosion or deposition. Relatively small snow avalanches and debris flows could occasionally block roads and pads and may damage above-ground structures. Avalanche releases could be triggered by construction activities and could endanger personnel and other properties. Alluvial fans and the thawed gravels below Atigun Pass and the Chandalar River provide limited sources of ground water that do surface to form massive icings. Creation of new or larger icings in streams near the 13 miles proximate to the authorized ANGTS right-of-way could divert streams and has the potential to damage facilities. A related hazard that is peculiar to this area is ice mounding, formed by under-ice water under high hydrostatic pressure. Ice mounds have been known to explode and cast large blocks of ice tens of feet (USGS 1976).

From the base of Chandalar Shelf to South Fork of the Koyukuk River the where the alignment would be located adjacent to the floodplains of the Dietrich and Middle Fork Koyukuk rivers. These streams are braided, are generally aggrading, ice severely, and are subject to rapid diversion. Winter icing levels frequently exceed normal open-water flood levels. Diversions could be caused by instream works that alter flow patterns, such as construction of river training structures or roads or by disruption of winter flow patterns which causes icings. Diversions or icings could affect environmental values and TAPS, authorized ANGTS, or state highway in the floodplain. Much of the remaining alignment would be located on active alluvial fans tributary to the Dietrich and Koyukuk rivers. Channels on these fans are unstable and subject to rapid diversion and scour. Alteration of these minor streams by TAGS could seriously damage adjacent pipelines and the highway. The crossings of the two forks of Bonanza Creek present a risk of causing a diversion. Most of the streams crossed tend to ice severely in the winter. Creation of new icings could easily cause diversions or inundate existing facilities. Limited supplies of shallow ground water tend to exist in the unfrozen valleys. Alteration of the thermal regime could create new icings or relocate existing icings and thus affect the existing pipeline or roads.

The Yukon River Bridge would span the entire river with only one instream pier. When completed the bridge would have minimal permanent impact on the stream. Construction of the instream pier would introduce some silt into the stream and would present a risk of contamination from construction related oil spills. When completed, the bridge should reduce existing tendencies for ice jams at the downstream highway bridge because it would presplit the ice sheet. These risks could be eliminated by placing the pipe on the existing bridge.

From the Yukon River to the Elliott Highway near Fairbanks the streams tend to be clear and free from suspended sediment. Slopes along the alignment tend to be steep, and soils are more erodible than in most areas. This means that there would be a higher than average risk of increasing erosion and sedimentation. Ground water exists in valley alluvium and fractured bedrock. Icings are common in valleys and hillsides. The location and size of icings could change as the result of construction or as the result of operating a cold pipe. These changed icings could affect the TAPS and authorized ANGTS or the highway.

From the Elliott Highway near Fairbanks to Fort Greely the route lies in areas of soils that erode easily. Throughout this portion of the route, impacts to water quality and minor changes in drainage paths caused by erosion would be of particular concern.

From Fort Greely to Paxson Lake most streams crossed or paralleled by the pipeline route are glacial. Almost all of the tributaries of the Delta River are crossed on rapidly aggrading alluvial fans which could shift channels rapidly. Maintaining channels in existing locations at highway crossings requires extensive maintenance. The stability of an existing channel on a fan could be easily disrupted by construction, and resulting channel changes could impact TAPS and the state highway. The Delta River and Phelan Creek are rapidly aggrading braided rivers that tend to ice to high levels. Diversions are frequent. Icing levels sometimes exceed highway grades. These streams are subject to glacial outburst floods from the Gulkana Glacier.

All of these facts combine to make this area particularly sensitive and difficult for pipeline construction. TAPS is protected by an extensive series of river training structures. Impacts to adjoining property from effects of TAGS construction could occur. Effects from operating the pipline would be minimal. Several areas are subject to snow avalanche, however, their chief impacts could be to hinder construction and maintenance activities. Because of the large natural bed load carried by streams in the area, effects from erosion on water quality would be minimal. The chief potential impact to ground water would be in altering icing patterns. Ground water from alluvial fans apparently surfaces as springs along the toe in the Delta River and Phelan Creek.

Throughout much of the section between Paxson Lake and the Tonsina River the soils are ice-rich, relatively warm, fine-grained, and easily eroded. Sourdough, Willow, and Rock creeks tend to develop icings. There would be, therefore, a risk of diversion and accelerated erosion and consequent degradation of the existing high-quality water. Two major stream crossings, the Tazlina and Klutina rivers, are glacial. The Tazlina is subject to frequent glacial outburst flooding, and a meander cutoff is impending. The Klutina has had four extremely large icings since 1935. The largest, in 1964, blocked the Richardson Highway for nine days (COE 1967).

Both of these crossings should accommodate glacier impacts. The Tazlina River would be crossed in an elevated mode which should minimize problems. The Klutina River would be a conventional buried crossing which could effect the existing icing conditions. Icings, caused by springs on hillsides and in streams, occur frequently. Construction- and operation-induced changes in soil permeability in this sensitive area would alter existing icing locations and sizes. These new icings could affect adjoining property and resource values. Areas of particular concern would be Spring Creek and Sourdough Creek.

From the Tonsina River to the mouth of Keystone Canyon the alignment generally follows the valleys of the Little Tonsina, Tiekel, Tsina, and Lowe rivers through the Chugach Mountains. Stream valleys tend to have narrow floodplains and in many places are constricted by the existing highway or TAPS pipeline. Construction of the TAGS pipeline would further constrict the floodplains and could create changes in the stream that might affect existing facilities. This would be a particular concern in the Tsina and Lowe river valleys. The route crosses several very active alluvial fans which could aggrade rapidly during large floods.

From Keystone Canyon to Anderson Bay, the route crosses several very steep active streams with beds of shallow alluvium over bedrock except on active fans near tidewater. Diversions on fans, caused either by constructed works or by deposition of sediment, are possible. These diversions could damage existing facilities.

4.2.9.5 Summary

Construction of TAGS would cause a wide range of impacts to both the surface and subsurface waters along the route. All of these impacts would be minimized by application of the mitigating measures described in the Project Description and by special conditions in various required permits issued by regulatory agencies. Impacts consist of changes in stream geometry, introduction of sediment and pollutants, and depletion of water supplies. These impacts to water resources would in turn affect other resource values and possibly property and habitat value both up- and downstream of the TAGS. Impacts caused by TAGS would be very similar to and frequently cumulative with those created by TAPS and the state highway system or postulated for ANGTS. TAGS impact to stream geometry is constrained by the need to not allow changes to stream geometry which would adversely affect existing and presently permitted riparian property. Overall, impacts would be moderate during construction and operation.

4.2.10 Marine Environment

4.2.10.1 Introduction

Six general types of impacts on the marine environment and potentially on marine biota that could be expected to occur as results of the TAGS project include impacts:

- From construction and presence of the LNG terminal and appurtenant structures;
- From liquid effluent discharges to marine waters;
- From LNG and from oil lost during storage, transfer, or shipping;

- From facility operations and increased tanker traffic on marine mammals and birds related to disturbance;

- To use of the area by recreational and commercial fishermen;

- From increased human population and ancillary developments on the marine and adjacent terrestrial habitats.

4.2.10.2 Impacts from Construction of LNG Terminal Facilities

Impacts from construction of the LNG plant, terminal and appurtenant facilities would be largely those from fill operations (see Figure 2.2.1-5). The LNG plant and terminal property site would occupy approximately 5 percent of the Port Valdez shoreline this area would be modified or occupied for the life of the project. The most significant physical change to the nearshore area would be the placement of fill on approximately 100 acres of littoral or sublittoral sea floor in the area immediately offshore of Anderson Bay, and the adjacent plant site.

There would be a small net loss of subtidal benthic habitat and an even smaller loss of intertidal habitat. Data from available studies (Feder and Matheke 1980, Feder 1983, CDD 1986) indicate that dominant forms are invertebrates, mainly small polychaete worms and bivalve molluscs, living in the substrate. The species composition, numbers of species, and organism densities at sampling stations close to Anderson Bay were similar to most other sample stations in the western Port Valdez. These data suggest that soft substrate benthic habitat that would be covered by fill contains no unique organisms or unusually high densities and is, in fact, characteristic of more than 30 percent of the Port Valdez sea floor. The Port Valdez shallow subtidal benthos has not been considered as limiting as a food source to higher organisms such as fish, birds, or marine mammals and the loss of 100 acres of benthic habitat would be insignificant to higher forms that feed on benthic invertebrates. Any hard substrates that might be covered would reduce the amount of algal substrate available for deposition of eggs by spawning herring. In the context of the low total amount of substrate that might be affected, impacts would be minor to moderate.

During construction of the plant and terminal facilities, there would be localized increases in sediment suspended in the water column and rates of sedimentaton to the proximal nearshore area. In the context of excessively high sedimentation rates from river and stream discharges during the summer months when construction would be taking place, the localized increase would probably be negligible. Because the sediments of Port Valdez are uncontaminated from industrial wastes and low in organic matter (Feder, et al. 1973, Hood et al. 1973), problems such as toxicity, chemical oxygen demand, or hydrogen sulfide release would not be anticipated and overall impact would be minor.

The presence of the terminal facilities and associated fill material would not be expected to cause any appreciable alteration in tidal flow, circulation, or deposition patterns.

Both commercial and sport fishing for salmon occur in Valdez Narrows and into Port Valdez through the vicinity of Anderson Bay (J. Brady, pers. com.). The Solomon Gulch hatchery releases pink, coho and chum for commercial fisheries, and chinook in Anderson Bay for commercial fishing purposes. Construction timing and procedures could affect salmon return migration. Construction activities would exclude both commercial and sport fishing in the immediate vicinity of offshore construction due to safety considerations. Further, all vessels are required to stand clear of a 200-yard safety zone around all Alyeska terminal waterfront facilities. Vessels are required to notify the Coast Guard Vessel Traffic Center (VTC) for permission to enter the safety zone. Assuming a similar safety zone around the proposed TAGS facilities, there would be a limited area that is currently available to fishing that would become unavailable for the life of the facility. Due to the small size of this area relative to the total fishing area, this impact would be considered moderate.

4.2.10.3 Effluent Discharges

Project-related discharges into marine waters would include potentially oily wastewater from plant operations, domestic wastewater from the facility, and LNG tanker ballast water. General plans are for a system that would include both primary and secondary treatment of wastes prior to their discharge into Port Valdez. Specific aspects of system design and discharge location would be developed as the project proceeds into design and would be subject to federal and state regulations through National Pollution Discharge Elimination System (NPDES) permitting and state water quality certification processes. An oil/water separator would be used to remove floatable oils and grease and potentially settleable solids. Sludges and skimmings would be incinerated and the water effluent piped into a secondary treatment system, probably incorporating biological removal of dissolved organic and inorganic wastes, followed by settling of solids. A disinfectant treatment such as ozonation, chlorination, or ultraviolet light, could also be incorporated into the treatment process if necessary. Total volumes have not been estimated but are low relative to industrial and port facilities that include process wastewaters and/or treated oily ballast water. Thus, though some potential problems have been identified with compliance of discharges from the Alyeska Marine Terminal with their NPDES Permit, these have been associated with the discharge from the facility's oily ballast treatment system. LNG tankers serving the TAGS terminal would have segregated ballast and do not have the potential for a similar discharge problem.

Treated combined wastewater would be expected to have parameters with the general maximum concentrations shown in Table 4.2.10-1.

Table 4.2.10-1
Anticipated Combined[a] Waste-Water Treated Effluent Quality

BOD	30 mg/l
COD	80 mg/l
Suspended Solids	30 mg/l
Metals	Trace
Nitrogen (as total N)	30 mg/l
Phosphorus (as total P)	8 mg/l
Chlorides[b]	50 - 80 mg/l
Oil and Grease	Low enough to not cause a sheen upon discharge
Bacteria	Less than 200 ml MPN

(Source - YPC)

a Secondary treatment of combined domestic wastewater and treated oily wastewater.
b Increase in chlorides with treatment if chlorination disinfection is used.

Concern for potential adverse impacts is lessened by the favorable hydrographic conditions in Port Valdez. The receiving water body is large and deep and has a relatively high estimated flushing rate as represented by the large tidal prism (approximately 26 percent) and short residence time (on the order of four to six weeks). Further, the requirement for specific federal and state regulatory review and approval for any discharges ensures that full analysis would be given to specific design features of a later stage in the project. Potential impacts from a permitted, treated wastewater discharge are expected to be negligible outside of the mixing zone.

LNG tankers would process sanitary and other liquid wastes (including bilge wastes) at sea in accordance with U.S. Coast Guard standards. Because LNG tankers do not co-mingle LNG and ballast water, there would be no potential problem with discharge of oily ballast water. Ballast water discharged into the marine waters of Alaska would be clean sea water and have negligible impact on marine water quality.

4.2.10.4 Impacts from LNG or Oil Released into the Marine Environment

The natural gas and liquefied natural gas would be the primary fuels used to power the LNG plants and LNG tankers. Hydrocarbon spills other than LNG or natural gas would come from minor or chronic spills of lubricating oil and grease or fuel for other machinery or during bunkering. The facility would operate with a full Spill Prevention Control and Countermeasure Plan and other discharge contingency plans as would be required. Such spills would be minimal and would most likely be contained within spill containment devices, such as diked walls or booms, specifically designed for that purpose.

A spill of LNG such as from a tanker or pipeline rupture would be followed by a freezing of virtually any material encountered by the LNG, as it draws heat from the environment, volatilizes, and disperses into the air. Thus, unlike spills of crude oil or refined oil products, leakage of LNG into the environment poses a greater potential problem as it vaporizes into the air than it does to the marine environment. Though any organisms in the direct path of the dispersing LNG would be expected to be killed, in general, marine impacts would be expected to be localized and short-lived or minor.

4.2.10.5 Impacts to Use of the Anderson Bay Nearshore Area by Commercial and Recreational Fishermen

The operation of the TAGS marine terminal would restrict use of the nearshore area by recreational and commercial fishermen by excluding from use a restricted zone in the immediate vicinity of the docks, tankers, and moving dolphins as well as a larger area during docking and berthing operations. The TAPS marine terminal had established by law a safety zone area within 200 yards of TAPS faciliites and within 200 yards of tankers in transit or in port. Assuming that the U.S. Coast Guard establishes a similar restricted safety zone for the TAGS facilities as was done for TAPS, a nearshore area on the order of 200 acres would be restricted from use by fishing vessels. With the proposed configuration of facilities, most of Anderson Bay itself would remain open for recreational and commercial fishing. The direct and indirect impacts would be moderate.

4.2.10.6 Impacts of Disturbance to Marine Mammals and Birds

The proposed facility would be located in an area with minimal direct use by marine or shorebirds or marine mammals and would cause little displacement or disturbance to bird or marine mammal populations The single bald eagle nesting area on the western shore of Anderson Bay would be well outside of the proposed 330-foot buffer zone for developments (Valdez CDD 1986) and should not be affected. Tanker passage through Hinchinbrook Entrance and on into Port Valdez would be via existing vessel traffic corridors and negligible impact disturbance to birds or marine mammals would be anticipated.

4.2.10.7 Marine Impacts from Increased Human Population and Ancillary Development

Hunting of marine mammals in Prince William Sound is not allowed except by Alaska Native subsistence hunters; marine sports fisheries and waterfowl hunting in Port Valdez are not resource limited. The potential for increased disturbance of marine mammals and birds with increased human population exists but is not quantifiable. Because Port Valdez is large, it is not anticipated that an incremental increase of the port for pleasure boating and fishing, should the project result in increased population and increased rereational uses, would create a disturbance problem with existing marine-associated wildlife.

4.2.10.8 Summary

Impacts of the TAGS project on the marine environment would result from fill operations, construction, operation of the marine terminal, and aquatic discharges from the LNG plant. There would be direct loss of subtidal soft-substrate habitat, and organisms living on the sea floor in areas dredged or filled would be destroyed. Subtidal sediments in the vicinity of Anderson Bay are generally characteristic of those for the entire western Port Valdez, so organisms and habitat loss would not be unique or particularly important to the system.

The LNG plant and marine terminal facility would have minimal impacts on recreational or commercial fishing in Valdez Narrows and Port Valdez. There would be some area near Anderson Bay closed to recreational and commercial fishing during operation due to public safety zones , similar to that for the Alyeska Marine Terminal. Permanent restricted safety zones would remove some portion of the nearshore area around the marine terminal from use for commercial or recreational fishing.

Effluent discharges would be required to meet state and federal water quality requirements and would be subject to the NPDES permitting process. Treatment requirements, discharge characteristics, and contaminant levels would be considered and controlled through this process. In addition, Port Valdez has a good flushing rate and there should be very limited potential for pollutant buildup. LNG tankers have segregated ballast tanks and do not have an oily water ballast discharge and therefore no impact is expected.

Overall, project activities are not expected to greatly increase disturbance to marine mammals or birds.

4.2.11 Fish Impacts

4.2.11.1 Introduction

Studies related to the construction and monitoring of impacts related to the TAPS pipeline have led to a fairly good understanding of the streams and lakes along the TAGS route, including fish species present, their life history and habitat use patterns, and construction and operation effects of a major pipelines along this corridor. Much more is known about anadromous fish streams than the others. Nevertheless, there is the potential for damage to occur to the fish resources along the proposed route during construction and operation. The following discussion presents information on impacts to fish resources by major sources of those impacts and covers special circumstances.

4.2.11.2 Stream Crossings

The major potential impact to fish resources would be due to the more than 200 stream crossings for burying the gas pipeline. Primary impacts would be temporary blockage of the stream and turbidity. Erosion, turbidity, and siltation are part of the natural cycle of physical changes occurring in both running waters and lakes along the route. Most streams and lakes and the organisms therein adjust readily to some level of silt and turbidity; however, there would be problems when there is an abnormally high silt load, its duration is longer than normal, it occurs at an unusual time of the year, or it is of a different type of sediment than the watershed is accustomed to. Many project activities also have the potential to increase the sediment load, thereby producing a variety of possible effects, including reduction of primary production, reduction in numbers and variety of benthic organisms, mortality to fish eggs or larvae, or interference with sight feeding (Hynes 1970). Increased turbidity or siltation is seldom lethal to adult fish.

Since there is so much variety in the chemical, physical, and biological characteristics of the streams and lakes along the route, each stream will be considered separately in regard to final engineering design of stream crossings, which will include environmental stipulations concerning those crossings. Table 3.2.11-1 presents a list of most of the streams inhabited by fish which would be crossed by TAGS, along with the species present and the most and least sensitive times for crossing. Prior to construction each anadromous stream would require a specific stream crossing permit from ADF&G. There are no direct lake crossings anticipated, although some lakes would be affected by turbidity due to nearby access roads, stream crossings, or other construction activities.

Streams have the capacity to recover from moderate amounts of siltation, both natural and man-induced. This recovery depends on velocity of flow, ambient clarity, and size of introduced particles. One of the worst effects of heavy siltation is the creation of a sill at the mouth of tributary streams that might last for years and dramatically reduce fish entry to the tributary. Temporary blockage or rerouting of the stream during construction has considerable impact potential but would be averted by selecting the construction period properly.

Siltation would not normally affect anadromous fish in the migratory streams but would greatly affect salmonids in their spawning and rearing areas. The increased turbidity and disturbance during construction of crossings would be extreme but typically local and temporary in nature. There is some possibility of long-term siltation near unstable road cuts and thermokarsting areas. The impacts due to erosion and siltation would be major for short periods of time but would be negligible after construction, given proper culvert installation.

4.2.11.3 Access Road Construction

The construction of new gravel access roads to the construction area, borrow pits, and construction camps, etc., would entail crossing many small streams. The primary potential for impacts at stream crossings would be temporary blockage or channeling during construction and placing of culverts. Temporary bridges would be used over some water crossings. Temporary blocking and changing of streams channels is virtually unavoidable but would typically occur during the least sensitive period and would be quite brief in most instances.

Culvert placement and design have been notoriously poor in the past, especially on the North Slope with its shallow permafrost and wide surface drainage. Recent design improvements, including steel culverts, heating and insulation of culverts, and deeper placement have greatly improved drainage and fish passage. Mitigation which includes use of these improvements would be utilized whenever necessary to ensure fish passage.

Culverts can also change stream flow patterns. There is usually a pool below the culvert, very swift water through it and another pool or swift water area directly above the culvert. These conditions can impede fish passage and provide areas of concentration for predators of downstreams migrants. Design criteria that can mitigate this situation would be used to ensure the flow gradient in the culvert does not impede passage of small fish and that the bottom lip of the culvert is always below the water surface at the downstream end.

Culverts that freeze completely and stay frozen later in spring would cause flooding and fish passage problems. These culverts can be thawed with in-place heating elements if located in sensitive areas. Spring or fall floods with resulting washouts may occur and impact fish passage or destroy spawning beds. Crossings and culverts would be designed with 100-year floods in mind. Impacts due to access road construction would be moderate during construction and negligible during operation.

4.2.11.4 Borrow Sites

Some dewatering and disruption of subsurface flow would affect stream hydrology, especially during overwintering and in dry periods. Normally, borrow pits would be located on the terrace above, and berms constructed between the borrow pit and the active streambed, resulting in only minor impacts.

Construction in the larger river floodplains or access roads to the construction site or borrow pits has some impact potential and might result in washouts, increased sedimentation, and stream channelization. This would be most likely to occur on the upper Sagavanirktok River and in the Atigun, Dietrich, Delta, and Koyukuk river floodplains and the west side Galbraith Lake route. Construction would typically occur in these areas during periods when they are frozen or when fish are not present, which would reduce but not eliminate the potential impact. Impacts from borrow site would be moderate during construction and minor during the postconstruction period.

4.2.11.5 Other Impacts

The potential for the spill of fuel from tanker trucks, diesel storage tanks, or large equipment into surface water bodies always exists. Such spills are usually small but common on construction sites. Due to the large number of streams crossed by access roads and the buried pipeline, there would very likely be some spills into watersheds during construction. Such spills would be prevented to the extent feasible and immediately controlled and cleaned up, but there may be local impacts, especially to bottom fauna and sensitive fish life stages.

Buried stream crossings of chilled gas pipelines would possibly cause frost bulbs to form. These frost bulbs could result in downstream aufeis formation, possible blockage of flow for long periods of time, unusually severe flooding during breakup, and loss of critical fish overwintering and spawning habitat and could affect fish migration routes. These formations could also affect springs which maintain spawning beds and produce essential overwintering habitat.

To prevent those impacts, the TAGS has proposed mitigation such as temperature controls of the pipeline would be maintained or the pipe buried deep enough so that the chance of frost bulb formation is minimal and proper placement of buried pipelines and timing of construction in sensitive fish streams would minimize impacts to sensitive areas.

The presence of more people and better access would result in increased pressure on catchable fish resources by sport, subsistence, and personal use fishermen. For indigenous species this would result in selective removal of the larger fish and loss of the more desirable species from accessible locations. In areas such as the North Slope, where fish are slow growing and have reduced reproductive capacity, this would be a significant local effect. Reduced size and numbers of desirable species has already occurred in accessible areas near the haul road system and recently (1987) Paxson and Summit lakes near the Richardson Highway have been closed to winter fishing due to reduced spawning populations of burbot and lake trout.

River training structures would be installed at some crossings to prevent washouts or excessive siltation. These structures would channel the stream and increase the flow velocity in these sections, possibly resulting in reduction of rearing habitat, impeding upstream migration, and accelerating downstream movement by semiplanktonic life stages of fish. This might result in reduced survival rates for salmonids. Location of these structures would be carefully considered before implacement and would typically not be installed in highly productive and sensitive anadromous fish streams.

Other possible sources of impacts include water withdrawal from lakes and deep pools in rivers, winter ice road construction, and various types of activities in watersheds and floodplains, such as airstrips, disposal pits, camps for construction personnel, and compressor stations. None of these should have high impact potential given appropriate design and construction techniques and the adherence to state and federal regulations regarding construction in floodplains.

Several especially sensitive streams must be crossed or otherwise disturbed. For example, Jim River near Milepost 270 has ACEC fish overwintering, salmon spawning and rearing habitat, and excellent grayling fishing. Other sensitive areas include an elevated crossing at Solomon Gulch Creek, with its private salmon hatchery, several pristine salmon and steelhead streams such as the Gulkana, Little and upper Little Tonsina rivers fish creek and major fish-producing rivers or recreation areas such as the Yukon and Chena rivers. These areas will be moderately impacted. The existing and planned egg-taking and spawning facilities near the Gulkana River crossing would also potentially be affected. Canyon Slough is one of the many clear water salmon spawning area on the Lowe River system which could be moderately impacted during construction.

Highly sensitive fish overwintering areas would potentially be affected by all the previously mentioned activities. These areas would be avoided and protected to the extent necessary. Most important overwintering areas are known and stream crossings would be planned and engineered according to state-of-the-art technology. Water would not be withdrawn from fish overwintering areas; withdrawal pipes would be screened to prevent impurgement or enstrainment of larvel fish. Impacts to these sensitive areas would probably be moderate during construction and minor during operation.

4.2.11.6 Summary

Although there would be ample opportunity during construction and operation of the TAGS project for moderate effects on the local and regional fish populations, most impacts would be prevented or mitigated using state-of-the-art arctic pipeline engineering and construction techniques and by constructing during the least sensitive period. Other possibe effects could be reduced by utilizing appropriate resource management techniques such as restricting access and fish catch size and limits along the corridor, especially for construction personnel, and providing for permanent catch and release fisheries near popular access points. This would be up to the ADF&G to implement, should they feel it necessary.

Construction and operation would result in localized and moderate short-term effects to the fish populations of corridor streams and lakes. There is no indication that anadromous fish populations would be decreased or threatened.

There are no threatened or endangered fish species in Alaska.

4.2.12 Vegetation and Wetlands

4.2.12.1 Introduction

The impacts of the proposed TAGS project on vegetation and wetlands would be diverse and vary considerably in extent, severity, and duration throughout and, to some extent, beyond the life of the project. Although it is difficult to quantify such impacts, experience gained during TAPS construction and operation would prove invaluable in anticipating and preventing or mitigating many TAGS impacts. In this regard, useful discussions and recommendations concerning problems encountered during pipeline construction and operation have been presented by FPC (1976a), Burger and Swenson (1977), Pamplin (1979), Brown and Berg (1980), the U.S. General Accounting Office (1981), and Woodward-Clyde Consultants (1980) among others, and are incorporated by reference in this subsection.

The USACE developed a strategy for processing the TAGS authorization for the dredging or disposal of fill as described in Subsection 1.11. This strategy identifies a two-phased approach to the permit application process. The generic phase, or phase one, for which the initial approval/disapproval would be received, would be satisfied by the generic information contained in this EIS. However, for the site-specific approval during the second phase, detailed identification and characterization would be required for disposal of fill into wetlands and other USACE regulated water bodies to that site-specific mitigation could be applied. Mitigation would be determined by the value and importance of wetlands impacted or lost. With this approach, the USACE and resource agencies would now focus their review and evaluation on the design and major alignment alternatives and later address the localized impacts to specific wetlands.

The activities associated with the proposed project would be categorized as follows: construction, postconstruction rehabilitation and revegetation, operation and maintenance.

The impacts anticipated from the project are considered under combinations of these headings.

4.2.12.2 Construction Impacts

The preconstruction and construction phases of the proposed project are considered together because of the similarity of activities involved, although most of the impacts discussed would occur during construction. Due to the magnitude of the construction effort and the number of people involved, this phase would have the greatest impact on vegetation communities along and adjacent to the proposed route. The total area directly disturbed would be approximately 22,910 acres for the entire TAGS project. Although detailed estimates of the magnitude of direct impacts on specific habitat types are not yet available for TAGS, the areas affected would be similar to those affected by TAPS. Approximately 59 percent (about 16,200 acres) of the total TAPS area directly affected by that project (excluding the Dalton Highway) consisted of wetland habitats, including wet-meadow tundra, tussock tundra, bogs, marshes (Pamplin 1979), riparian willow, approximately one-half of spruce woodlands, and unvegetated floodplains.

The primary impact would be the direct removal of vegetation during preparation of the right-of-way through clearing, grading, and gravel placement. The total amount of ground area disturbed just along the pipeline working right-of-way during this phase is estimated at 14,473 acres. Based on the area affected by the TAPS workpad (Pamplin 1979), approximately 47 percent of the area of the TAGS right-of-way would be expected to directly affect wetlands. Wetlands were affected more by TAPS workpad and Dalton Highway construction than by any other activities (Pamplin 1979). Disruption and compaction of the organic surface layers of vegetation would lead to increases in the depth of the active (seasonal thaw) layer.

The extent of active-layer increase would depend on vegetation type, soil characteristics, intensity of disturbance, and season (FPC 1976a). In areas of ice-rich permafrost, destruction or disruption of the insulating vegetative layer would lead to thaw settlement, slumping on slopes, and ponding (How 1974), making reestablishment of vegetation difficult. Removal of the forest canopy would also lead to moderate increases in active-layer thickness and in changes in species composition due to elevated levels of insolation of the forest floor.

Vegetation killed, injured, or weakened in forested areas by construction activities could provide favorable breeding conditions for insects, such as the spruce bark beetle, and disease organisms that could spread to adjacent unaffected vegetation (FPC 1976b). Appropriate disposal of slash piles through immediate mulching or controlled burning would reduce these potential.

Where conditions favor the use of snow/ice workpads and roads, impacts on vegetation would be less severe than elsewhere because no grading or gravel placement would be necessary. Nevertheless, negative impacts would occur, primarily in arctic tundra wetlands. Those impacts would include compaction of the organic layer, reduction of microtopography, reduction in cover of vascular plants, and increases in thaw depth (Hernandez 1974, Brown and Berg 1980). Brown and Berg (1980) indicated that the reduction in vascular species cover and increase in thaw depth might be relatively short-lived. Additional damage would be likely if low snowfall necessitated the collection of snow from large areas or the hauling of snow or water from distant sources (DOI 1976).

In addition to direct removal of vegetation along the right-of-way, the extraction of 33 million BCY of gravel and rock from material sites and the subsequent use of those materials in the construction of workpads, access roads, construction camps, compressor stations, storage yards, and airstrips would result in substantial direct losses of vegetation. In this regard it is noteworthy that the area disturbed in developing material sites during the TAPS project construction (including the Dalton Highway) was significantly greater than was initially estimated (12,200 acres versus 5,760 acres) (Pamplin 1979). Approximately 29 percent of the surface area directly disturbed by TAPS material sites involved wetlands. This proportion would be lower during TAGS construction because of lower demand for gravel in the arctic drainage area because most of that area consists of wetlands.

Construction of the TAPS material sites, Dalton Highway, and workpad accounted for the majority of damage to terrestrial habitats by that project (Pamplin 1979). The extensive use to be made of existing gravel pads for the proposed TAGS facilities would mitigate a substantial portion of the adverse impacts expected from material extraction and placement. Adherence to recommended guidelines for gravel mining (Burger and Swenson 1977; WCC 1980) would further mitigate adverse impacts. Nevertheless, the additional losses of vegetated habitats through these activities would constitute a major component of the expected impacts. Any loss of riparian willow habitat in arctic floodplains would potentially be disruptive in view of its high value as wildlife habitat and its limited occurrence (Hernandez 1974; Pamplin 1979).

The disruption and alteration of surface drainage patterns by soil compression; permafrost degradation; trenching; erosion-control measures; grading; and gravel pad, access road, and pipeline mound construction would constitute major, though generally localized, impacts on vegetation and wetlands (FPC 1976b). Inhibition of cross-drainage would cause ponding and thermal erosion on the upslope side of linear gravel structures and gradual drying of habitats on the downslope side. Both types of impact would result in changes in species composition over the long term and in direct mortality of some plants in the short term (Hernandez 1974). Gully erosion downslope, induced by the concentration of flow through culverts onto ice-rich soils not previously subjected to such flow, would also occur in some areas (Brown and Berg 1980). Ponding problems would be exacerbated by clogging of culverts through icing and road-maintenance activities. Careful attention to terrain and drainage features in the placement of culverts and low-water crossings, coupled with proper maintenance, would mitigate some of these impacts. However, alteration of drainage patterns would constitute a principal construction-related impact on the vegetation communities and wetlands along the proposed route, particularly on the coastal plain.

Dust fallout from vehicular traffic on gravel roads would occur throughout the life of the proposed project but would undoubtedly peak during the construction phase. This impact would be most noticeable along the Dalton Highway and would add to the impacts from existing traffic. Studies along the Dalton Highway have demonstrated that some plant species, especially certain mosses and lichens, are sensitive to road dust, and a few species appear to respond positively to it (Everett 1980; Alexander and Van Cleve 1983). Thus, some changes in species composition near gravel roads would be anticipated. In addition, the accumulation of dust on the snow within 100 to 300 feet of heavily traveled roads causes early snow melt (Everett 1980), which accelerates the chronology of growth of plants near the road by perhaps as much as two to three weeks. On the other hand, the chronology of plant growth would be delayed in areas where snowdrifts persist in spring as a result of snow accumulation along access roads and near project structures.

Accidental spills and leaks of toxic fluids such as fuels and antifreezes would occur throughout the life of the project but would be most likely during construction. The direct impact on vegetation would be considerable in localized areas and would vary according to the amount spilled, the terrain, and the season of the year (FPC 1976b). Such spills would be especially serious in riparian zones and wetlands. Careful construction practices would reduce the frequency and size of spills, and appropriate cleanup would reduce the impacts on vegetation.

Fire would increase along the proposed route as a result of the operation of construction and incineration equipment, the use of flammable materials, and the carelessness of smokers (FPC 1976b). Although management agencies no longer view fire as being necessarily detrimental to wildlife habitat values and often increases habitat value by regrowth of forage species, it would constitute a direct, dramatic impact on vegetation along the route that would add to the incidence of naturally occurring wildfires. On the other hand, the cleared right-of-way would function as a firebreak and would allow access for fire-fighting equipment if suppression was deemed necessary.

4.2.12.3 Rehabilitation and Revegetation

After construction, disturbed areas would be rehabilitated. This would include the stabilization of bare soil by mechanical means or physical structures and the reestablishment of vegetation. The primary goals of such efforts are the reduction of both hydraulic and thermal erosion and the maintenance of slope stability (Hernandez 1974). A related goal is reduction of the aesthetic impacts of such a large-scale project. Rehabilitation and revegetation of disturbed areas are thus important measures for mitigating impacts; however, it would be impossible to restore the affected areas to their former natural condition.

Although revegetation in past projects has primarily involved the use of "domesticated" species of grasses, emphasis is now being placed on the use of native species. The use of species developed from indigenous stocks is preferred because they are better adapted to the environmental conditions along the route and would not create the potential problems associated with introducing exotic species into adjacent ecosystems. The species selected should be compatible with the climatic conditions prevailing along those portions of the route in which they are to be seeded (Johnson 1980, 1981; Alexander and Van Cleve 1983). In areas not prone to wind or water erosion, YPC proposes to encourage native revegetation through appropriate soil preparation, thus allowing the areas to return to near-preconstruction conditions.

4.2.12.4 Impacts of Project Operation

The transition from construction to operation and maintenance of the proposed project would cause a substantial decrease in the amount of area disturbed directly and in the amount of project-associated activity affecting vegetation along the route. It is estimated that the total area directly disturbed would be 8,119 acres, of which 5,114 acres would be along the operational right-of-way and 1,740 acres would involve material sites and site-access roads for maintenance purposes. The proportion of wetland areas affected would be approximately the same as that affected during the construction phase.

Continuing alteration of drainage patterns would constitute the major impact on vegetation communities, particularly wetlands, during the operational phase of the proposed project. In addition to the impacts from disruption of surface drainage already described, frost-bulb formation and freezing of granular fill around the chilled pipeline would impede subsurface drainage across the proposed route. The specific impacts of this phenomenon would vary among vegetation communities, but the general effects would include saturation and flooding of substrates upslope from the pipeline, causing drowning of some plants and increased drainage and drying of substrates downslope. These impacts would be greatest in wetlands and would cause changes in species composition and abundance (Hernandez 1974; FPC 1976a). Cooling of the soils directly above the chilled pipe would lead to a decrease in thaw depth, affecting root penetration and growing-season length and possibly interfering with revegetation efforts.

Gas flowing through the proposed pipeline would be chilled only through Compressor Station 8. Thus, permafrost degradation could potentially be accelerated in boggy wetlands of the Copper River basin where pipeline temperature rise above 32 degrees through the combined effects of thermal and hydraulic erosion along the pipeline route. Subsequent disuption of both surface and subsurface drainage would cause the impacts on vegetation already described (upslope flooding, downslope drying, altered species composition).

A direct impact on vegetation during the operational life of the project would result from maintenance of the right-of-way, albeit at reduced width. The removal of invading shrubs and trees to permit pipeline surveillance, maintenance, and repair would maintain the vegetation on the right-of-way in a stage of early succession except in tundra (FPC 1976a).

Emergency repairs to the pipeline system would have the potential to cause significant local impacts, depending on community type and season of the year. The need to use all-terrain vehicles (even low-ground-pressure varieties) during summer in permafrost-rich areas would cause the greatest impacts, primarily through compaction of the vegetation and organic layer and corresponding increases in thaw depth (FPC 1976a).

Operation of compressor stations would be likely to produce minor impacts on aquatic vegetation and wetlands through discharge of effluents or leaching of toxic substances from landfills or disposal sites. Appropriate sewage treatment and sludge-disposal techniques as proposed by YPC would reduce such impacts.

Emissions, particularly of sulfur oxides from compressor station operations, would have the potential for minor to moderate impacts on lichens in localized areas where air stagnation is common in winter, such as in the Yukon River drainage area. Although such emission levels would be low, chronic exposure potentially could cause some mortality of lichens (DOI 1976; FPC 1976a).

4.2.12.5 Summary

The primary impact on vegetation and wetlands during construction of the proposed project would be the direct mortality of vegetation on the estimated 22,910 acres that would be affected by material extraction, pipeline placement, and related structures. This loss represents an adverse impact that cannot be avoided. The severity would be moderate to minor in the area of the right-of-way, material sites, and facilities, and of short- or long-term duration, depending on the vegetation communities traversed and the success of postconstruction rehabilitation. Natural revegetation would mitigate impacts to some extent, and the amount of area directly disturbed during the operation phase would decrease to an estimated 8,119 acres.

Disruption and alteration of local drainage patterns during both construction and operation would cause moderate (long-term) to minor (short-term) impacts through upslope flooding, downslope drying, and subsequent mortaility of some vegetation as well as changes in species composition; for some wetlands, these impacts could be major to moderate.

A variety of other impacts would occur from the use of winter roads and workpads, accidental spills and fires, dust fallout, revegetation and right-of-way maintenance, emergency repairs, effluents, and emissions, but those impacts would primarily be minor to negligible in severity. In some cases, however, the impacts of spills, fires, and dust fallout could cause moderate (long-term) local changes in species composition. There would be some positive impacts due to clearing of mature timber, fire, and natural revegetation by shrubs such as willows. In many areas of the southern part of the route, this would improve moose forage.

4.2.13 Wildlife

4.2.13.1 Introduction

In general the range and magnitude of specific impacts would be proportional to the diversity of wildlife habitats traversed by the proposed route. Because the TAGS route would parallel the TAPS and routes approved ANGTS and involve a similar level of construction effort and associated effects, adverse impacts on wildlife due to habitat loss and human activity would be expected. Note, however, that the proposed buried pipeline would avoid a major impact issue that resulted from elevating much of the TAPS pipeline, namely, the need for special large-mammal crossing structures during the operational phase of that project.

Based on the knowledge gained from developments in Alaska and Canada, including TAPS, the predicted impacts of the proposed project on wildlife can be grouped into six interrelated categories:

- Direct mortality from collisions with vehicles and facilities, shooting (hunting and destruction of nuisance animals), and stress (exhaustion) from deliberate harassment;

- Passive or active disturbance caused by human activities, especially during critical periods or seasons (calving, denning, nesting, breeding, winter);

- Indirect loss of habitat through displacement of animals or disruption of movements and migrations;

- Direct habitat loss through physical alteration;

- Attraction to artificial food sources; and

- Contact with, and contamination of food by pollutants, especially fuel and oil spills.

These impacts would occur during both the construction and operation phases of the proposed project. However, for all categories, the magnitude of impacts would be greater during construction than during operation due to the much higher levels of human activity and the amount of area disturbed during the former phase.

More detailed discussions of these impacts are presented by Calef (1974), Jacobson (1974), Kucera (1974), Klein and Hemming (1977), Klein (1979), Douglass et al. (1980), Bliss and Klein (1981), and Hanley et al. (1981) and are hereby incorporated by reference. The following discussions focus specifically on the predicted impacts on the more large mammals and bird species during both the construction and operational phases of the proposed project. Table 3.2.13-1 presents a list of specific areas considered to be sensitive for these species.

4.2.13.2 Large Mammals

4.2.13.2.1 Caribou

The proposed TAGS route would traverse the ranges and affect several different caribou herds in various ways, depending on the season and geographic area. The greatest impacts would be experienced by caribou of the Central Arctic Herd (CAH), whose year-round range is transected by the route. Next most affected would be the Nelchina Herd, whose winter range would be crossed by the route. The Nelchina migrates across the proposed route in both spring and fall. Minor-to-negligible effects would be experienced by caribou from the Western Arctic, Porcupine, Steese-Fortymile, Delta, and Mentasta herds. The proposed route crosses or contacts only small portions of their winter ranges.

Direct mortality of caribou during both the construction and operation phases would occur primarily from increased pressure by hunters, both legal and illegal. Construction of the Dalton Highway opened a large area of previously inaccessible caribou range to road access. Despite regulations governing highway access and use of off-road vehicles and closing areas along the TAPS corridor to shooting, hunting mortality has increased in recent years on CAH caribou (K. Whitten, ADFG, pers. comm., 1986). Legal bow hunting along portions of the Dalton Highway on the coastal plain contributes to this mortality. Hunting pressure has the potential to cause a major decrease in caribou numbers.

To the extent that the proposed TAGS project would bring more humans into contact with caribou in remote areas, any mortality would contribute to impacts on that herd. Increased traffic levels associated with the project would add to mortality from collisions with vehicles, although overall effect would be minor. Intentional harassment of caribou, especially by aircraft, could cause mortality through exhaustion or abortion of fetuses, particularly in late winter when energy reserves are low. Preventive and mitigative measures for these impacts include the prohibition of hunting by project workers, controlled access to project roads and facilities, aircraft altitude restrictions, and worker education programs dealing with the effects of disturbance.

Disturbance resulting from normal construction and operation activities would have moderate to minor impacts. Caribou cows are very sensitive to disturbance during the calving season, and localized avoidance of development activities has been documented (Shideler 1986). The only calving grounds traversed by the proposed route are those of the CAH, and some caribou would be displaced by project activities during the calving season. This impact would be minor because few cows calve in the vicinity of the route. The sensitivity of caribou to human disturbance decreases during the summer when harassment by insects causes movements to insect-relief habitat along the coast. Some contact and disturbance would occur during that season, although it would not be extensive.

An issue that has received much attention is the disproportionately low representation of CAH cows and calves in the vicinity of the TAPS corridor. This phenomenon is generally considered to be an avoidance response to human activity along the corridor, although different habitat preferences have also been mentioned as a possible reason (Shideler 1986). This impact would be moderate in terms of the overall TAGS project and would be most noticeable during construction. Normal activities associated with operation of the pipeline would likely have a negligible impact with the exception of surveillance helicopters and traffic on the Dalton Highway. Noise from Compressor Stations 1, 2, and 9 would cause minor local impacts through avoidance of the immediate vicinities of the stations although habituation would be expected to diminish the impacts over the long term.

The temporary disruption of migrations and local movements during the construction phase, resulting from high levels of human activity and the presence of the open pipeline ditch and associated material stockpiles, would have minor to moderate impacts on portions of the CAH and the Nelchina Herd. Groups attempting to cross the route would be deflected by the open ditch and would parallel the route until they could cross or turn back. Such disruption would be greater for the Nelchina Herd because the primary migratory routes have an east-west orientation rather than north-south, as for the CAH. The impact would be neglibile. Increased traffic levels on roads would also delay or deflect movements. The results of these impacts include indirect habitat loss through restriction of access and increased energy expenditure caused by detouring from chosen travel routes. Such impacts could be reduced through careful scheduling of construction activities and traffic and restriction of the length of open ditch and time the ditch is open in specific construction segments. The underground mode of the pipeline and the much lower levels of activity during the operational phase of the project would reduce these impacts to minor or negligible levels.

Direct loss of habitat from the placement of project facilities, borrow pits, and accidental oil spills would occur, causing slight reductions in the amount of forage available. Through revegetation, however, some additional forage plants would become available. In any event the overall impact would be minor or negligible due to the relatively small area affected.

4.2.13.2.2 Moose

As with caribou, increased access by humans would result in increased direct mortality of moose through legal hunting, poaching, and collisions with vehicles during both the construction and the operational phases. The tendency of moose to concentrate in riparian and shrub habitats along transportation corridors would make them more susceptible to these mortality factors during winter.

Disturbance by activities in or near concentration areas would cause some avoidance by moose, potentially displacing them from preferred habitats. Generally, however, moose tend to tolerate human activities better than caribou, and such impacts would likely be local, short-term changes during the construction phase of the project. Avoidance of the immediate vicinity of compressor stations would probably occur during the operational phase. Local displacement from calving habitats (see Table 3.2.13-1) by disturbance would probably occur in some areas, although moose are generally more dispersed at that season than in winter. Disturbance of aggregations in the fall would have the potential to disrupt breeding behavior.

The presence of the open ditch and high levels of construction activity would temporarily interfere with the local movements of moose. Of more consequence would be the disruption of migratory movements undertaken by some moose between summer and winter ranges (Van Ballenberghe 1977, Douglass et al. 1980). The magnitude of these movements varies greatly among individuals. Distances between seasonal ranges may be as little as a few miles or may exceed 50 miles, depending on snow levels (Van Ballenberghe 1977). Thus, the energetic costs of deflection would be proportionately greater in a year with deep snow. Disruption of migratory movements would not be likely to occur during pipeline operation.

Direct habitat loss would potentially constitute a major impact on moose at their northern range limit on the North Slope, where suitable winter habitat is restricted to riparian willow flats. The development of material sites during TAPS construction caused major impacts on arctic riparian habitats (Klein 1979, Pamplin 1979), and such activities during TAGS construction could cause adverse impacts on moose. A review of the TAGS experience by Burger and Swenson (1977), Pamplin (1979), and WCC (1980) resulted in the preparation of guidelines which could reduce gravel-mining impacts. Moose browse would be increased in forested areas in which habitat alteration resulted in early successional stages of vegetation (shrub habitats).

4.2.13.2.3 Dall Sheep and Mountain Goats

The potential impacts of the proposed project on Dall sheep and mountain goats are considered together because of similarities in habitat use and behavior. As described earlier, Dall sheep occur in all of the mountain ranges crossed by the proposed route, whereas mountain goats occur near the route only in the Chugach Mountains.

Due to the rugged nature of the terrain inhabited by sheep and goats, impacts from direct mortality and habitat loss would likely be negligible, although a few sheep have been killed by vehicles in the Atigun Valley. Primary impacts would involve disturbance of, and increased energy expenditure (due to stress) by, animals near the route during construction. Sheep are sensitive to disturbance from aircraft, construction activities (especially blasting), and simulated compressor-station noise (Kucera 1974, Douglass et al. 1980). They are particularly susceptible to such disturbances when at mineral licks, lambing cliffs, and winter habitats. Temporary displacement of sheep from areas within a mile of noise sources such as construction equipment, generators, and simulated gas compressors has been documented (Kucera 1974).

Although little is known regarding the reactions of mountain goats to development activities, they likely respond in ways similar to Dall sheep. Thus, moderate to minor construction-related impacts would be expected in areas where the proposed route closely approaches sheep and goat habitat, such as along the Atigun, Dietrich, Delta, Little Tonsina, Tiekel, Tsina, and Lowe river valleys. Some of these impacts could be reduced through restriction of aircraft traffic to specific corridors and altitudes and through implementation of noise-attenuation measures. Although no preconstruction data are available for the TAPS project, no habitat displacement has been documented; such an impact by the TAGS project would thus be negligible. It is probable that some degree of habituation to continuous noise from Compressor Stations 3, 8, and 10 would occur during pipeline operation.

In mountain valleys crossed by sheep and goats traveling to and from mineral licks and between seasonal ranges, temporary disruption and deflection of movements during construction would constitute a minor impact. Attraction of sheep to some revegetated areas has occurred during TAPS operation and would be likely during TAGS operation.

4.2.13.2.4 Bison and Musk Ox

The bison and musk ox populations along the proposed route consist of small groups that have become established in several localized areas as a result of transplants from elsewhere. The proposed TAGS route would transect the range used by bison in the Delta area and would contact the western extremities of the ranges of musk oxen on the arctic coastal plain and of bison in the Chitina and Copper River areas.

The Delta bison herd would experience several types of impacts from the proposed project. Direct mortality from highway traffic has been documented at existing levels of traffic and would increase as pipeline activities increased during construction (Douglass et al. 1980), although the impact would likely be minor. The TAGS project would cause the direct loss of very little habitat used by bison, which during winter includes agricultural fields in the Delta Junction area. The principal impacts of the project would result from increased disturbance levels, primarily by aircraft, and from temporary disruption of migratory movements during pipeline construction. These impacts would be minor to negligible. Bison cross the route while traveling between winter range near Delta Junction and calving and summer ranges along the Delta River floodplain. The proposed project probably would have no impact on the Copper River and Chitina bison herds.

Musk oxen on the coastal plain are distributed mostly to the east of the proposed route, but the population is expanding in numbers and in the size of the range used. Small numbers of musk oxen would probably encounter proposed project facilities during the life of the project. The short-term impacts during construction would be minor to negligible, consisting of some disturbance by aircraft and increased traffic on the Dalton Highway and possibly deflection of dispersal movements if any animals attempted to cross the route. Operational impacts would be negligible, consisting primarily of overflights by surveillance aircraft.

4.2.13.2.5 Carnivores

The projected impacts of the TAGS project would be similar among the species of carnivores considered in this section: brown bear, black bear, wolf, red fox, and Arctic fox.

Based on experience from the TAPS project, attraction of carnivores to areas of human activity would be a major impact during both phases of the proposed project (Klein and Hemming 1977, Douglass et al. 1980). This attraction stems from the presence of artificial food sources at project facilities, including feeding by project personnel, improper food storage, and inadequate disposal of garbage (Milke 1977, Follmann et al. 1980). Such artifical feeding disrupts natural foraging behavior. For instance, some bears might delay entry into winter dens. More importantly, the animals would become habituated to humans, and direct mortality would increase. Habituated bears may cause extensive property damage and pose serious threats to the safety of project personnel, resulting in conflicts that end in the destruction of "nuisance" animals. Habituated foxes and wolves would be easy targets for poachers and would also increase the risks of disease transmission to other animals and to humans, most notably through rabies and hydatid disease. Habituated animals seeking food along roads would also be much more likely to be killed by vehicles.

Additional impacts would result from construction-related disturbance and destruction of natal den sites of wolves and foxes and of winter den sites of bears although the numbers are expected to be very low in the project areas. Bears are sensitive to disturbance by aircraft and ground vehicles. Wolves and foxes are very sensitive to disturbance during the denning season and will move pups away from sites that have been disturbed, increasing the risk of pup mortality (Stephenson 1974, Chapman 1977). Bears driven from winter dens by disturbance would be susceptible to starvation. Den sites can only be excavated in well-drained soils with adequate active layers, which restricts the amount of denning habitat available. The direct loss of a small number of established den sites and of potential denning habitat would constitute a minor to negligible impact of the overall project.

4.2.13.3 Birds

4.2.13.3.1 Raptors

Disturbance associated with human activity and noise would be the most likely impact on nesting raptors near the proposed TAGS corridor (Roseneau et al. 1981). The degree of impact, however, would vary dramatically with species and individual behavior, stage of nesting, degree of nest seclusion, age of the birds, and prey abundance. Types of disturbance would include fixed-wing aircraft and helicopters, explosions, machinery and vehicle activity, and pedestrians. Disturbance could cause adults to abandon nests; interrupt incubation, brooding, or other important activities (e.g., hunting, feeding); injure nestlings during sudden departures; cause premature fledging; and attract predators to the nests (Fyfe and Olendorff 1976, Roseneau et al. 1981).

Many raptors are considered sensitive to aircraft disturbance during nesting. Substantive behavioral studies that might lend support to actual impacts, however, are limited. Windsor (1977) and Platt (1977) showed that peregrines and gyrfalcons visibly reacted less to aircraft at higher altitudes (more than 1,000 feet) than at lower ones. No significant difference in reproductive success for either species was recorded between disturbed and undisturbed pairs. Use of aircraft during raptor nesting surveys, which might be considered severe disturbances due to close approaches to nests, has not revealed more than short-term changes in the behavior of nesting birds (Roseneau et al. 1981). Conservative flight zoning and restrictions to reduce disturbance during the arrival, incubation, and nestling stages of raptors would lessen the impacts of aircraft-related disturbance to minor-to-negligible levels.

Disturbance from human activities on the ground near nests would cause moderate impacts on nesting raptors, including abandoment of some nest sites (Roseneau et al. 1981). In general, most raptors are more tolerant of activities: (1) below their nests than above; (2) during the nestling period than during incubation and courtship; (3) at higher, more secluded nest sites than at lower, accessible sites; and (4) where stimuli do not appear harmful (for instance, distant, tangential road traffic vs. visits to the nest). TAGS construction activities would include ground survey crews, machinery, and human activity near workpads and compressor stations. In addition, minor impacts would occur if off-duty field workers inadvertently disturbed nesting birds. Restricting human access in some areas, educating personnel regarding disturbance impacts on raptors, and locating facilities outside of prime raptor habitats would reduce impacts to acceptable levels as identified by the Eagle Protection Act and the Peregrine Falcon Recovery Plan.

Other types of disturbance to raptors associated with TAGS would include construction-related blasting. Although some species have shown adaptability to loud noise, scheduling of blasting activities should consider the breeding season and nesting territories to reduce impacts during these sensitive periods.

TAPS Compressor Station No. 1 is located within the 2-mile radius of existing peregrine falcon nests. Even though it is located on the opposite side of the Dalton Highway from the nests, and the noise levels would be at ambient between 5,000 to 7,000 feet from the station, it is not sited in compliance with accepted requirements.

Direct mortality of raptors should be of negligible to minor significance. Because of their perching, scavenging, and hunting behaviors, raptors would inadvertently collide with vehicles and stationary objects such as guy wires and poles. Furthermore, they may collide with aircraft inadvertently or as a result of their attacking aircraft--a reaction occasionally exhibited by individual raptors (Nelson 1979).

Intentional destructive acts such as illegal shooting and nest destruction are possible. Such behavior during TAPS construction was minimal, however, and should not be a major concern (Roseneau et al. 1981). Restricting access and firearms and educating personnel would reduce this potential.

Other impacts on raptors would include changes in numbers, composition, or availability of prey, habitat alteration and loss, increased populations of competitors (e.g., ravens), and the presence of environmental contaminants. Based on experience gained from TAPS, the potential for more than minor impacts from these causes is limited. Furthermore, no demonstrable negative impacts to raptor populations were attributable to TAPS activity (White et al. 1977).

4.2.13.3.2 Waterfowl

Moderate impacts on waterfowl could result from TAGS development in some areas (see Table 3.2.13-1). The most obvious impact would be the construction disturbance of nesting, feeding, or staging habitats as a result of pipeline and facility siting. Specific components of the construction phase that could modify habitat include right-of-way clearing, gravel road and pad placement, and pipeline ditching. Impairment of surface drainge will be avoided since this could cause thermal surface erosion. However, some surface drainage problems may occur. Impairment of water drainage, thereby creating impoundments on the high side and reducing flow to the low side, would effectively alter existing habitats. Brink (1978) described this phenomenon as a major impact on nesting birds along the TAPS corridor. The severity of flooding and draining would be greatest in permafrost terrain (Hanley et al. 1981). On the other hand, impoundments are used during spring migration, at least until other habitats become snow free. In addition, earlier snowmelt and emergence of vegetation in the "dust shadows" of some roads and facilities associated with TAGS would induce waterfowl use of some habitats for a limited period in spring. This habitat selection occurs presently along the Dalton Highway, primarily north of the Brooks Range and is apparent in the Prudhoe Bay area (Murphy et al. 1986).

Indirect loss of habitat by disturbing waterfowl and effectively limiting the use of other habitats is also possible during TAGS construction and operation. Aircraft disturbance of staging waterfowl, especially geese, has been shown to cause short-term changes in behavior and distribution. The actual physiological consequences of these disturbances have not been determined, but frequent disruptions during staging could potentially result in increased mortality during migration. Traffic and human activity associated with TAGS access roads and facilities would also influence waterfowl behavior and the use of wetland habitats.

Incidents involving land and water pollution would undoubtedly accompany TAGS construction and operation. Potential pollutants include small amounts of spilled fuel, domestic solid and liquid wastes, and some hazardous chemicals associated with pipeline construction (Hanley et al. 1981). The degree and longevity of these impacts would be increased if the contaminants entered aquatic environments. Waterfowl would be the most vulnerable to these contaminants, and spilled fuel would have adverse effects on the insulative qualities of their plumage (FPC 1976b). The degree of vulnerability would depend on the breeding stage, stage of molt, food habits, and behavior of the species present (Albers 1977).

Direct mortality due to increased hunting, illegal shooting, and intentionally destructive acts would likely be minor to negligible. Mortality due to collisions with vehicles and permanent structures such as buildings, fences, and towers would generally be minor. However, the severity of these impacts would increase if structures were located within or near major migration routes (FPC 1976b). In addition, losses due to collisions might be greater in areas where foggy weather predominates, as on the coastal plain and the Prince William Sound region. Such effects would be negligible.

Finally, an indirect effect of TAGS would be increased numbers of predators of waterfowl (foxes, gulls, ravens), especially near camps.

4.2.13.3.3 Other Birds

A variety of other bird species would be influenced by TAGS construction and operation. Other waterbirds, especially loons, shorebirds, and gulls, would be affected by a set of potential impacts similar to those described for waterfowl. Chief among these would be displacement by disturbance and direct habitat loss and alteration.

Tundra-nesting bird densities could be reduced locally not only by direct habitat loss, but also by indirect loss through a "road effect," extending laterally several times the actual width of the road (Hanley et al. 1981). This road effect on birds would be caused by the combined impacts of noise, activity, dust, and persistent water or snow. The same effect could also occur near workpads and permanent camps.

Sandhill cranes migrate in spring and fall in the tens of thousands across the TAGS corridor in the Delta Junction area. Some direct mortality due to collisions with aircraft, towers, wires, and facilities would be possible, but these impacts would be negligible to minor. Disturbance by some TAGS activities, such as air traffic, could affect movements and distribution of cranes. The timing of crane migrations is very restricted, and appropriate scheduling of pipeline activities could reduce potential impacts.

Ptarmigan and grouse are particularly vulnerable to collisions with vehicles, and direct mortality would increase with increased traffic. Improved access and increased human presence would cause greater hunting pressure on these species.

Raven and gull populations could rise locally due to the introduction of artificial food sources, thereby increasing their predation on other birds nesting nearby since they are effective predators and nest robbers. Careful disposal of camp wastes and control of artificial feeding would reduce this impact.

4.2.13.4 Summary

The impacts of the proposed project on large mammals and birds are broadly divisible into several categories. Direct loss of habitats would occur during construction and the operational phase, although rehabilitation and artificial and natural revegetation would restore some habitat values by providing early successional plants for ungulate forage. The impacts of direct habitat loss would be minor to negligible overall.

Of more consequence are those impacts that result in direct mortality or energetic stress to wildlife or in additional loss of habitat indirectly, through avoidance and displacement. Direct mortality due to collisions with vehicles and structures, increased poaching, more legal hunting, destruction of "nuisance" animals (bears and foxes), and stress/exhaustion from deliberate harassment would occur to some extent during the life of the project. Proposed mitigative measures would reduce direct mortality to minor or negligible. Vehicle collisions would probably result in moderate impacts during construction.

Disturbance by humans could increase energetic stress on wildlife populations, especially during critical life-history periods or seasons. Such disturbance would be greatest during construction but would be mitigated by careful scheduling of activities. The overall impacts from disturbance would be moderate to minor. Reduced human activity and habituation by wildlife would reduce indirect impacts to minor or negligible during project operation.

Attraction of carnivores to artificial food sources would cause moderate impacts during construction, leading to direct mortality of some animals. These impacts typically occur despite preventive measures but would be reduced to minor or negligible levels during operation. Minor to negligible impacts would occur throughout the life of the project.

4.2.14 Threatened or Endangered Species

4.2.14.1 Introduction

Threatened and endangered species are of paramount importance in considering the impacts of an 800-mile pipeline and associated tidewater and marine transportation facilities. This is especially true when endangered and/or protected species are known to be present very near the route and there is some potential to disturb them. The following subsection also considers plant species threatened and candidate - endangered in both the marine and terrestrial environment. Table 4.2.14-1 lists the threatened, endangered, or protected raptors and whales and the candidate plant species. BLM initiation required consultative procedures with the Fish and Wildlife Service and the National Marine Fisheries Service on January 29, 1987. Those processes are not complete, and therefore evaluations in this section are to be considered as "preliminary-subject to change".

4.2.14.2 Terrestrial Species

The only terrestrial threatened or endangered species of any real concern during construction and operation of the pipeline and its associated facilities would be the peregrine falcon. There are several nesting sites near the proposed route and compressor station location. Each of these areas is specified in Table 4.2.14-1 Of similar importance are the nesting sites of bald eagles. Although neither threatened nor endangered in Alaska, they are endangered in the Lower 48, and their nesting sites are protected by federal law.

Types of impacts which might affect raptors would include blasting, rock crushing, vehicle traffic, aircraft noise, oil spills, and collision at high structures such as towers and buildings. Impacts would include but not be limited to the possibility of ingesting oil soaked prey, premature flight by fledglings, abandoning or deserting their nests or nesting areas. Other possible consequences would involve collisions with vehicles and aircraft and project structures and reduced use of

Table 4.2.14-1 Sensitive Areas for Peregrine Falcons and Bald Eagles

Species	Area	Sensitive Period
Peregrine Falcon	Franklin Bluffs Area	April through August
Peregrine Falcon	Sagwon Bluffs	April through August
Peregrine Falcon	Slope Mountain	April through August
Golden Eagle and Gyr Falcon	Atigun Valley	April through August
Peregrine Falcon	Yukon River	April through August
Peregrine Falcon	Grapefruit Rocks	April through August
Bald and Golden Eagles	Chatanika River	April through August
Peregrine Falcon	Chena River	April through August
Peregrine Falcon	Salcha River	April through August
Peregrine Falcon	Delta/Tanana River Junction	April through August
Bald and Golden Eagles	Delta/Tanana River Junction	October through April
Bald and Golden Eagles	Little Tonsina River	April through August
Bald and Golden Eagles	Tiekel River	April through August
Golden Eagle	Tsina River	April through August
Bald Eagle	Lowe River	April through August
Bald Eagle	Abercrombie Gulch	April through August
Bald Eagle	Anderson Bay	April through August

traditional breeding or feeding habitat during construction. In at lease one instance peregrine falcon nesting areas have been successfully reestablished in close proximity to the TAPS Pump Station 2. That existing facility has activity and noise characteristics similar to those expected of a TAGS compressor station.

Impacts on nesting or breeding sites of these raptors would be prevented to the extent possible by a combination of careful route selection, winter construction in these sensitive areas, proper environmental education of construction workers, preparation of adequate responses to stipulations, and agency monitoring during project construction and operation. Impacts on these sensitive species are expected to be moderate to minor in most instances.

The project would NOT COMPLETELY comply with the requirements of the Eagle Protection Act and the Peregrine Falcon Recovery Plan.

4.2.14.3 Marine Species

There are several endangered whale species in the Beaufort Sea and northern Prince William Sound (see Table 4.2.14-1). These cetaceans could be affected by collisions with project-related ship traffic, noise from ships or marine construction activities, or by oil spills from project related accidental spills . All of these impacts are preventable to a large degree and even under the worst scenario would not be detrimental to the population. Noise from tankers, blasting or pile-driving might cause increased but temporary avoidance of the area. Overall, impacts to endangered whales are expected to be minor.

4.2.14.4 Summary

The proposed route and LNG plant facility site are, in some cases, quite near peregrine falcon or bald eagle nesting areas. Also, the marine transportation routes pass through areas with endangered whale species. In both the terrestrial and marine environments, similar facilities and transportation routes already exist in these areas with no signficant impacts noted. By using proposed mitigation and timing and compliance TO THE EXTENT POSSIBLE with the conditions established in the Eagle Protection Act and the Peregrine Falcon Recovery Plan by the USFW, the impacts to these species would be expected to be moderate during construction and minor during operation.

4.2.15 Recreation, Aesthetics, and Wilderness

4.2.15.1 Introduction

As with many other aspects of the project, there would be both positive and negative impacts pertaining to recreation and aesthetics. Generally, the negative impacts would emanate from construction noise, dust, and visual scars on otherwise undisturbed and natural areas. Positive impacts would be derived from the additional recreation access points created by the project and greater number of people who would be able to see the areas where construction would take place.

The pipeline route would extend from Prudhoe Bay to Valdez through an existing utility corridor for most of its length. Recreational use along the road associated with this route from Livengood south to the Valdez area is heavy and would be impacted primarily during construction by competing uses between tourists and construction workers,since most recreation facilities are highway oriented and ground access is limited. From Fairbanks to the Chandalar Shelf area, recreation use has been increasing rapidly because a major portion of the Dalton Highway is now open to public traffic.

4.2.15.2 Recreation

The area from Chandalar Shelf north to Prudhoe Bay at present has only light recreation use consisting mainly of fly-in hunting and fishing. Several hunting guides operate from airstrips near the TAPS, especially the Galbraith Lake and Sagwon airstrips. Due to an increasingly relaxed permit procedures, recreational use is expected to continue to increase along the Dalton Highway. A concession to drive tourists one way down the haul road from Prudhoe Bay to Fairbanks was recently issued for the summer of 1987. Recreation use along this scenic route would be expected to increase due to the number of construction workers. Impacts would be expected to be minor.

The proposed gas pipeline route runs parallel to, or a few miles away from, a highway system along its entire route. Lateral access roads from the existing highway to the proposed route would, if open to the public, very likely be used by recreationists. This access would extend the area and amount of use that already exists and could significantly increase the recreational opportunities.

Examples of potential openings of new access to pristine areas would include: Galbraith Lake, Summit Lake, and Grayling Lake. Impacts would be moderate on these areas. The Galbraith Lake and the Sukakpak Mountain areas are well-known entrance points to the nearby Brooks Range wilderness parks, including Gates of the Arctic and the Arctic National Wildlife Refuge.

During construction, there would be moderate recreational use of areas along the pipeline by construction workers. Desirable recreation for travelers and vacationers on highways along the route might be temporarily altered during the construction period. Most of the recreational activity occurs in the late spring, summer, and early fall months. However, there would be significantly increased use by construction workers and others in the winter months where roads are kept open and maintained.

Recreation use includes hunting, fishing, boating, hiking, mountain climbing, cross-country skiing, snowmobiling, sightseeing, photography, and similar activities. Unless steps are taken to provide adequate recreation facilities, campgrounds, picnic areas, overlooks, boat access sites, trail leads, parking areas, turnouts, and rest stops, damage to the vegetation and trash from uncontrolled recreation use and a general degradation of recreation and aesthetics would result.

Facilities such as communications towers, buildings at compressor sites, block valves, and the LNG site, would be visible from the air and highway for great distances in some cases. At times, the linear pipeline berm would also be visible to those hiking in the nearby mountains. Lights on communications towers and at compressor stations would be visible over long distances, especially at night. Impacts would be minor to moderate along the corridor.

Boaters on and hikers near rivers might be disturbed by construction noise or by visual obstructions such as elevated crossings. In the Salcha River the recreational experience should not be affected except where the right-of-way traverses the river creating a visual scar.

Artificial odors from engine exhaust, fuel areas and camps would be evident near recreational areas during construction.

Wildlife populations near the corridor would be temporarily affected by the construction of the proposed project and possibly by increased pressure from hunting and harassment by workers. If the present restrictions on shooting within 5 miles of the haul road and use of access roads associated with the TAPS facility, the total numbers of wildlife available near the pipeline and the recreational viewing potential of the area would not be decreased.

Unregulated use by all-terrain vehicles, trail bikes, snowmobiles and other off-road vehicles could have a significant adverse impact on recreation and aesthetics by permanently scarring the landscape, damaging the vegetation, compacting the soil, causing erosion, and harassing the wildlife. These activities would probably be restricted as they are along the TAPS access roads at the present time. Therefore, the impacts would be minor.

A discussion of these 4(f) lands has been grouped with other special areas associated with the proposed TAGS project in Subsection 4.2.19.

Project related increased recreational use assumes that gas pipeline construction and operation would increase potential for recreational users of the area because more people would become aware of the recreational possiblities of the area through publicity and personal association with employees. Increased use would inevitably bring increased control; thus, present recreationists might experience such things as reservation systems, reduced options for types of experiences, and restrictions on places they may go and their length of stay. An example would be the January 1987 REDUCTION OF CATCH LIMIT ~~closure~~ of Summit and Paxson lakes to burbot and lake trout fishing due to the large number of ice fishermen AND RESULTANT FISHING PRESSURE. These impacts to present uses would be moderate but long lasting.

4.2.15.3 Aesthetics

Aesthetics is a value judgement; everyone looks at it differently. One beneficial aspect due to the project would be an increased availability of a beautiful area to more people.

A more direct impact of construction on recreation resource would be the visual scars resulting from buried pipeline construction and the visual impacts of aerial stream crossings. In all cases this gas pipeline would be at least a third utility and perhaps a fourth to be located in the corridor area; consequently it would not be the same as building a new pipeline across an undisturbed area.

Nearly all the proposed right-of-way south of the Brooks Range would require the clearing of brush and forest cover. This would significantly alter the natural environment and in these areas would degrade the aesthetic value of the corridor, particularly where long straight clearings are visible from the road or the air. These impacts would be moderate during construction and minor during operation.

Recreationists within several miles of the line would have their experiences affected by increased noise levels from construction and operation activities. When the route passes within a mile or so of presently used recreational areas, the impacts would typically be negative, especially during construction. Noise, traffic, additional dust, and the scars from clearing and ditching would decrease the ~~recreational~~ experience, sometimes to & AN AESTHETIC considerable degree. The noise from low-flying fixed and rotary-wing aircraft along the corridor would also be a recreational negative. Impacts to the corridor vicinity during construction would be moderate and negligible thereafter.

Many of the aesthetic impacts have already been discussed under recreation. The major impact to many people would be the viewshed as seen from the air, during hiking, driving on the main roads, and boating on rivers. Visual disturbances include the long straight clearing along existing rights-of-way, new compressor stations, special elevated stream crossings, and any new borrow areas.

For those people whose appreciation of aesthetic qualities are related to beauty, sensations, or to the congruity of the environmental features, the proposed project would have a major adverse effect on the resource. Likewise, long tangents may add attraction to otherwise repetitive, though natural views.

4.2.15.4. Wilderness

THE AREA ALONG THE CORRIDOR IS ALL PRESENTLY DEVELOPED TO SOME EXTENT AND IS NOT A WILDERNESS. HOWEVER, THERE IS WILDERNESS ON BOTH SIDES OF THE CORRIDOR IN SOME STRETCHES

The preferred TAGS routing involves two small areas where existing wilderness studies and recommendations to Congress have not been completed. Until BLM makes its recommendations on wilderness to Congress and Congress takes specific action, the preferred TAGS route will not be approved. An acceptable route option exists and therefore the effect on wilderness value is negligible.

4.2.15.5 Special Areas

Several areas along this section are designated as existing or potential 4(f) lands or lands dedicated by the state for parks or other public purposes). Should the proposed route pass within 1/2 mile of such lands, they are subject to special considerations and permitting by the federal DOT and the U.S. Coast Guard.

There would be no impacts to the Gulkana and Delta Wild and Scenic River areas since the route would not cross the designated portions of these rivers. Units of the National Park or Refuge Systems authorized by ANILCA are not involved. The portion of the LNG terminal buffer area within the Chugach National Forest is classified as a general multiple use forest area.

4.2.15.6 Valdez Area

In the Valdez area, most recreation is centered around fishing, sightseeing by car, boat and by foot, and some hunting. These recreational pursuits would be stressed considerably during construction due to the large influx of people to an area with limited accessibility. The aesthetic experience of fishing for anadromous species such as salmon would be impacted, but there are other factors which affect these activities more than crowded stream access points.

Hiking opportunities should be increased AFTER CONSTRUCTION, especially in such areas as Keystone Canyon where accessability to trailheads would be somewhat improved. The locally popular Goat Trail and Riddleston Falls would be affected only during the construction period. Aesthetics of this region would be only moderately AFFECTED once construction was completed since the pipeline would be buried within the roadway.

The Copper River Railroad Historic Area would not be disturbed but would be less accessible during construction. Some present forest uses such as fishing, overnight stays, and access to the Chugach National Forest across the buffer zone would be foreclosed by construction of the LNG plant in Anderson Bay. These impacts would be moderate.

4.2.15.7 Summary

The impacts to recreation and aesthetics would be widespread due to the length of the area disturbed, but the band of disturbance would be quite narrow.

Primary disturbance would occur during construction and would involve impacts to present uses and users of the area, especially by tourists, ~~and~~ sight-seers, and wilderness enthusiasts. Impacts to aesthetics would be more long-lasting. The visual impacts would include long stretches of linear clearing of vegetation, many new borrow sites where vegetation has been removed, and the linear scar from the berm over the pipeline.

There would be negligible impact on wilderness value.

4.2.16 Cultural Resources Sites

4.2.16.1 Introduction

Adverse impacts to cultural resource sites as a consequence of a large-scale project such as TAGS would be either primary or secondary in nature. Primary or direct adverse impacts would be those resulting from activities directly associated with the construction and operation of the proposed gas line. Beginning with the Federal Antiquities Act of 1906, a suite of federal and state laws has been enacted to protect significant cultural resources sites (and paleontological sites as well).

Any ~~such~~ activity that causes the nonscientific alternation of a cultural resource site, ranging from total destruction to only slight damage can substantially diminish the potential value of the site to contribute to understanding of the human past. Secondary or indirect impacts, which also can result in the loss of significant data, include alteration of the local site environment (topography, ground cover, etc.) in such a way as to increase the possibility of future erosion, unauthorized artifact collection by individuals associated with the project, and an increase in human utilization of the region because of maintenance activities and generally improved access.

Formal consultation with the State of Alaska Historical Preservation Office (SHPO) under Section 106 of the National Historic Preservation Act was initiated by BLM in February 1987.

4.2.16.2 Potential Primary Impacts

Formal consultation between BLM and the SHPO has been initiated to develop a Memorandum of Agreement to protect cultural resources during the construction of TAGS. Without an appropriate cultural resource site protection plan, the potential for direct adverse impacts on cultural resource sites as a result of TAGS varies dependent upon the location of construction areas:

4.2.16.2.1 Construction Areas Previously Surveyed for TAPS or ANGTS

Presumably, pipeline construction in areas previously surveyed for TAPS or in anticipation of ANGTS holds relatively little potential for causing damage to cultural resource sites because most, if not all, sites in such areas have been identified and evaluated and many have been excavated. Those remaining sites deemed to be significant cultural resources, according to National Register of Historic Places criteria, should be protected by extant federal and state laws. However, it is always possible that some cultural resource sites, particularly those that are deeply buried, may have escaped the notice of earlier investigators, no matter how thorough their survey. Furthermore, while potential danger to sites identified during the TAPS project may have been mitigated by avoidance, it might be necessary because of routing changes or the need for additional borrow material to disturb these sites during construction of TAGS. Any archaeological sites which were partially excavated during the TAPS project because constructed needs dictated that they could not be protected by avoidance, as was the case at numerous material source sites, may be at considerable risk of major impact if TAGS construction proceeds because they are concentrated on material source sites which were previously mined to the perimeter of the archaeological site. Implementation of an appropriate cultural resource protection plan would ensure that potential impacts are minor or negligible.

4.2.16.2.2 Construction Areas Not Previously Surveyed for TAPS or ANGTS

In the absence of an appropriate cultural resource site protection program, the potential exists for major adverse effects during TAGS construction on significant sites in areas not previously surveyed for TAPS or ANGTS during the construction of TAGS is substantial. The earlier surveys have demonstrated the considerable potential for archaeological remains in the unsurveyed portions of the proposed TAPS corridor. Cultural resource sites situated along the actual pipeline, on material sources, and in other areas that would be disturbed by construction may be subject to severe damage or even destruction. Location of such sites and employment of appropriate mitigation measures as part of a cultural resource protection plan would reduce the potential impact.

4.2.16.3 Potential Secondary Impacts

The potential for indirect adverse impacts on cultural resource sites as a result of TAGS construction is potentially major and of special concern because of difficulty in mitigating such effects. Sites within and adjacent to the proposed TAGS corridor will be at risk in terms of secondary impact regardless of whether or not a previous archaeological survey has been conducted in a specific area. The only difference is that without knowledge of the sites in unsurveyed areas it would be impossible to make an estimate in the future of the extent to which secondary impact has diminished the data base.

Many types of secondary impacts are possible. Unauthorized collection of cultural materials by personnel associated with large-scale construction projects, similar artifact removal later in time by others who are associated with the operational aspects of the project, and collecting by individuals who simply have greater access to the region because of improved transportation facilities. Unfortunately, the latter has been common in Alaska. Though control of erosion and other measures designed to provide general environmental protection in construction areas may also protect cultural deposits, the possibility of adverse secondary impact because of such conditions as altered thermal regimes (which may accelerate deterioration of organic materials) still exists. Site disturbance can result from erosion attributable to postconstruction phase activities such as increased use of areas adjacent to the pipeline by off-road vehicles. Maintenance activities long after pipeline construction could also result in loss of archaeological data.

4.2.16.4 Summary

Any disturbance to a cultural resource site, including scientific excavation, holds the potential to cause adverse impact. However, an appropriate cultural resource protection program, such as that now being planned in conjunction with the proposed construction of TAGS, has the capacity to reduce risk to an acceptable minor or negligible level. Furthermore, the execution of such a program has the potential to make major contributions to our knowledge of the past.

4.2.17 Subsistence

4.2.17.1 Introduction

The potential effects of the proposed project on subsistence uses are a function of the impacts on fish and wildlife used for subsistence, access to subsistence resources, and potential interference with or disruption of harvest activities.

Potential direct effects of the proposed project on subsistence uses include the following.

- Reduction in the availability of subsistence resources due to various aspects of project construction and operation
- Interference with or preclusion of access to subsistence resources and harvest methods
- Competition for subsistence resources by project personnel

Potential indirect impacts are adverse effects on communities and individuals from a loss of traditional harvest activities such as loss of traditional supply of foods, an increased outlay of cash for substitute foods, a reduction in time available for subsistence activities due to employment commitments, and sociocultural impacts from reduced participation in the harvest, processing, and distribution of subsistence resources.

Following are some criteria that determine significance of potential effects.

- Relative abundance and distribution of the subsistence resource and harvest activities compared to that affected by the project
- Duration of the impact
- Relative importance to the communities/individuals of the affected resources and uses
- Availability of other sources of affected resources or acceptable replacement resources

4.2.17.2 Impacts to Fish and Wildlife

Construction and operation of the project can affect fish and wildlife resources used for subsistence activities in three ways, resulting in their reduced availability for subsistence harvest. First, mortality could occur from project construction or accidental events such as an oil spill. Fish would be most at risk due to the potential for siltation or fuel spills into a watercourse. Second, fish and wildlife might avoid the project area due to construction activities, or in the case of poorly placed drainage and fish passage structures, be unable to physically migrate through the project area. Animals that can avoid the area during construction activities, such as moose and caribou, are likely to do so. Finally, construction and operation of project-related facilities could result in habitat loss and a reduced level of utilization of the project area by fish and wildlife. Here the level of impact depends on the particular habitat disturbed by pipeline, road, borrow pit, and facility construction. Fish spawning and overwintering areas and loss of riparian vegetation that supports moose populations are among the habitats most sensitive to disruption. The duration of impacts would be generally limited to construction activities on any of the six construction spreads, which would not exceed 2 YEARS ~~34 months~~. Specific activities include clearing the right-of-way workpad construction (4 to 11 months), and pipe ditching and laying (6 to 7 months).

North Slope Borough

The potential for impacts to fish and wildlife resources used for subsistence purposes varies along the TAGS route. In the North Slope Borough, some fish resources would be affected by mortality, obstructions to migration, and loss of critical habitat. ~~primarily along the Sagavanirktok River.~~ However, there are other important areas used by village residents for fishing, and impacts to fish would be minimized through proper design and construction procedures proposed for the TAGS project. Moderate impacts to moose, sheep, and caribou are potentially more significant on a short-term basis. Avoidance of construction areas and induced changes to distribution or migration patterns would cause temporary hardship to individuals who utilize areas along the route for the subsistence harvest of moose and caribou, requiring increased harvest effort elsewhere. Loss of riparian habitat could reduce the availability of moose. Because the area along the TAGS route is not a primary subsistence use area of Kaktovik, Nuiqsut, and Anaktuvuk Pass, impacts to fish and wildlife in this area would be minor and are not significant in terms of subsistence.

Northern Corridor

Along the northern corridor, caribou, moose, and fish would also be sensitive to TAGS-related impacts. Communities close to the TAGS route would be more likely to be affected, such as Nolan/Wiseman and Livengood. Fish and wildlife avoidance would temporarily require a greater level of harvest effort in areas more remote from construction activities. The communities of Allakaket/Alatna, Bettles/Evansville, Rampart, and Stevens Village use many areas other than the TAGS route for subsistence activities and would not be as affected by impact to fish and wildlife.

Fairbanks-Delta Area

The type of impacts in the Fairbanks-Delta Area would be similar to those in the northern corridor, except that this area is not classified as a rural subsistence use area by the State Boards of Fisheries and Game and the participation in subsistence is lower in that area. Since no construction activities occur in the vicinity of personal-use fisheries, impacts would be limited to the unlikely occurrence of a catastrophic fuel spill event.

Glennallen/Copper Center Corridor

Potential impacts in the Glennallen/Copper Center corridor would be moderate and similar to those in the northern corridor, with fish, moose, and caribou being the most sensitive subsistence species. However, there will be no migration impacts to the Nelchina Caribou herd. Because there are no activities in major rivers used for subsistence or personal-use fisheries, impacts to subsistence fisheries would be minimal, except in the unlikely event of a catastrophic fuel spill.

Some avoidance of the construction area by moose and caribou would occur. Communities adjacent to the TAGS route would be affected and include Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities.

Valdez/Tatitlek

Like other areas of the TAGS route, moose and fish in the Valdez area are the subsistence species most sensitive to impact. However, because subsistence hunting and fishing by Valdez residents is minimal, subsistence impacts would not be significant. Valdez is not PRESENTLY classified as rural by the State Board's of Fisheries and Game. Tatitlek relies on marine subsistence species and primary harvest areas are located outside Valdez Arm (City of Valdez 1986). Marine mammals used for subsistence might be sensitive to increased levels of tanker traffic. Other subsistence fish and wildlife species are unlikely to be affected.

Adverse impacts to fish and wildlife used for subsistence purposes could result in some increased effort for adequate subsistence harvest and economic and social impacts. Again, communities adjacent to the TAGS route would be moderately affected.

4.2.17.3 Interference/Access Impacts

TAGS project construction and operation has the potential to interfere with subsistence activities. The primary causes of interference are restriction of access to traditional subsistence use areas and restriction on hunting and fishing in the vicinity of the TAGS project. Construction activities and placement of facilities, roads, and borrow pits throughout the project area would eliminate or restrict some access to areas traditionally used for subsistence activities. In the Glennallen-Copper Center area, access restriction associated with the TAPS pipeline have affected firewood and household log harvesting (R. King, pers. com., 1987). During construction, workpad construction and pipeline ditching and laying activities would last for periods of up to 11 months (although the pipeline ditch would not likely be open for more than 30 days in any given location). Construction camps, access roads, and borrow pits could be operational for the period of construction. The potential for these impacts would be moderate but temporary, and limited to the length of construction activities in a given area.

Regulations regarding hunting and trespassing in the vicinity of the completed TAGS line can also have the effect of restricting subsistence use of traditional sites. Loss of hunting access due to restrictions around oil and gas facilities is a common complaint by North Slope Borough residents (Woodward-Clyde Consultants 1984). Unlike an oil or gas field, the TAGS corridor is a narrow linear feature, and hunting restrictions would be less likely to result in the extensive elimination of subsistence activities in traditional use areas. Any closure of the TAGS right-of-way to public access would also affect access to traditional subsistence use areas. Because the TAGS pipeline would be buried for most of its length, the necessity for hunting and access closures after completion of construction would be minimized, and impacts would be minor.

Communities located adjacent to the TAGS route, such as those in the northern corridor (Nolan/Wiseman and Livengood) and Glennallen/Copper Center area (Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina Communities), are more sensitive to interference impacts than those which are further away or have broad subsistence use areas. Interference with subsistence activities would result in some increased effort for adequate subsistence harvest and economic and social impacts, particularly in communities adjacent to the TAGS route.

4.2.17.4 Increased Sport Hunting, Fishing, and Trapping Competition

Increased levels of sport hunting, fishing, and trapping would be associated with construction and operation of the TAGS project. The project would introduce large numbers of direct and indirect employees into the project area and likely result in improved access into many places with fish and wildlife resources. This work force and its dependents would participate in sport hunting, fishing, and trapping activities. Left unregulated, such participation would compete with subsistence users for fish and wildlife resources and threaten maintaining the populations of fish and wildlife used for subsistence purposes. Sport hunting, fishing, and trapping activities by employees would be concentrated around the locations of construction camps. During TAPS construction many companies participating in construction prohibited employees from sport hunting and fishing while on the project. In addition, a 5-mile corridor on each side of the pipeline was closed to sport hunting and fishing by the State of Alaska. If a similar action is taken by the State Boards of Fisheries and Game, it may be necessary to exempt traditional subsistence users from closures.

Due to the availability of public access to hunting and fishing areas and the subsistence reliance on the area in the immediate vicinity of the TAGS project, the northern corridor (Nolan/Wiseman and Livengood) and Glennallen/Copper Center/Sourdough-Paxson/Gulkana/Upper Tonsina communities would be more vulnerable to increased competition from sport hunting, fishing and trapping than those which are further away or have broad subsistence use areas. Fish (salmon, grayling, burbot, and whitefish), moose, and caribou are important dietary components to communities of these areas and are also popular sport hunting and fishing species. Small and medium-size furbearers are trapped to provide materials for local handicrafts and pelts which are an important source of cash for some families. Increased competition from sport hunting, fishing, and trapping would result in moderate impacts and increased effort for adequate subsistence harvest, and ~~so~~economic and social impacts.

Currently, there are restrictions on hunting with firearms in the 5-mile wide corridor on each side of the Dalton Highway, which also applies to subsistence hunting.

However, because fishing is not restricted and both sport and subsistence hunters will likely go outside the corridor to hunt, competition will remain a likely impact.

The duration of competitive impacts would be limited to the period of construction, although the operational work force could continue to compete with subsistence users on a smaller scale.

4.2.17.5 Impacts From Employment

Even in those Alaska communities oriented towards a traditional subsistence way of life, most residents desire some level of employment. Employment provides cash, which is used to support subsistence activities (i.e., purchase of boats, snowmobiles, supplies) and is often distributed along the same kinship lines used for distribution of subsistence resources. Project employment opportunities are very important to local residents, and wage income would offset loss of subsistence resources to some degree. However, employment also presents some disadvantages to participating in the traditional subsistence way of life (A. Lane, pers. Comm., 1981). Subsistence harvest patterns follow the seasonal availability of resources and they are also flexible to take advantage of unexpected harvest opportunities as they arise. Full-time employment does not provide the flexibility to participate in subsistence activities as they arise, particularly those that cannot be scheduled in advance. In many predominantly Native communities, full-time jobs such as those in school districts and government provide flexibility for subsistence activities (such as subsistence leave or school closures). During construction of the TAPS project, employers often reported that Native employees would request leave or quit to participate in subsistence activities. Likewise, many Native employees felt full-time employment did not provide the flexibility to participate in important subsistence activities. Because the majority of local employment opportunities would be during project construction, minor impacts from employment would generally be temporary.

The communities most sensitive to employment-created subsistence impacts are those that are predominantly Native and which have a social structure and community identity that revolves around participation in subsistence activities. These include the three North Slope communities, Evansville, Allakaket/Alatna, Stevens Village, Rampart, Minto, Copper Center, and Tatitlek. The effects of an employment-induced reduction in subsistence participation are primarily social.

4.2.17.6 Relocation/Increased Harvest Effort

An indirect impact of the TAGS project, resulting from the primary impacts described above, is increased harvest effort required to offset loss of subsistence resources in the vicinity of the project. Any reduction in harvest levels attributable to the project would result in this increased effort to make up the loss taking place in other areas unaffected by the project (relocation). In addition to the time involved with extra travel, increased harvest effort usually requires additional outlays of cash for fuel and supplies.

Communities located adjacent to the TAGS route, such as those in the Northern Corridor (Nolan/Wiseman and Livengood) and Glennallen/Copper Center (Sourdough/Paxson, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities) area, are more sensitive to impacts from relocated or increased effort than those which are further away or have broad subsistence use areas. Because of greatly reduced levels of activity and construction facility closure/rehabilitation after construction, relocation, and increased effort impacts would be moderate during construction but negligible during project operation.

4.2.17.7 Economic Impacts

A second indirect subsistence impact of TAGS construction and operation is adverse economic impact on communities that are oriented towards a subsistence way of life. This impact would be partially offset by any local hire/employment opportunities. Economic impacts result from increased outlays of cash to replace reductions in subsistence harvests and to support increased harvest efforts to make up for reductions in resources. Where a reduction of harvest in traditional use areas occurs, a resulting increase in or relocation of harvest effort may require additional cash outlays for supplies such as food and fuel for boats and snow machines.

Harvest replacement with store-bought foods is often expensive, and cash used for these purposes may be diverted from other needs, such as heating fuel, clothing, and equipment.

In communities where employment opportunities are few, additional cash outlays are a hardship since no ready sources of cash are available. This partially would be offset by local hire employment opportunities provided by the project. Communities with limited employment opportunities and located adjacent to the TAGS route, such as Native communties in the northern corridor and Glennallen/Copper Center area, are more sensitive to competition impacts than those which are further away or have broad subsistence use areas. The level of economic impacts would be moderate during construction activities, which are the major source of fish and wildlife, interference/ access, and relocation/increased effort impacts, but negligible during project operation.

4.2.17.8 Social Impacts

The social impacts from the loss of participation in subsistence activities are complex and include loss of cultural identity and status in the affected community, dietary impacts, and aggravation of social problems such as depression and substance abuse (Woodward-Clyde Consultants 1984). As indicated earlier, the foundation of sociocultural systems of many rural communities is the subsistence utilization of the natural environment and its fish, wildlife, and vegetation resources. A reduction in the ability to participate in subsistence activities would result in community and individual identity loss through being unable to provide and distribute subsistence resources at traditional levels. Subsistence foods are a physically and psychologically important source of nutrition to Alaska Natives. A moderate reduction in such foods and their replacement with a limitied range of store-bought foods can also lead to dietary problems and a loss in sense of well being.

The communities that are most likely to be sensitive to social impacts from reduced subsistence activities are those that are predominantly Native and which have a social structure and personal identity that revolves around participation in subsistence activities. These include the North Slope communities, Evansville, Allakaket/Alatna, Stevens Village, Rampart, Minto, Copper Center, and Tatitlek. Proximity to the TAGS route, severity of harvest opportunity reduction, and limited alternatives for relocation of harvest effort would also aggravate social impacts. Duration of social impacts are likely to be limited to the period of project construction.

4.2.17.9 Summary

The TAGS project would result in several categories of impacts to subsistence uses and activities: impacts to fish and wildlife used for subsistence; interference and access impacts; increased competition from sport hunting, fishing, and trapping; impacts from project employment; relocation of and/or increased harvest effort; economic impacts; and social impacts. With few exceptions, these impacts would be minor to moderate and temporary, limited to construction activities that occur over a 34-month period in any given construction spread. Minor levels OF IMPACT permanent or "life-of-the-project" ~~impacts~~ would result from habitat loss (due to borrow activities and placement of facilities), interference with or restrictions by ADF&G to access to hunting adjacent to the right-of-way, and limited hunting/fishing/trapping competition from the operations work force. These impacts do not constitute a "significant restriction" of subsistence uses or activities. Some temporary impacts, such as fish and wildlife avoidance of the project area, interference with or restrictions to access to hunting on the ROW, hunting/fishing/trapping competition from the construction work force, and associated relocation of and/or increased harvest effort, economic impacts, and social impacts would result in a major but temporary restriction in subsistence uses and activities by communities located adjacent to the TAGS route. Affected communities and resources include the following: Nolan/Wiseman, Livengood, and Minto (hunting for moose and caribou and fishing); and Paxson/Sourdough, Gakona, Copper Center, and Upper Tonsina (hunting for moose and caribou, and fishing).

See Appendix M for an analysis of subsistence findings required by Title VIII of ANILCA.

~~For an analysis of subsistence and findings required by Title VIII, ANILCA, refer to Appendix L.~~

4.2.18 Public Safety

4.2.18.1 Introduction

This discussion describes the risks and consequences of possible upset conditions and hazards associated with the proposed project which could affect public safety. The safety system analysis is based on a review of routing and siting, criteria, design and construction requirements, operations and maintenance requirements, and proposed mitigation. Safety elements that have been incorporated in project design include gas detection, fire detection and protection, high-pressure relief and emergency venting, containment, and control of LNG spills or leaks, shutdown systems, geologic and seismic consideration, noise control, adherence to applicable design codes and regulations, personnel training, and quality assurance/quality control.

4.2.18.2 Pipeline

As discussed in Section 2, the pipeline system was designed to minimum federal safety standards for the transporation of natural gas as prescribed in 49 CFR 192. These regulations outline the minimum requirements for materials, design, fabrication, assembly, construction, operation, inspection, testing, and maintenance of pipelines transporting natural gas. Noncompliance with any of these requirements could result in adverse safety conditions.

The proposed TAGS would be constructed near TAPS and/or the authorized ANGTS at Atigun Pass, Sukapak Mountain, Yukon River, at several pipeline and road crossing locations, and near the TAPS oil terminal in Valdez. Although an acceptable determination of compatibility has been identified (see Appendix A), both public safety and national security concerns could result should a system failure occur at these "pinch points."

Specific designs have been developed by YPC to accommodate the expected seismic areas crossed by the pipeline. Seismic criteria would consider two levels of earthquakes - a design-contingency earthquake and a design-operating earthquake. All elements of the pipeline system, including the compressor stations, would be designed to withstand the loading of a design-operating earthquake in accordance with conventional engineering practices and criteria and remain operational during and after such an event. For a design-contingency earthquake, the pipeline system would be shut down for inspection to determine if any maintenance would be necessary.

The pipeline system would be equipped with an emergency pressure relief system and mainline block valves to handle emergency shutdowns along the system. Such a system would be remotely operated with block valve spacing between 5 and 20 miles and at critical locations such as at meter stations, compressor stations, aerial river crossing, and fault crossings. At these locations, block valves would be located immediately upstream and downstream to provide isolation capability.

Cathodic protection facilities would be installed along the entire pipeline route for external corrosion control to prevent pitting due to chemical reaction between the soil and the carbon steel pipe. If pitting were not controlled, it could reduce the wall thickness of the pipe sufficiently to cause a break.

The security for the pipeline would be provided by both aerial and ground reconnaissance. Frequent overflights would be conducted along the entire length of the pipeline system. All above-ground facilities would be fenced to prevent unauthorized entry. The aerial crossings of the pipeline would be provided with a security area on either bank of the river crossings or at the aboveground fault crossings.

4.2.18.3 Compressor Sites

Each of the proposed TAGS compressor stations would be manned full time for station operations and maintenance. The stations would be equipped with gas detection, fire detection, communications facilities, and utility systems sufficient for stand-alone operations. The TAGS compressor station would be equipped to handle and control emergency situations with emergency shutdown systems to allow for isolation and venting of all station piping and equipment. Station block valves would be provided to isolate the station and pipeline from the mainline gas while allowing flowing gas to bypass the stations. Since each of the 10 compressor stations is located in remote areas, no adverse impacts to public safety should result from operations.

4.2.18.4 LNG Safety

4.2.18.4.1 LNG Safety Regulations

The Federal Energy Regulatory Commission (FERC) staff have evaluated the risk of similar facilities for many LNG projects, including studies of Gravina, Nikiski, and Cape Starichkof. These risk assessments and public safety sections are incorporated by reference from both the El Paso (1976) and Western LNG (1978).

Subsequent to these FERC studies, the U.S. Department of Transportation Office of Pipeline Safety, certified the "Liquefied Natural Gas Facilities, Federal Safety Standards" (49 CFR 193), which prescribe safety regulations for LNG facilities (see Appendix H). These regulations govern and standardize criteria for the siting, design, installation, or construction of an LNG facility and prescribe requirements for the maintenance and operation of the facility, personnel qualifications and training, fire protection, and security.

The system safety and reliability for a project as large and complex as TAGS must balance the risks and consequences associated with the construction and operation of the system with the technical and economic feasibility of system design criteria and operational procedures.

All system safety and reliability design criteria, operational procedures, and other mitigating measures as specified in 49 CFR 193 would be implemented and are intended to reduce the possibility of system failures and to reduce risk to public safety.

Federal LNG Safety Standards -- Philosophies, Facts and Standards (see Appendix I) states that the "public concern would not be assuaged by probabilistic risk analyses of questionable merit. Rather, credible federal safety standards were necessary for achievement."

4.2.18.4.2 Public Risk of LNG

The risk to the public from the proposed LNG liquefaction and marine terminal at Anderson Bay would result from the effects of a catastrophic leak or spill of LNG. LNG is an extremely cold (-259°F), volatile, lighter than air and flammable product which readily vaporizes when exposed to external heat sources such as water, soil, or air. LNG produces 620 to 630 cubic feet of natural gas for every cubic foot of liquid at ambient temperature. Pure LNG vapors, if confined, are not explosive, but a mixture of 5 to 15 percent vapor to air is flammable. Should such a mixture of LNG vapors be allowed to disperse in the presence of an ignition source, an explosion could occur.

The major concern of a large-scale LNG spill would be an intense fire at the spill site. A more remote hazard would be that the vapor plume would drift downwind, and then explode or catch fire. Once the air-vapor mixture has been ignited, the fire would probably propagate back to the fuel source (FERC 1978). Although there is little actual experience with such a hazard to the public from this type of facility, impacts would be highly variable and would depend on the following.

- Location of the spill and the population of the areas adjacent to this location.

- Presence of an ignition source within the dispersion limits of the vapor cloud and whether the cloud became ignited.

- Flammability of the structures and materials encompassed by the vapor cloud or exposed to radiation from a large LNG pool source.

- Repairability of the leak source and the time it takes to accomplish shutdown.

- Time required to notify the public and take appropriate mitigation actions (FERC 1978).

4.2.18.4.3 Anderson Bay LNG Plant and Marine Terminal Safety Considerations

The site at Anderson Bay was selected for location of the proposed TAGS LNG plant and marine terminal facilities based on specific analyses conducted by YPC with respect to the compliance with the requirements of 49 CFR 193. Anderson Bay is a relatively remote location within Port Valdez. The distances which separate Anderson Bay from existing developments contribute to the inherent safety of the site. Alyeska Pipeline Service Company ~~owns and~~ operates the TAPS terminal at Jackson Point in Port Valdez. This terminal is located approximately 3.5 miles to the east and is the only existing industrial activity near Anderson Bay. The existence and operations of TAPS terminal would not adversely affect the operation of the TAGS facility. Valdez Narrows, located more than 3 miles west of Anderson Bay, is used by vessel traffic to enter and depart Port Valdez, including tankers which carry TAPS crude oil. Shipping use of the Valdez Narrows or Port Valdez would not be adversely affected by the operation of the TAGS facility. The City of Valdez is located more than 5 miles east-northeast of Anderson Bay on the opposite (north) shore of Port Valdez.

The Anderson Bay site would be developed at three major graded bench elevations. An upper bench graded to elevations of approximately 155 to 165 feet would be constructed to accommodate placement of pipeline gas receiving facilities, process units, power plant, operational control and maintenance facilities and process flare stack. A middle bench graded to an approximate elevation of 100 feet would be constructed to accommodate placement of LNG storage tanks and an impoundment. A lower bench graded to elevations of approximately 50 to 60 feet would be constructed to accommodate harbormaster facilities, shoreline berths, dock entrances, wastewater treatment facilities, and an isolated area for the marine flare stack.

The LNG storage tanks and impoundment area would be based on the use of four 800,000-barrel storage tanks, a four-cell system of 450 foot by 450 foot by 35 foot high reinforced earth and concrete wall dikes, and would require approximately 50 acres. The cells would be sized for isolated containment of 150 percent of the contents of each storage tank. A 100-foot-wide perimeter roadway would provide access to the storage tank and impoundment area.

Based upon conceptual definition of the plant relief system, approximately 40 acres of surrounding fenced or over-water security area is required for the process flare stack. This area was determined as the radiation zone exceeding 2000 Btu/hr-ft^2 around the flare.

For safety and access, the proposed TAGS LNG plant facilities would have proper facilities separation to allow multiple points of access and egress between all site areas and to allow personnel and equipment to move around the facility during an emergency. At minimum, the distances specified in the National Fire Protection Association Code 59-A for LNG would be adopted.

The Anderson Bay site is located on the south shore of Port Valdez, Alaska. It is an ice-free weather-protected fjord with established navigational facilities and procedures for large vessels. Water depths are 50 feet within 300 feet of the shoreline, an area suitable for a tanker turning basin of over 1 mile in radius. The subbottom is known to be bedrock. Marine access to the City of Valdez is relatively easy.

The Anderson Bay site would be of suitable size, topography, and configuration to safely accommodate the proposed LNG facility. All area, distances, separations, impoundments, and access-ways developed by YPC during conceptual definition of the LNG plant facility could be accommodated in a plant layout configuration at Anderson Bay. The resulting LNG plant/marine terminal site layout as identified in Figure 2.2.1-5 appears constructable with a design that minimizes hazards. LNG tanker berths could be safely located along the Port Valdez shoreline east of Anderson Bay (Figure 2.2.1-4).

YPC's layout of the Anderson Bay site has considered emergency access. Cargo vessel berth and ferry landing facilities at the extreme east end of the site and an alternative off-loading dock area at the extreme west end of the site would provide ease of access for personnel, equipment, and materials in the event of an emergency. Multiple access routes would be available from either dock area to facilitate fire-fighting, spill control, or personnel evacuation.

The Anderson Bay site appears to meet the prescribed siting requirements of Subpart B of 49 CFR 193 at an appropriate conceptual level, including the general requirements for site size, topography and configuration, thermal radiation protection, and flammable vapor gas, dispersion protection, seismic investigation and design, flooding, soil conditions, wind, severe weather and natural occurrences, adjacent facilities, and requirements for separation of facilities.

The risk to the public from the proposed LNG plant and marine terminal facility would be the effects of thermal radiation and flammable vapor gas dispersion of a catastrophic leak or spill of LNG. Within the vicinity of the proposed Anderson Bay facilities, several areas of public or private land uses were identified as identified in Table 4.2.18-1.

Table 4.2.18-1 Private and Public Land-Use Areas Near the Anderson Bay LNG Plant and Marine Terminal

	Distance From Site/Ft.
North shoreline of Port Valdez	14,300
Entrance Island	14,800
Shoup Bay spit	15,000
Alyeska terminal	16,500
City of Valdez	31,400
Old Valdez	44,000
Alaska Pacific Refinery	58,000
Valdez Airport	52,800

YPC performed an analysis of the thermal radiation and flammable vapor-gas dispersion for an LNG spill. The results of their analysis are attached as Appendix J and are summarized below.

The thermal exclusion zone evaluation conducted by YPC for the proposed Anderson Bay site was for a postulated LNG pool fire for the content of an 800,000-barrel LNG storage tank spilled and burning within the dike. The results of the thermal radiation calculations worst case, using the American Gas Association thermal radiation methodology, was for an unattenuated incident radiant flux level of 1,600 Btu/hr-ft^2 (prescribed by 49 CFR 193.2057) extended for a maximum distance of 1,725 feet from the center of a tank dike. All public and private land-use areas, as identified above would be located outside the thermal exclusion zone.

A flammable gas-vapor dispersion exclusion zone associated with an average gas concentration in air equal to 2.5 percent (prescribed by 43 CFR 193.2059) for A ~~was determined~~ postulated LNG spill. YPC performed these calculations using the conservative American Gas Association Model and the U.S. Coast Guard "Development of an Atmospheric Dispersion Model for Heavier-Than-Air Gas Mixtures." The greatest flammable vapor-gas dispersion distances was for the 800,000-barrel storage tank spill into the dike area and for a 10-minute loading arm spill onto water at the rate of 12,000 gallons per minute. Results of the conservative model indicated the maximum dispersion distance would extend 11,700 feet from the dike wall for the storage tank spill and 11,920 feet for the 10-minute loading arm spill onto water while for the U.S. Coast Guard model the results were 6,854 feet and 6,243 feet, respectively. The results for the model evaluations indicate that all public and private land-use area identified above would be located outside the maximum dispersion exclusion zone.

In summary, results for both the thermal exclusion zones and vapor dispersion analysis indicate that the proposed facility could be safely located at the Anderson Bay site and meet the thermal radiation protection and flammable vapor-gas dispersion protection requirements of 49 CFR 193. Review of the study indicated that this analysis was a reasonable and prudent application of 49 CFR 193 and that no readily apparent fatal flaws that would prohibit use of the proposed Anderson Bay site for the TAGS project exists.

4.2.18.5 LNG Tanker

LNG tankers traversing Prince William Sound to and from the proposed Anderson Bay marine terminal would be subject to the U.S. Coast Guard Vessel Traffic Service (VTS) which consists of four basic components:

- A Traffic Separation Scheme
- A Vessel Movement Reporting System
- Radar Surveillance
- Regulations

The purpose of the VTS is to prevent collisions and groundings and to protect the navigable waters of the area from environmental harm resulting from collisions and groundings. The users of the VTS are not only the tankers transiting to and from the Alyeska Marine Terminal, but also ferries, cargo vessels, tugs, tour boats, and other vessels.

The U.S. Coast Guard has indicated ~~by~~ IN a letter of February 20, 1986 ~~(McCarty to~~ TO THE BLM ~~Tileston)~~ that the additional tanker traffic which would result from the proposed TAGS project would not have any adverse affect on the capabilities of the VTS since existing vessel traffic movements are low. The VTS would be capable of handling a significant increase in vessel traffic without changing the present operations.

For further public safety protection, especially in the vicinity of critical port areas, the U.S. Coast Guard normally identifies safety zone regulations. The waters within 200 yards of any waterfront facility at the Alyeska Marine Terminal complex or vessels moored or anchored at the terminal complex and the area within 200 yards of any tank vessel maneuvering to approach, moored, unmoored, or depart the Alyeska marine terminal complex is a safety zone. It would be anticipated that for public safety a similar safety zone would be identified for the TAGS project facilities and tankers (DOT 1984).

4.2.18.6 Summary

TAGS would be designed, constructed, and operated in accordance with all applicable codes, standards, and regulations to reduce the possibility and consequences of system failures such as fires, explosions, LNG spills, and other impacts to public safety.

Design criteria for such site-variable parameters as seismic hazards, wave run-up, or corrosion potential would be based on existing information, supplemental studies, as required, and the technical and economic feasibility of specific design criteria. Operating procedures and mitigation measures would be in accordance with a variety of regulatory agency requirements, as well as good engineering practice. Proper training of operations staff further ensures system safety by reducing the probability and severity of accidents. All system safety and reliability design criteria, operations procedures, and mitigation measures are intended to reduce the possibility of system failures and to reduce the adverse public safety impacts associated with such failures.

Overall, it appears that YPC location and conceptual design reflects consideration OF ~~to~~ the excellent safety record experienced by the LNG industry in general during the last ten years, as well as the safety record for ~~the~~ LNG FACILITIES which ~~has~~ HAVE operated safely for more than 15 years.

4.2.19 Areas of Special Concern Along the TAGS Alignment

4.2.19.1 Introduction

TAGS project proponents identified seven areas along the route where special construction considerations are necessary. These are due to unusual engineering constraints, environmental sensitivity, or land-use conflicts. In addition to these seven areas, other issues of special concern were raised through the EIS scoping process. Impacts to these areas are generally considered by discipline in the appropriate sections of this document. This subsection summarizes the important environmental impacts in each of these areas.

4.2.19.2 Sagwon Bluffs ACEC (Proposed)

The initially proposed location of Compressor Station No. 1 was changed from the east side of the Dalton Highway where there are active Arctic peregrine falcon nests and historically used peregrine nests near Sagwon Bluffs to the west side of the highway just outside of the Sagwon Bluffs proposed ACEC.

Compressors are normally audible for 6,000 to 7,000 feet to humans (FPC 1976a) and would perhaps be audible to peregrine falcons for greater distances. Gas blowdowns occur infrequently but even using stack silencers would be in the range of 80 dBAs at 100 feet (FPC 1976a). Blowdown, if timed properly, would not affect the peregrine falcons; however, in an emergency situation such as unscheduled venting during the critical breeding or nesting season, some impacts, including disorientation and nest abandonment, could occur.

Under routine operations it is expected that compressor operations would be less disturbing than normal highway noise. Overall, potential disturbance would be less than if the compressor was located on the east side of the highway.

Overall impacts to raptors by the project would be minor in this area except during emergencies; impacts could then be moderate.

4.2.19.3 Slope Mountain ACEC (Potential)

The TAGS pipeline route at Milepost 115 crosses near the toe of Sheep Mountain where TAPS has an existing material site. Habitat created by the mineral material site provides important Dall sheep use areas and raptor nesting. TAGS proposes that much of the pipeline work in this area take place during the early winter. Overall impacts to Dall sheep and to raptors would be similar to that experienced with TAPS construction.

Sheep Mountain also contains a mineral lick. This mineral lick would not be available to sheep ~~for~~ DURING the TAGS construction period.

Overall, the effects of TAGS on the sheep and raptors of the SLOPE mountain ACEC would be minor during construction and negligible thereafter. Commercial guiding opportunities would be displaced to the extent they now use the TAPS construction camp pad.

4.2.19.4 Galbraith Lake Area (Milepost 137to 164)

4.2.19.4.1 TAGS Preferred Route

The proposed TAGS pipeline route is on the west side of the Galbraith Lake while the Dalton Highway, TAPS, and the authorized ANGTS corridors are on the east side. As proposed, the pipeline might affect a relatively undeveloped area which was identified for special consideration in the BLM's Utility Corridor Resource Management Plan (RMP). Galbraith Lake, along with the TAPS access road, airstrip, and construction camp pad, would be totally enclosed by the TAGS pipeline and the Dalton Highway.

The buried pipeline may also close or reduce the options for access to the west toward Gates of the Arctic National Park unless special construction techniques were utilized at specific points to allow crossings. Since these techniques are used frequently subsequent to pipeline construction, impacts to future access should be minor.

Permanent access roads and the construction workpad would potentially open approximately 20 miles of new access along the west side of Atigun River valley upstream from Galbraith Lake to offroad traffic. There would be an additional visual impact to those driving along the Dalton Highway since the construction related scars would be visible.

On the east side of the highway near Mosquito Lake, TAPS and the authorized ANGTS traverse several sites of cultural significance. Though no new surveys have been conducted along the TAGS alignment, it is likely that several additional sites could be affected by construction.

Although the impacts to the streams entering Galbraith Lake would be similar to those crossed in other areas, there is a growing pingo next to one of the streams (Dean 1987) which has the potential to disrupt the local water regime should the construction and/or operation affect the pingo.

Golden eagle and gyrfalcon nests are present on the bluffs west of the road and could be disturbed during construction by high noise levels and aircraft as discussed in Subsection 5.14.

Other than the major short-term construction effects, the long-term effects would be primarily one of increased access with moderate visual effect along the highway.

4.2.19.4.2 Preferred Route Option

At BLM's request the proponent developed an optional alignment on the east side of the highway adjacent to TAPS and authorized ANGTS. This optional route has construction difficulties such as insufficient space between TAPS and the mouth of Atigun Gorge for both TAGS and authorized ANGTS; fine-grained, ice-rich soils and massive ice beneath the active floodplain; major "pinch point" upslope of TAPS Remote Valve No. 26, a joint highway/below-ground TAPS crossing in the upper Atigun River active floodplain; and to accommodate both TAPS and authorized ANGTS, the TAGS route would be located upslope on terrain with steeper cross slopes. Visual intrusion of this route from the Dalton Highway would be major due to construction on the upslope canyon wall where deep cuts would be required.

4.2.19.4.3 Summary

During the construction of TAPS, geotechnical conditions at the Atigun River crossings indicated the need for large separation distances between existing and future pipelines in order to minimize adverse impacts and to ensure compatibility between pipelines. In addition to TAPS, there might not be sufficient space for the authorized ANGTS and TAGS in the mode.

The existing TAPS Remote Valve No. 26 creates a "pinch pont" for two additional pipelines and would require TAGS to be on steep cross slopes uphill of above-ground TAPS and the buried fuel gas line, again sufficient space for authorized ANGTS and TAGS would be questionable. This would potentially disturb the resident Dall sheep population on the western slope.

An evaluation of the preferred TAGS alignment on the west side of the Dalton Highway and the route option to the east of the highway demonstrates preference for the west side option primarily due to the increased visual intrusion created by the route on steeper canyon slopes. The west side is generally rolling terrain similar to what the highway is built on and would create less visual impact, although creating a new scar 1 to 4.5 miles ~~for~~ FROM all other existing activities.

The preferred TAGS route, if located on the west side of the Dalton Highway, would open this area to easier access. The impacts to aesthetics and to the Dall sheep habitat would probably be moderate. The impact to cultural resources would not be known until a detailed survey was conducted.

4.2.19.5 West Fork Atigun River ACEC (Potential)

The wildlife and aesthetics values of the West Fork Atigun River area near TAGS Milepost 155 are similar to those described for Slope Mountain (Subsection 4.2.19.3) except there is no known raptor nesting. This area is not readily accessible at the present time. The proposed TAGS alignment along the west side of Galbraith Lake opens this area to easier access. Accordingly, the impacts on Dall sheep habitat, especially the existing mineral licks, would be moderate. The area of the mineral licks would not be available for a TAGS mineral material site. Accordingly impacts to Dall sheep using the licks would be minor.

4.2.19.6 Atigun Pass (Milepost 164.5 to 167.5)

Atigun Pass is identified as a "pinch point," where up to three major pipelines and the Dalton Highway need to be accommodated in a narrow pass. Construction would occur in two summer work seasons and would be coordinated with the DOT/PF. The major potential impact in this area is the interruption of normal traffic by construction operations. With minor exceptions, traffic delays would be on the order of several hours or less at a time during the two construction seasons. Construction would be timed to coordinate with existing traffic patterns and traffic controlled to keep delays to a minimum. There would also be some potential short-term impacts of construction to Dall sheep lambing on the south-facing slopes of the pass as occurred during TAPS. During construction the sheep avoided the areas closest to the noise source; following construction the sheep returned to their traditional lambing areas.

Of particular concern to DOT/PF would be the potential impacts that could result from a landslide during construction or operations. Such a landslide could close the only access to Prudhoe Bay for the entire time required to remove the slide material and restabilize the altered slopes. The impact would be that the highway supply route to and from Prudhoe Bay would be interrupted until the road was reopened. Such an impact would be short term but major.

4.2.19.7 Snowden Mountain ACEC (Potential)

The proposed TAGS alignment runs along the western lower slopes of Snowden Mountain in close to the Dalton Highway, TAPS, and the authorized ANGTS near Milepost 188 to 198. Site-specific locations of mineral material sites ~~will~~ would take into account the special geologic, paleontologic, and wildlife habitat values of this area. Available information indicates TAGS would have impacts similar to those for the Dalton Highway and TAPS. Accordingly, impacts would be considered minor during construction in that sheep may not come as close to the construction area and the Dalton Highway as they now do. Impacts on geology and paleontology would be negligible.

4.2.19.8 Sukakpak Mountain Area (Milepost 200 to 210)

The TAGS pipeline route on the north side of Sukakpak Mountain involves another "pinch point," where the highway, TAPS, and authorized ANGTS meet at the confluence of the Dietrich and Bettles rivers with the Middle Fork of the Koyukuk River. The route would avoid geotechnical, thermal, and hydrologic conditions that are incompatible with the construction and operation of a high- pressure gas line. YPC is evaluating special routing, design, construction, and mitigation techniques with respect to pipeline routing in the Sukakpak Mountain area and would consider the superlative visual quality of the area, proximity constraints related to construction near TAPS, authorized ANGTS, and the Dalton Highway. Other constraints are related to placement of the pipe in the Koyokuk River and the slope of Sukakpak Mountain. Construction of the Dalton Highway along the bench below the flanks of Sukakpak Mountain has revealed there are geotechnical issues that will need attention in the design and maintenance plans for TAGS. Foremost is the dramatic incidence of subsurface water flow above the highway as expressed by frost bulb and small pingo-type formations that developed after the highway was built.

The preferred TAGS route would have crossed the forested saddle on the northwest edge of Sukakpak Mountain and then across its western-facing lower forested flanks in an area very visible to travelers that has high scenic value along the Dalton Highway.

The preferred route would have crossed through an area where BLM denied mineral material extraction for TAPS construction because of scenic values. Accordingly YPC was told by BLM that a saddle crossing would not be approved. The major potential impact would still be to the scenic value of the area. Impacts would be moderate in this area.

4.2.19.9 Nugget Creek ACEC (Potential)

Values in this unit are similar to those at Sheep Mountain (Subsection 4.2.19.3) except there appears to be no raptor nesting. The ACEC unit is located on the west side of the Middle Fork Koyukuk River from the present Dalton Highway, TAPS, authorized ANGTS, and the proposed TAGS near Milepost 215. No access requirements to the area have been identified for TAGS. Accordingly, negligible impacts would result.

4.2.19.10 Grayling Lake

The proposed route is located on the east side of Grayling Lake on the bench above the lake and the riparian zone and crosses Grayling Lake Creek approximately one-half mile south of the lake. Since the highway, TAPS, and other facilities are on the west side of the lake, the TAGS workpad would potentially improve access, creating increased fishing and hunting pressure, poaching, and offroad vehicle use. Impacts in this area would be moderate.

4.2.19.11 Jim River ACEC (Potential)

The proposed ACEC and adjacent area near Milepost 260 to 275 proposed for the TAGS alignment contain an array of special values ranging from cultural to biological.

The proposed TAGS alignment is close to the Dalton Highway, TAPS, and authorized ANGTS. Impacts for TAGS would be similar to those from construction, operation, and maintenance of the Dalton Highway and TAPS and would be quite similar to impacts from the authorized ANGTS. Special measures to protect existing resources in the Jim River area were successful during TAPS construction. Similar protective measures would be used for TAGS. Accordingly overall impact of TAGS on the Jim River area is considered minor except for the indigenous fish population such as grayling. The greater accessibility and more people would probably result in moderate impacts to this resource.

4.2.19.12 Yukon River Bridge (Milepost 349)

The construction of an independent suspension bridge approximately 1,000 feet upstream from the existing highway and TAPS bridge would result in the substantial reduction of use or complete loss of a public boat-launch ramp and recreation area due to construction requirements and necessary security for the bridge abutments and for the above-ground pipeline on both bridge approaches. This structure is shown in Figure 2.3.4-4. The present public boat ramp and recreation use is at an existing access point on the north bank upstream from the existing Yukon River bridge where an air cushion barge landing was established for moving equipment and supplies across the Yukon River before and during construction of the highway bridge. Additionally, the river is used both for boat/barge navigation and by light aircraft during marginal flying conditions. The bridge piers would create an additional hazard for water traffic, while the high steel towers on top of the concrete piers would create an additional hazard to pilots using the river for navigation during low ceilings. The pier would also be the first ice breakpoint. before ice reaches the highway bridge.

Appropriate safety devices such as strobe lights would be installed.

The security requirements would be a major impact to those who use the public boat-launch ramp and recreation area throughout the life of the project. Due to the good access to the Yukon River from the bridge, another area in the vicinity of the bridge would probably be used for access to the Yukon.

4.2.19.13 Grapefruit Rocks (Milepost 410)

The pipeline route crosses the Grapefruit Rocks area north of Fairbanks near a steep promontory west of the Dalton Highway and would require drilling and blasting through rock, as was done for construction of the highway. The route alignment is within 2 miles of a peregrine falcon gyrie located on the east side of the highway. Blasting could affect the birds should it occur when they are present. Such activities would be restricted during specific periods critical to the peregrine falcons. Additionally, the area is used by local rock climbers and has been recommended for administrative designation as a public reserve in the Tanana Basin Area Plan.

4.2.19.14 Salcha River Area (Milepost 486 to 490)

In the vicinity of the Salcha River, Compressor Station No. 7 is located approximately 1.5 miles northwest of the proposed TAGS pipeline crossing of the Salcha River. As one travels along this recreational river, it would be possible to occasionally view the compressor station; and, depending on atmospheric conditions and wind direction, hear it during operation. As previously stated, a compressor station could be audible for a distance of 6,000 to 7,000 feet. The location of the compressor station could affect the recreational value of the river and homesites in this area. Additionally, a permanent 5-mile access would be required from Johnson Road to the compressor station. No access would be provided from the Richardson Highway to the compressor station site or to the pipeline alignment. Construction access would be along the existing TAPS corridor. No discharges would occur into the Salcha River.

The pipeline crossing of the river would create another cut through the vegetation, resulting in loss of riparian habitat and creating a visual scar for those using the river for recreation. No additional gravel pit development would occur within the Salcha River Valley.

4.2.19.15 Quartz Lake State Recreation Area (Milepost 520)

Quartz Lake SRA, which receives significant fishing pressure, is a 600-acre, year-round use recreation area established in 1975 and expanded to present size in 1980. The lake is stocked with land-locked silver salmon and contains an indigenous population of lake trout. The TAGS pipeline alignment would be routed through the extreme southwest corner of the Quartz Lake SRA for a distance of about 1,000 feet in order to avoid an area of steep cross slopes with fine-grained soils to the south of the SRA boundary. The pipeline alignment within the SRA boundary would be location adjacent to the main Quartz Lake access road where the disturbance to new terrain would be minimized. This area is subject to Section 4(f) of the federal DOT act of 1966, which was intended to protect parklands and historic sites. YPC is considering an optional routing to the south of the SRA boundary which might allow complete avoidance of the area. On-site evaluation of this routing would be required during the summer of 1987 before feasibility could be determined. Should no feasible alternative be found, the major impact would be during construction when access would be restricted. Since construction would occur proximate to the existing access road, no permanent impacts should result, but impacts during construction would be major.

4.2.19.16 Phelan Creek (Milepost 585.6 to 587.6)

Pipeline construction in the Phelan Creek area, another "pinch point," would require co-use with the Richardson Highway for approximately 1.5 miles. A road bypass around the entire area would be constructed on the Phelan Creek floodplain to facilitate normal traffic. Traffic delays would occur during blasting and material hauling. The primary impact to this area, however, would be the potential for the chilled gas pipeline to exacerbate existing aufeis conditions.

The Phelan Creek co-use area, because the existing highway is located immediately above a wide braided floodplain area, affords considerable latitude in providing bypass for traffic around the construction zone.

Of concern to DOT/PF would be the potential impacts created during construction should a landslide close this "pinch point" or should a catastrophic accident occur during operation and result in road closure. Impacts of a catastrophic accident would be major.

4.2.19.17 Summit Lake Area (Milepost 595 to 610)

The proposed pipeline would be located west of Summit Lake and the upper Gulkana River, whereas all other facilities, including the Richardson Highway and TAPS, are located east of Summit Lake. The construction workpad has the potential to open the area on the west side of the lake, already subject to significant recreational use, to additional pressure. This would include increased hunting and fishing and winter snow machine travel. Summit and Paxson lakes are presently restricted as to burbot and lake trout fishing due to overfishing of the breeding stock. There is now a size and low catch limit.

A revised location for crossing the Gulkana River, immediately downstream of the Denali Highway bridge, was selected after a field trip with ADF&G for improved access for construction and for pipeline maintenance and because confined river flow downstream of the bridge structure serves to minimize the crossing length and the disturbed area.

In this area the upper Gulkana River contains major salmon resources that could be affected by construction. There are proposed fishery enhancement programs planned for this area, one of which is in place upstream of the crossing.

4.2.19.18 Dry Creek State Recreation Area (SRA) (Milepost 672)

The Dry Creek SRA located between Gulkana and Copper Center includes 372 acres and was established in 1973 prior to the construction of TAPS. It contains a small wooded campground and picnic area and receives heavy summer use by the local residents for picnicking and by travelers on the Richardson Highway. Minimal off-season use occurs. Depending on construction timing, there could be a loss of use for one season.

4.2.19.19 Worthington Glacier State Recreation Area (SRA) (Milepost 760)

Worthington Glacier SRA is a 113-acre scenic area established in 1976 which provides a viewpoint of and direct access to Worthington Glacier, a National Natural Landmark, for travelers along the adjacent Richardson Highway. Greatest use is during the summer tourist season. No overnight facilities are available. The TAGS pipeline alignment would be routed between the TAPS pipeline and the Richardson Highway through the Worthington Glacier SRA and would be located approximately 120 feet west of the roadway shoulder on the highway right-of-way in an area which would not interfere with the operation of the recreation area. No feasible route options exist. This area is subject to Section 4(f) of the federal DOT act of 1966 which is intended to protect park lands and historic sites. Recent realignment of the Richardson Highway adjacent to the SRA boundary has blocked routing options along Ptarmigan Creek on the east side of the Richardson Highway and SRA boundary. The Worthington Glacier lies to the west of the SRA, blocking any route option to the west of the area. The impacts would be major during summer construction when access would be restricted. Since construction would occur proximate to other developments, minor impacts should result.

4.2.19.20 Blueberry Lake State Recreation Site (SRS) (Milepost 765)

The Blueberry Lake SRS is a 192-acre scenic area, established in 1972 as a day-use area of visual and scenic alpine high country located on the south side of Thompson Pass adjacent to the Richardson Highway and provides a panoramic vista of the Chugach Range to travelers. Use is primarily during the summer tourist season.

The proposed pipeline crosses the Blueberry Lake SRS along the abandoned state highway roadbed which traverses the site in order to minimize clearing and disturbance adjacent to the existing roadbed. Route options to the east of the SRA boundary are precluded by a steep sloped drainage immediately adjacent to the east SRA boundary that leads to Heiden Canyon. An optional route to the west was rejected because of extremely steep slopes and potential soil stability concerns. This area is subject to Section 4(f) of the DOT act of 1966 which is intended to protect park lands and historic sites. During summer construction, the typical impacts related to the construction of a pipeline would occur which would exclude use of part or all of the area during the single construction season. Once construction is completed, the roadbed would be returned to preconstruction condition and so once construction is completed, impacts would be minor.

4.2.19.21 Keystone Canyon (Milepost 770.8 to 774.5)

The proposed TAGS route traverses Keystone Canyon for approximately 4 miles along the Richardson Highway. Both are routed proximate to the Lowe River which is incised in a steep-walled canyon. Except where TAGS proposes to route the pipeline through the Old Richardson Highway tunnel, pipeline/highway co-use is proposed. For the sections north and east of the tunnel, a temporary bypass would be constructed in the Lowe River floodplain to allow traffic to pass without significant delay during normal construction operations. Construction would be coordinated with DOT/PF to keep summer highway traffic delays to a minimum. Traffic would be carefully controlled on a 24-hour-per-day basis by means of radio-equipped flagmen and a pilot car to reduce traffic impacts. Construction through the canyon should not impact Ruddleston Falls or the Goat Trail located on the rock cliffs above the highway.

DOT/PF is concerned about the potential impact during construction or operations should a landslide occur, closing this "pinch point". This is the only land route from Valdez to other areas of the state. Completion of the new state highway through Keystone Canyon and Thompson Pass and the construction of TAPS have provided a baseline of data and experience for the proposed TAGS project. No evidence of rock failure was observed in Keystone Canyon during the 1964 earthquake, and there has been an excellent record of highway performance. There is a concern about the potential for creating localized unstable rock slopes by the undercutting or day-lighting of discontinuities in the bedrock during construction of the pipeline. The failure of a locally undercut or day-lighted bedrock section would create additional traffic delays and increased requirements for rock reinforcement. Since construction through the canyon would be limited to short 200- to 400-foot sections, the extent of a potential problem area and its potential impact would be limited to relatively short and manageable durations.

YPC would conduct detailed field investigations to accomplish geologic mapping, core and soil borings and testing, ground-water investigations, surface water hydrology, and rock slope stability evaluations. The detailed design and construction plan for TAGS would be based on the results of the field investigation and evaluation and would be coordinated with the DOT/PF during the final design phase. Coordination of blasting and excavation procedures, rock reinforcement requirements, traffic control and safety are considered to be a necessary part of a successful design by YPC.

4.3 COOK INLET-BOULDER POINT ALTERNATIVE

4.3.1 Introduction

In the consequences sections for the proposed project, the basic construction and mitigation techniques described for the proposed project were used as a baseline and the existing facilities were considered in depicting and comparing the impacts between the proposed TAGS project and the Cook Inlet-Boulder Point alternative.

4.3.2 Socioeconomics

The Cook Inlet-Boulder Point route would provide the State of Alaska with similar benefits as discussed in Subsection 3.2.2.

This alternative route has not had the experience with a major pipeline project. Since nearly all of the communities and settlements north of Cook Inlet are located along the Parks Highway, during construction they would be impacted by a major increase in traffic which could increase travel time, traffic hazards, and damage the highways.

Potential construction camp locations have not been determined for the Cook Inlet-Boulder Point alternative corridor; however, during peak construction, camp populations could easily exceed those residents in many areas. Although most workers would live in camps, they would likely have minor impact on local settlements, particularly those with bars, since the construction camps would prohibit alcohol.

In 1986 the unemployment rate along the Cook Inlet-Boulder Point route was at least 15 percent. Residents in all portions of the corridor have experience in construction and petroleum-related projects and would be interested in employment.

Summer construction and transport of pipe and other materials would conflict with the summer tourism season and could be a major problem for visitors to Denali National Park and Preserve, which is one of the state's major tourist attractions.

During the construction and operations phases the Kenai area would experience major short-term relative impacts. The construction period in Kenai would be five years compared to three years in the corridor north of Cook Inlet. During the peak year of TAGS construction, the project would create an estimated 850 additional direct and indirect jobs in the Kenai area. Most of this employment would be associated with the LNG plant and the marine terminal at Boulder Point. This increase would represent a 15 to 20 percent increase in employment in the Kenai area, a short-term major benefit.

Due to the current slump in the Kenai economy, local officials noted that most residents would probably welcome the employment and economic development opportunities the TAGS project could provide. The community's infrastructure could accommodate the growth during the construction period much more easily than Valdez.

Careful planning would be required to prevent the community from overbuilding to accommodate the relatively short-term growth druing the construction period. The Boulder Point LNG plant and marine terminal would have an operation work force of 100 compared to 850 during construction. However, the operations employment would still be a significant increase in local long-term economic base and would help to offset recent decreases in Cook Inlet petroleum development employment. A major positive impact of the project would be an estimated $2 billion addition to the tax based of the Kenai Peninsula Borough.

Overall, consequences of a project such as TAGS would have major impacts during both construction and operation in a state with a population and community infrastucture such as that found in Alaska.

4.3.3 Land Use

Impacts to present land uses of the area along the Cook Inlet route would be quite similar to those described in Subsection 4.2.3 this document. Major differences are:

- The route passes through or very near five important and sensitive areas for wildlife and people, including Minto Flats, Denali National Park and Preserve, Denali State Park, the Susitna Flats State Wildlife Refuge, and the Kenai National Moose Range.

- More land is in private hands along the Cook Inlet route, and there would be many different landowners to deal with.

- An existing transportation corridor occurs along this route just as along the primary route, but the Cook Inlet transportation systems is much more heavily used. Therefore, the potential for impacts to this system are more pronounced.

- Much higher levels of recreational use of the Cook Inlet area. Impacts to these land uses could be absorbed in some areas and would create problems in others.

- Pipeline construction would require the development of material sites and the construction of access roads, workpads, and compressor stations in the presently roadless Minto and Susitna flats areas. A total of more than 100 miles of these two areas would be traversed. Permanent access to the compressor stations in each area would be required.

For these reasons the impacts to land use during both construction and operation would probably be somewhat more severe along the Cook Inlet route and would be classed as moderate during construction and operation.

4.3.4 Transportation

Impacts to the transportation system would be similar to, but more severe than the those impacts discussed in Subsection 4.2.4 for the proposed route. The greater severity would be due to additional vehicle and air traffic in an already crowded system. Construction on the Susitna Flats and the North Kenai area would require some air support in areas with existing heavy use by small aircraft traffic. There are hundreds of small aircraft flights per day across the lower Susitna area during the summer. Increased flights would add noise disturbance to an already noisy area. Railroad traffic would be increased during construction of the Cook Inlet-Boulder Point alternative, but overall impacts of increased rail traffic would be positive. Pipe and material storage areas could be located close to the rail network to alleviate double haul to storage sites.

Construction of access roads, highway crossings, and movement of vehicles carrying equipment and gravel would cause traffic delays, sometimes for several hours. These delays would be coordinated with DOT/PF and would be timed to occur when low traffic counts were present.

Increased vehicle traffic due to construction personnel and supply vehicles also has the potential to exacerbate existing traffic problems, especially at peak periods such as early morning, late afternoon, and on Saturday mornings and late Sunday afternoons.

Selection of the Cook Inlet-Boulder Point alternative would increase the air traffic at area airports, including Anchorage, Seward, Homer, and especially Kenai. Likewise, the ports of Whittier, Seward, Homer, Anchorage and especially Nikiski Point would be heavily used, creating a positive economic benefit for the port areas. The port facilities and the larger airports could handle increased TAGS traffic without any problem. The impacts to the existing transportation systems would likely be moderate during construction and negligible during operation.

4.3.5 Noise

The alternative project would add to the ambient noise through construction equipment, large trucks, increased vehicle and small aircraft traffic, possible blasting at material sites, blowdown at the compressor stations, and block valve venting.

Noise impacts would be similar to those described for the proposed project in Subsection 4.2.5. Since there is more ambient noise in most areas along the Cook Inlet route, there would be a greater impact associated with an increase in background noise. Certain operational functions such as blowdown of the gas lines would affect local residents and perhaps wildlife.

Minto Flats and the Lower Susitna Valley are not within a developed corridor, and both would have a compressor station in their vicinity. Noise during construction and operation would have moderate impacts in these areas.

Unless unforeseen amounts of blasting at materials sites, pipeline trenching, or other unusual noise-producing activities were required, a short-term noise increase for one or two seasons would be evident, primarily by aircraft and vehicles associated with construction. Impact would be moderate. An increase in noise during the operation phase by surveillance aircraft and compressor stations during blowdown also would likely be minor.

4.3.6 Meteorology/Air Quality

Along the section from Livengood to Nenana, conditions are suitable for atmospheric pollution, including calm winds and very strong temperature inversions near the surface. Such conditions are more pronounced in open valleys with gentle slopes, especially at lower elevations. The effluents from construction or compressor station operation would not be sufficient to produce severe ice fog conditions in this area since there are few other sources of emissions. Impacts would be negligible. The present pollutant load from the two existing coal-fired generating stations in the Clear AFS and Healy areas might experience some addition, but since atmospheric conditions are not as conducive to inversions in this area, and impacts probably would be moderate.

Air effluents that would degrade the Class I area around Denali National Park and Preserve are prohibited. Therefore, compressor stations would have to be located as far north and south of the park as possible. Dust and effluents from construction and construction equipment would have to be suppressed to avoid any degradation.

In the area between the Denali Park and Preserve and Cook Inlet the major source of ambient emissions is vehicular traffic along the Parks Highway; effluents from the Beluga gas-fired generating facility; and slash burning from the agricultural area near the east side of the mouth of the Susitna River. Existing pollution levels can be quite high in this area under certain atmospheric conditions, and impacts could be moderate at these times.

Several sources of emissions already exist near the proposed Boulder Point LNG Plant facility and marine terminal. They include the large Tesoro refinery, the Chevron refinery, the Phillips LNG facility, and the nitrate fertilizer plant. The air quality problems would most likely be moderate during construction and minor during operation in this area, depending on prevalent atmospheric conditions.

4.3.7 Solid Wastes, Hazardous Materials, and Sanitation

The TAGS project would produce solid wastes in many forms, including unused soil and spoil materials, trash, garbage, construction waste, and equipment. During TAPS construction these wastes were burned and buried at selected materials sites, and it is assumed this would occur with the Cook Inlet-Boulder Point alternative as well. Impacts from solid waste burning and disposal should be minor, even during construction since state permit requirements are conservative and would protect the local water and air quality.

Hazardous wastes such as herbicides, pesticides, solvents, antifreeze, and diesel fuel would be generated during construction and facility operation. There might be some local oil spills or exposure of workers, but with proper precautions and treatment there would be no severe impacts. If hazardous wastes are properly stored, secured, transported, and disposed of out of state according to strict state and federal criteria, impacts of hazardous wastes would be minor both during construction and operation.

Sanitary wastes generated at construction sites, construction camps, and compressor stations during construction and operation would be treated either with a portable chemical system, a self-contained package treatment system, or with properly placed leach fields. State and federal permits must be obtained prior to any disposal of sanitary wastes or sludge and these wastes and their disposal would be strictly regulated. Therefore, it can be anticipated that impacts to surface waters from sanitary wastes would be minor.

4.3.8 Physiography, Geology, Soils and Permafrost

This section presents a discussion of the potential impacts and interactions between the Cook Inlet alternative route and the geologic environment. The potential interactions between the pipeline and the geologic environment for the proposed Prince William Sound route were presented in Subsections 4.2.8. The discussion in this subsection applies to a varying degree to the Cook Inlet-Boulder Point alternative route. A description of the differences in alternative pipeline route/geologic environment interactions follows.

4.3.8.1 Geologic Interactions

In the Cook Inlet-Boulder Point alternative route segment from near Livengood to Compressor Station 9A near Summit, continuous permafrost would be encountered. Degradation of ice-rich permafrost on side slopes and in valley bottoms could develop as a result of construction activities. The potential for surface modification due to thermal degradation of the relatively warm permafrost along this segment would be especially high during the construction and prior to startup operations. Mass wasting could occur locally where areas of highly developed solifluction lobes were disturbed by construction activity. This problem would be of concern along the moderate to steep slopes bordering the Tanana River valley. The fine-grained soils exposed as a result of mass wasting would be susceptible to erosion and gullying.

An important concern within the Tanana River valley would be the degradation of locally ice-rich frozen silts and alluvial gravels underlying its many small tributary streams. Alluvial gravels along the Nenana River to Clear Creek are generally free of permafrost; however, liquefaction of these saturated, alluvial materials as a result of a severe earthquake could impact the pipeline and associated support structures.

Within the Alaska Range, the Cook Inlet-Boulder Point route is characterized by a potentially high level of seismicity. The greatest potential impact for this segment of the alternative route would be differential movement along the Denali Fault. An earthquake of magnitude 8 accompanied by fault offset of at least 20 feet along the McKinley strand of the Denali fault system would have similar consequences for a pipeline constructed along either the proposed primary or alternative route. Loss of pipeline integrity due to fault rupture is of primary concern; however, construction techniques as described for the fault crossings in Section 2 should reduce potential impacts. A delineation of earthquake epicenters indicates the alternative corridor also crosses a seismically active fault in the vicinity of Healy (Gedney et al., 1972). The seismic zonation of the alternative route is not well known due to a lack of detailed geologic and geophysical data. Other impact considerations for this section are ground motions and subsequent liquefaction of alluvial silts and sands along the floodplain of the Nenana River.

Most of the Broad Pass Depression is underlain by permafrost. The potential impacts within the Broad Pass Depression would be from degradation of locally ice-rich frozen silts and alluvial gravels underlying the abandoned floodplain and benches bordering the Chulitna River. Impacts to these areas would be minor except for locally induced mass wasting on valley slopes.

The Broad Pass Depression opens on its south end to the Cook Inlet-Susitna Lowlands. The Castle Mountain Fault lies close to the alternate route in the vicinity of Houston. Along this section of the route, the seismic risk is major. Primary impacts to the pipeline would occur as a result of ground cracking and liquefaction of thawed soils. Loss of pipeline integrity due to fault rupture is possible but is considered to be of secondary importance due to its relatively low probability and the construction mitigation for fault crossings. Isolated local pockets of permafrost may occur under muskeg in lowlands along the Susitna River. Clearing and trenching in these areas could result in localized thaw settlement of these materials. Thaw settlement could affect pipeline integrity due to loss of bedding material and subsequently, local pipe support.

From Knik Arm to Boulder Point, the route is permafrost free. Principal impacts would be from minor terrain modification as a result of clearing and trenching. These impacts would be primarily visual in nature and would be of secondary importance and minor over the operational life of the pipeline. The most important considerations for this segment of the alternate route are those related to earthquake hazards. The potential for a damaging earthquake is major, as demonstrated by damage to structures in the Anchorage area as a result of the 1964 earthquake (magnitude 8.5). Impacts to the pipeline as a result of seismic activity and ground failure or saturated soils on the bluffs of Knik Arm and Cook Inlet, or damage to pipeline support structures due to strong ground motion would be moderate.

Overall, impacts due to construction and operation along the alternative route would be moderate.

4.3.9 Surface and Ground Water

General types of hydrologic impacts that may arise along the alternative route are the same as those for the primary route described in Subsection 4.2.9. The following paragraphs identify specific impacts most applicable to various segments of this alternative route.

4.3.9.1 Livengood to the Nenana River

Permanent effects would accrue from the need to provide permanent access along the 50-mile portion of this route that is not connected to the existing road or railroad system. To ensure year-round access, the road would have permanent bridges and culverts. The route would also require development of material sites to supply gravel for both the workpad and access road. This would possibly cause major and long-lasting disturbances to a undisturbed area. Hydrologic impacts would result from the introduction of sediment and pollutants into Minto Flats. Erosion control would be particularly difficult due to the instability of the ice-rich silts on the hill slopes and because of the tendency of the streams to ice. A compensating effect would be improved access for TAGS oil spill control and cleanup activities should they be necessary. Overall, impacts would be expected to be major for for this area.

The Tanana and Nenana river crossings are in a very unstable area. As the result of pipeline construction, or due to natural activities which constrict the river, ice jams could divert the Nenana River through any one of the existing distributaries forming its junction with the Tanana. This could breach the alternative route between the crossings, endanger the pipeline, and alter the existing geometry of both the Tanana and Nenana rivers. These changes in geometry could affect navigation on the Tanana and conceivably increase risks of flooding. Impacts would be expected to be moderate.

4.3.9.2 Nenana River to Summit

Through this area the primary challenge would be to coordinate the drainage design with that existing for the railroad and the highway so as to not accelerate erosion for either of the existing systems.

4.3.9.3 Summit to Cook Inlet

Through both the Chulitna and Susitna portions of section, the prime hydrologic impacts of the pipeline would be the potential for affecting the water quality of the existing streams or alterating hydraulics of the adjoining highway or railroad drainage structures.

Primary hydrologic impacts in the Willow to Cook Inlet section would be construction-related pollution and erosion. Additional long-term impacts to water quality might arise because of improved access to an otherwise inaccessible area. Impacts would probably be minor in this section.

4.3.9.4 Cook Inlet to Boulder Point

Impacts are primarily from construction-related erosion and would most likely be minor.

4.3.10 Marine Biology and Oceanography

The marine environment could affect or be affected by project construction or operation in ways similar to those described for the proposed project (Subsection 4.2.10.1). The Cook Inlet-Boulder Point alternative is notably different from the proposed project in its additional requirement for a 15-mile subsea pipeline. This introduces a major construction activity into the marine environment and subjects the project to an additional potential impact from accidents and pipeline maintenance or repair. Further, there are several major differences in the characteristics of the marine environment for the Cook Inlet-Boulder Point alternative that influence potential environmental impacts. The presence of tidal extremes in excess of 30 feet vertical height and accompanying currents reaching as high as 6 to 7 knots present major problems to marine construction, facility design, and routine operations that would also increase the potential for accidents. Extreme winter icing conditions would increase the probability that operations would have to be curtailed at times and also increase the potential for accidents. Sites north of the East Forelands were considered as technically unacceptable for the proposed western LNG facility by YPC staff for reasons including "severe winter ice conditions which could adversely affect the operation of the marine terminal associated with the proposed project" (FPC 1978, p. 239). Extensive shoaling areas off the East Forelands just south of Boulder Point would require some dredging and pose potential navigational hazards, while sedimentation, scour, and the presence of mobile submarine bedformswould effect engineering design suitability for marine terminal facility offshore components.

Burial of the pipe crossing Cook Inlet deep enough to ensure it would not be exposed by scour or endangered by ships anchors would be difficult. Winter construction or repair would be practically impossible because of floating ice and the extreme tidal current. To ensure dependable service, two crossings might be necessary. The crossings would need to be widely separated so that in the event one fails flow could be maintained by diverting gas to the other crossing. Impacts in this area likely would be moderate. All these factors make construction of the pipeline crossing and construction and maintenance of the marine terminal more difficult and possibly make the entire systems more susceptible to accidents during operations.

There is less deepwater turning room for tanker maneuvering and anchoring in Cook Inlet, which has a narrow channel and major potential problems with ice in the winter season. The number of vessels passing through the area is not as great as in Valdez Arm, but there is the chance vessels might anchor in the vicinity of the pipeline crossing and perhaps drag the anchor across the pipe. The subsea transmission line from the west side of Cook Inlet has been broken in this manner, causing electrical outages in Anchorage.

The marine terminal pilings could cause sediment to accumulate or erode due to changes in current patterns, resulting in sills being created or producing a deeper channel which could impact marine operation.

Marine birds, fish, or mammals would not be affected by the facility or resultant tanker traffic. There is an increased possibility of an oil spill due to increased ship traffic in the area; and such a spill could cause damage to the local clam beds or affect bald eagle populations which gather each summer at the mouths of most Cook Inlet rivers. Spills would be difficult to control or clean up in the area during high winds and/or broken ice conditions.

There could be minor incidents of collision of beluga whales with ship traffic.

4.3.11 Fish

Since construction techniques, mitigation procedures, and types of streams involved are similar, impacts along both routes would be similar. (Fish impacts along the proposed route are discussed in Subsection 4.2.11.) Those areas where impacts would be different are discussed below.

More fishing pressure from construction workers and possibly improved access would result in increased stress to fish populations during TAGS construction and possibly operation along the Cook Inlet route. There is also a chance that some existing, heavily used areas would have restricted access after construction due to creation of an exclusion or security zone around some TAGS-related facilities, resulting in decreased fishing pressure. Much of this can be regulated. A number of access roads, workpads, and culverts crossing many streams could result in temporary blockage of small streams and cross drainages, erosion and resultant turbidity into local streams along the Cook Inlet-Boulder Point route, as would excavation of a greater number of new materials sites. Impacts would probably be moderate during construction and minor during operation.

There would be minor impacts from the compressor stations, LNG plant, or marine terminal to freshwater or anadromous fish resources along the Cook Inlet-Boulder Point route.

It is not known whether construction would occur on active floodplains or whether any training structures would be required at major river crossings along the Cook Inlet alternative route, so these impacts, if any, would be undetermined.

4.3.12 Vegetation and Wetlands

The impacts on vegetation and wetlands along and adjacent to the proposed alternative route to Cook Inlet would essentially be the same as those described in detail in Subsection 4.2.12. No quantitative estimates of the amounts of specific vegetation types directly affected by the proposed project activities are available other than the approximate proportions from the DOI (1976b).

The wetlands directly affected by this alternative would constitute a relatively large proportion of the route, primarily involving lowland spruce-hardwood forests, bogs and marshes along the eastern Minto Flats, lowlands between Nenana and the Alaska Range, the lower Susitna River valley, and the coastal marshes of the Susitna Flats. Overall impacts to vegetation and wetlands would be major during construction and operation.

The DOI (1976) identified the higher susceptibility to fire of the forests on the Kenai Peninsula, as opposed to coastal forest in the Valdez region, as the major difference between the two routes. However, fire is often quite valuable to wildlife habitat and is used as a habitat enhancement tool on the Kenai Peninsula.

4.3.13 Wildlife

The general impacts of the proposed Cook Inlet alternative route would be the same as those described in Subsection 4.2.13. Of primary concern would be disturbance and local disruption of movements of large mammals during the construction phase. With this proposed route, however, no important caribou migration routes would be crossed, and effects would therefore be negligible. Disturbance of wintering Dall sheep in the area of Compressor Station No. 8A would constitute a minor impact. Increased human activity and access and the probability of increased direct mortality through hunting and poaching of animals, especially moose, would cause minor to moderate impacts. The abundance of black bears along the proposed alternative route could possibly result in problems caused by attraction to artificial food sources; other carnivore species (brown bear, wolf, red fox) would be affected as well. Impacts would likely be minor.

The primary impacts on birds from the proposed Cook Inlet alternative route would involve disturbance of and increased access to important nesting and staging habitats of waterfowl, mainly in the Minto and Susitna flats. These impacts would be moderate for the Minto Flats area but minor overall. Other potential impacts on birds are discussed in Subsection 5.13.

4.3.14 Endangered or Threatened Species

Since no known nesting areas occur along the route for peregrine falcons, there would most likely be no impact to this species.

There is a good chance that the route would pass close to one or more occupied bald eagle nests. Construction during the fall and winter would prevent significant disturbance to these species. Oil spills could cause problems with eagles or other raptors which might feed on oiled birds and ingest toxic petroleum in that manner.

There is a possibility that the two candidate plant species could be disturbed during pipeline construction in high passes in the Alaska Range, but ground searches would be made before construction to identify and allow avoidance of any extremely important areas.

Overall, impacts to threatened or endangered plant or bird species would be minor to negligible.

4.3.15 Recreation, Aesthetics, and Wildlife

The environmental consequences of the Cook Inlet route on recreational resources would be of a similar nature to those described for the proposed route in Subsection 4.2.15. Major differences would occur because of the much larger population in the Railbelt area, resulting in heavier demand on all recreational resources. Nearly half of Alaska's population lives in or near Anchorage, which is only about 30 miles across the inlet from the mouth of the Susitna River. Many people from Anchorage came to and stay in Alaska to enjoy the unparalleled recreational opportunities.

The two major transportation routes from Anchorage lead to the Railbelt area or to the Kenai Peninsula, both of which are near the proposed Cook Inlet route. This causes accessible recreational sites in these areas to be very crowded seasonally. Fishing, clamming, hunting, and other pursuits occur primarily along the Kenai Peninsula beaches and rivers. The addition of several thousand workers during project construction would put a significant strain on existing, already crowded recreational access points.

Especially susceptible to impacts would be the highway-accessible fishing streams, such as Sheep Creek, Montana Creek, and Willow Creek. Access points to the rivers in the area (Kashwitna Landing, the Little Susitna, and Talkeetna) would be stressed, as would air charter services to such highly popular areas as the Theodore River, near the mouth of the Susitna, the Deska, or Lake Creek.

Hunting pressures, already heavy, would also increase in accessible areas near the road system and the major riverways such as the Susitna and the Swanson. Use of all recreational areas would increase, but many are presently underused and would not be stressed. Among those presently underused would be the Nancy Lake Recreation Area, the Little Susitna Campground, and Denali State Park. Air traffic would increase moderately, resulting in more noise and a less enjoyable outdoor and wilderness experience for many present users.

Overall, impacts to recreational resources would probably be moderate for this area during construction and moderate to minor during operation.

4.3.16 Cultural

Archaeological studies have been performed along or near the proposed Cook Inlet-Boulder Point route by the Susitna Hydro Project and the Anchorage-Fairbanks Intertie Project. The studies suggest this alternative route passes near a potentially important archaeological site, and the possibility is high for further significant finds in the area. The Dry Creek Archaeological Site, entered on the National Register in 1974, is thus far the oldest reliably dated site of human occupation in Alaska. Artifacts from the site show certain similarities to the later Upper Pleistocene Diuktai culture of northeastern Siberia. The site is also capable of yielding important paleoecological information. It is located about 100 miles south of Fairbanks near Healy.

Only general archaeological surveys have been conducted on the east side of the lower Susitna River. Prehistoric occupation did occur in this area, and further archaeological investigations in areas such as the Beluga coal field are expected to yield positive results.

Insufficient data exist to estimate the paleontological potential along the route. Virtually no archaeological work has been conducted on the north and west sides of Cook Inlet. These areas were occupied in prehistoric time, and investigation is expected to yield archaeological finds.

The Cook Inlet alternative route through the Railbelt lies near the most heavily populated and most developed region in Alaska. As a consequence, several archaeological surveys and investigations have been accomplished, but the possibility of damage to yet-unknown sites is still quite high. This potential damage could be quite major in light of the fact the Healy site is one of the most important archaeological sites in Alaska.

Although extensive archaeological surveys would be completed prior to construction along this route and those sites would be excavated or avoided to the extent possible, there is still the possibility of disturbance of sites without proper investigation, vandalism of sites, and/or removal of surface artifacts which might be of great significance. Since construction would be in the winter as well as summer, it is probable that excavation of some sites would have to be carried out under difficult winter conditions, causing destruction or loss of information on sites or artifacts.

Impacts to archaeological sites would be moderate along the Cook Inlet route during construction and negligible during operation.

4.3.17 Subsistence

The general impacts of the TAGS project activities on subsistence are discussed in Subsection 3.2.17. The impacts along the Cook Inlet alternative are similar to those along the proposed route. The seven types of impacts on fish and wildlife used for subsistence resources are: harvest and access interferences; project employment; relocation and/or increased harvest effort; reduced subsistence harvest; and reduced subsistence harvest levels. These are discussed in the following paragraphs.

The Cook Inlet alternative would result in reduced fish and wildlife resources used for subsistence activities in three ways: mortality, avoidance, and habitat loss. See Subsection 4.2.17 for further information.

Along the Nenana Corridor, caribou, moose, and fish would be the most sensitive to impact, although proposed construction and mitigation measures would minimize impacts to fish. Communities close to the alternative route would be more likely to be affected. These include Minto, Nenana, Anderson/Clear, Healy/Sultrana, and McKinley Village. Wildlife avoidance of the construction zone would temporarily require harvest in areas more remote from construction activities.

Impacts to Cook Inlet and Anchorage/Kenai communities would be similar to those in the Nenana Corridor except that these areas are not classified as rural subsistence areas under game management regulations, and participation in subsistence is relatively lower.

4.3.17.1 Interference/Access Impacts

As mentioned in Subsection 4.2.17.3 proposed TAGS project construction and operation have the potential to interfere with subsistence activities. The primary causes of interference would be restriction of access to traditional subsistence use areas and restrictions on hunting and fishing in the vicinity of the TAGS project. Rural subsistence communities located adjacent to the alternative route (Nenana, Anderson/Clear, Healy/Sultrana, and McKinley Village) would be more sensitive to interference and access impacts than those which have a broad subsistence use area or are less dependent on subsistence resources.

4.3.17.2 Increased Sport Hunting, Fishing and Trapping Competition

Like the proposed action, the alternative route would be subject to increased levels of sport hunting, fishing, and trapping during construction and operation of the project (see Subsection 4.2.17.4). The availability of public access along the alternative route already supports high levels of subsistence, sports hunting, fishing, and trapping activities. Introduction of direct and indirect employees would increase these activities. Rural subsistence communities located adjacent to the alternative route such as Nenana, Anderson/Clear, Healy/Sultrana, and McKinley Village would be more sensitive to interference impacts than those which are farther away from the route and have broad subsistence use areas or are less dependent on subsistence resources.

4.3.17.3 Impacts from Employment

Local employment on the alternative project would be highly desirable, and income provided would temporarily offset subsistence-related economic impacts. However, as mentioned in Subsection 4.2.17.5, employment also presents some disadvantages to participating in the traditional subsistence way of life by reducing the flexibility to pursue seasonal subsistence activities. The communities that are most likely to be affected by employment-created subsistence impacts are those that are predominantly Native with a social structure and personal identity that revolve around participation in subsistence activities. This would include Minto and part of the population of Nenana.

4.3.17.4 Relocation/Increased Harvest Effort

Any reduction in subsistence harvest caused by the project would result in relocation of and/or increased harvest effort (Subsection 4.2.17.6). Communities located adjacent to the alternative route, such as those in the Nenana Corridor and upper Cook Inlet area, are more sensitive to impacts from relocated or increased effort than those which are further away or have broad subsistence use areas. Because of greatly reduced levels of activity and construction facility closure/rehabilitation after construction, relocation and increased effort impacts would be minor during project operation.

4.3.17.5 Economic Impacts

Economic impacts result from increased outlays of cash to replace reductions in subsistence harvests and to support increased harvest efforts to make up for reductions in resources (see Subsection 4.2.17.7). Communities with limited employment opportunities located adjacent to the alternative route, such as Native communities in the Nenana Corridor (Minto and Nenana), would be more sensitive to competition impacts than those which are farther away or have broad subsistence use areas. These impacts would be partially offset by local employment opportunities.

4.3.17.6 Social Impacts

The social impacts from the loss of participation in subsistence activities include loss of cultural identity and status in the affected community, dietary impacts, and aggravation of social problems such as depression and substance abuse (Subsection 4.2.17.8)

The communities that would most likely be sensitive to social impacts from reduced subsistence activities would be those that are predominantly Native with a social structure and personal identity that revolve around participation in subsistence activities, such as Minto and Nenana. Proximity to the alternative route, severity of harvest opportunity reduction, and limited alternatives for relocation of effort would also aggravate social impacts.

Overall, impacts to subsistence communities would be moderate to some villages along the northern section of the route during construction and minor during operation. Impacts to subsistence uses would likley be negligible to communities along the southern part of the route during both construction and operation.

4.4 COMPARISON OF ENVIRONMENTAL EFFECTS OF THE COOK INLET ALTERNATIVE WITH THE PROPOSED PROJECT

4.4.1 Introduction

Table 4.4.1-1 presents a comparative summary of the environmental disciplines of the proposed TAGS project versus the Cook Inlet-Boulder Point alternative. The affected environment and potential consequences of the Cook Inlet-Boulder Point alternative were described in Subsections 3.3 and 4.3. The affected environment and environmental consequences of the proposed project to Anderson Bay are fully developed in Subsections 3.2 and 4.2. For each of the environmental disciplines addressed in this EIS, an evaluation was conducted to determine whether either the proposed project or the Cook Inlet-Boulder Point alternative presents a clear difference in the overall level of impact for the specific environmental disciplines. For most disciplines a variety of potential impacts emerged that had to be qualitatively considered and weighed and a judgment made on whether a distinctly preferable advantage existed for one route over the other. When advantages and disadvantages essentially balanced, the routes were considered to be similar in level of impact.

For 10 of the 16 discipline categories considered, no clearly preferable route (Table 4.4.1-1) emerged. These included socioeconomics; noise; air quality; liquid, solid, and hazardous wastes; geology; water resources; marine environment; fish; vegetation and wetlands; wildlife; subsistence; and geology.

The Cook Inlet-Boulder Point alignment is considered to have the least potential for adverse impacts to threatened and endangered species. The proposed project to Anderson Bay is considered to have the least potential for adverse impacts to land use, transportation, recreation and aesthetics, and cultural resources.

4.4.2 Disciplines Favoring the Cook Inlet Alternative

4.4.2.1 Threatened or Endangered Species

Though the Cook Inlet-Boulder Point alternative may need to contend with the presence of eagle nests along the Susitna River and two candidate threatened species of plants, the proposed project to Anderson Bay must address concerns with known peregrine falcon and bald eagle nests, endangered whale species, and several candidates for threatened plant species. Though mitigation measures that would be implemented for the project should prevent disturbance to any of these species, the greater number of such species with the applicant's proposed project indicate a greater potential for adverse impacts to threatened and endangered species.

4.4.3 Disciplines Favoring the Proposed Project

4.4.3.1 Land Use

The proposed TAGS route would parallel an existing pipeline/utility corridor, though it would cross or disturb several state recreational 4(f) areas at Quartz Lake, Dry Creek, Worthington Glacier, and Blueberry Lake. The Cook Inlet-Boulder

Table 4.4.1-1 Route Comparison Using Environmental Criteria

Environmental Topic	Environmentally Preferred Route
Socioeconomics	Routes Similar
Land Use	Proposed TAGS Project
Transportation	Proposed TAGS Project
Noise	Proposed TAGS Project
Air Quality	Routes Similar
Liquid, Solid and Hazardous Wastes	Routes Similar
Geology, Soils and Permafrost	Routes Similar
Surface and Ground Water	Routes Similar
Marine Environment	Routes Similar
Fish	Routes Similar
Vegetation and Wetlands	Routes Similar
Wildlife (and birds)	Routes Similar
Threatened and Endangered Species	Inlet Alternative Route
Recreation and Aesthetics	Proposed TAGS Project
Cultural Resources	Proposed TAGS Project
Subsistence	Routes Similar

Point alternative would cross a number of parks, and subsistence and recreation areas, including: Minto Flats, Denali National Park and Preserve, Denali State Park, the Susitna Flats State Game Refuge, Nancy Lake State Recreational Areas, and the Captain Cook State Park. The presence of a larger number of very sensitive areas and the larger amount of private land along the alignment and at the proposed LNG plant site favor the proposed project.

4.4.3.2 Transportation

Construction of the proposed TAGS project would very likely cause vehicular traffic delays at several points along the alignment such as Phelan Creek, Atigun Pass, and Keystone Canyon. There would also be a major increase in traffic along highways paralleling the alignment. For the Cook Inlet-Boulder Point alternative, however, there is a much larger base of existing traffic, and there are several key places for which major traffic delays would be likely to occur. These include the George Parks Highway in the general area of Denali National Park and Preserve, the Matanuska-Susitna Borough, and on the Kenai Peninsula. Both on the basis of affecting a larger existing volume of traffic and the additional locations likely to be affected, the proposed project would be expected to have the least impact on transportation.

4.4.3.3 Recreation and Aesthetics

Outdoor recreational pursuits are popular throughout the area of the proposed project as well as along the Cook Inlet-Boulder Point alternative. Recreational use would be affected by the number of recreational users, impacts to wildlife, access, traffic, and aesthetics and would relate both to construction and to operations. Though the most popular types of recreation vary somewhat among the two alignments, which might be a factor in the consideration of impact, the number of recreational users is substantially greater in the Cook Inlet alternative project area, and recreational and aesthetic impacts would be expected to have a greater effect with proposed project.

4.4.3.4 Cultural Resources

There are numerous small archaeological sites of minor importance along both the proposed Anderson Bay alignment and the Cook Inlet-Boulder Point alternative. Those areas along the proposed project are better known and documented due to the TAPS and authorized ANGTS siting work. Along the Cook Inlet-Boulder Point alternative alignment, one very important site has been identified, the Dry Gulch site near Healy, and most of the route has not been surveyed. On the basis of this one important identified site and the possibility that other sites may exist along the Cook Inlet route, there is a greater potential for impact to cultural resources along the Cook Inlet-Boulder Point route than for the proposed project.

4.4.4 Summary

The potential environmental consequences of constructing and operating a pipeline from Livengood, where the system would diverge from the applicant's proposed alignment, to an LNG plant and marine terminal at Boulder Point on Cook Inlet were analyzed and compared with environmental consequences anticipated for the proposed project. It was determined that on balance the impacts anticipated from either the proposed project or from the Cook Inlet-Boulder Point alternative would be similar in scope and range. The proposed project would be expected to have the greater potential to affect threatened or endangered species because of their greater occurrence in the vicinity of the project, whereas the Cook Inlet alternative to Boulder Point would have greater potential impacts in several areas, notably land use, transportation, recreation and aesthetics, and cultural resources. Since disturbance impacts to threatened or endangered species would be mitigatable, the applicant's proposed project was determined by the agency to be the preferred alternative.

4.5 CUMULATIVE IMPACTS

4.5.1 Introduction

The cumulative impacts for the proposed TAGS project considers the previous TAPS, existing highway construction and the authorized ANGTS project within the 796-mile transportation utility corridor, along with the Alyeska oil terminal, the proposed Alaska Pacific Refinery and Valpetro Petroleum Refinery in Port Valdez. Because the TAPS pipeline and Alyeska Marine Terminal are in place, specific details of the projects and impacts of their construction are already known. Construction, operations and maintenance impacts for TAPS have been documented for the past 10 years.

The Office of the Federal Inspector on October 3, 1986 noted that Northwest Alaskan Pipeline Company (NAPC) was considering the merits of shifting from a system designed around a 48-inch pipeline to a smaller, higher pressure delivery system. Informal discussion by BLM with representatives of NAPC in January 1987 led to a decision to prepare this evaluation on the basis of the existing, approved 48-inch pipeline. On February 18, 1987 the Office of the Federal Inspector in its annual report on ANGTS concluded that although action was suspended, "the project continues to offer great promise in making available to Americans abundant supplies of Alaskan natural gas." Accordingly this section evaluates the effects of TAGS assuming ANGTS is built as authorized.

Although there is no firm commitment to proceed for the two proposed Valdez refineries, the relative magnitude of the projects and their geographical coincidence with the proposed TAGS pipeline, LNG plant and terminal necessitates consideration of potential cumulative impacts. The cumulative impact discussions, by discipline, are general and qualitative and based on the supposition that none of these projects would be constructed concurrently. Key aspects of the authorized ANGTS and the proposed Valdez TAPS refineries are summarized below.

4.5.1.1 TAPS

The TAPS is composed of an 800-mile-long pipeline system with 12 pump stations along its length from Prudhoe Bay to the Port Valdez oil terminal. The proposed TAGS project is located primarily within the utility corridor developed for the TAPS project from Prudhoe Bay to Port Valdez. Since its initial establishment in 1974, the federal lands within the utility corridor have been transferred primarily to state and Native ownership. This is especially true for the area between the Yukon River and Fairbanks and in the Copper River Basin.

4.5.1.2 ANGTS

The approved ANGTS project would result in the construction of 745 miles of 48-inch-diameter pipeline from Prudhoe Bay to the Alaska/Yukon border with a total of 15 compressor stations. Of the 745 miles of pipeline alignment, approximately 550 miles would be adjacent to the proposed TAGS alignment along with 12 of the 15 compressor stations from Prudhoe Bay to Delta Junction. With the exception of several river crossings, the entire authorized ANGTS, like TAGS, would be totally below ground. This discussion assumes that ANGTS would be built according to the approved

Revision 4 alignment and that the construction of TAGS and ANGTS would not be concurrent.

4.5.1. Alaska Pacific Refinery

The proposed Alaska Pacific Refinery is a 100,000-bbl/day crude oil refinery which is scheduled to be built beginning in 1988 on the old ALPETCO site just east of the Valdez Airport near Robe Lake. This refinery would produce products ranging from fuel gas to No. 6 bunker fuel. The products are intended to be shipped from Valdez to Pacific Rim countries via tankers. There would be product lines from the refinery site to a marine facility located just off the grainery on the north side of Port Valdez.

4.5.1. Proposed Valpetro Refinery

The Valpetro Refinery is a proposed small topping plant that would process about 8,000 bbl/day of number 1 and 2 diesel, plus enough fuel gas to operate the plant. The facility is intended to be located on the hillside just east of the Alyeska terminal. Construction would begin in 1987. The product line would lead to an offshore loading bulkhead just east of Winnebago Point.

4.5.2 Socioeconomics

Cumulative construction and operational impacts of the project area would be positive in that the proposed TAGS project would take advantage of presently unused infrastructure and labor throughout the corridor and around the state. Construction would result in temporary need for housing and other services in Fairbanks, Delta Junction, Glennallen/Copper Center, and Valdez with minimal new infrastructure requirements due to the expansion during and following TAPS. The same would be true of the authorized ANGTS. Likewise, following construction, this greater magnitude would cause more employment and population declines after the projects were completed.

The cumulative impacts of the TAGS and approved ANGTS projects during the operating phase would be a slightly higher level of employment but would not affect housing and other services significantly. The major long-term impact of the two projects would be higher property tax revenues for the North Slope Borough, Fairbanks North Star Borough and the City of Valdez, and higher property tax, severence tax, and royalty income to the State.

Valdez would likely experience the largest relative cumulative socioeconomic impacts but

Valdez would be adequately prepared to accommodate the construction related impacts. Due to the present oversupply of all infrastructure, no major construction or operational cumulative impacts would be expected. Most beneficial to the economy of the State of Alaska would be the stretching out of each of these projects to make more efficient use of the existing infrastructure, labor force, and economic benefits.

4.5.3 Land Use

Cumulative impacts to present land uses would be minor since the route is primarily within the utility corridor created by TAPS and the highway system and are nonadditive except for minor route alignments which would be additive. Impacts to present hunting, fishing, recreation, subsistence, mineral resources, timber, and logging would be additive but minor due the present usage. Impacts to agriculture and agricultural lands would be negligible since the area involved would be small and the reuse of any disturbed areas could be accommodated after construction was completed.

Major impacts would likely occur from combined project gravel extraction. These resources are limited along the corridor and combined demand exceeds the supply that exists without crushing rocks from the talus slopes and exposed outcropping. Cumulative impacts, which would be additive, would include visual scars, increased erosion, and moderate wildlife habitat loss. Additional impacts due to gravel extraction would involve the cost to the developer of the less accessible gravel resources.

The construction of both the TAGS and authorized ANGTS, along with the presence of TAPS and the highway, would prohibit further pipeline or major north/south highway expansion at Atigun Pass, the Middle Fork of Koyukuk River near Sukakpak, Phelan Creek, and Keystone Canyon. These cumulative impacts would be major should the need for another pipeline or utility system be required, otherwise the impact would be negligible.

4.5.4 Transportation

Cumulative impacts of construction of the proposed TAGS facilities would be interactive with existing transportation systems and, except for the requirement for long-term availability of lowcost mineral material for highway maintenance,.

of short duration. Minor impacts would include traffic delays, dust accumulations during dry periods, stress on the integrity of the existing highway maintenance program, and increased potential for accidents. During construction, truck traffic would not exceed DOT/PF's maximum highway capacities; following construction, impacts would be minor. Individual construction impacts would be nonadditive for shipping and commercial transportation systems throughout the state. Coordinated scheduling would alleviate part of the problem, but impacts during construction would be moderate for all highway users and minor thereafter.

Future new transportation routes that might be established in a easterly or westerly direction from existing highways needing to cross TAGS in additional to ANGTS and TAPS would realize special design and construction costs. TAPS would have special access design features where such features were required of TAPS and authorized ANGTS. Accordingly, there should be no major cumulative impact on future transportation.

There would be some minor impacts to the marine transportation system, especially at Valdez Narrows and within Port Valdez. This would be alleviated to some extent by the strict U.S. Coast Guard controls, but there would still be the increased likelihood of minor and major oil spills and ship collisions, as well as competition for sea lanes between petroleum ships, fishing vessels, and other marine traffic.

4.5.5 Noise

Noise impacts of the project would mainly involve disturbance to humans and wildlife. Construction noise would increase either in duration or location with each project. Because all construction activities are short term, inconvenience to humans or dislocation of some wildlife would be temporary. Noise from long-term facility operations (including compressor stations, LNG plant and terminal), from transportation along land, air, and marine corridors, and from other activities associated with increased human populations and ancillary structures would be interactive with existing noise levels plus that of other potential projects. There would be minimal cumulative increases in noise mainly along the pipeline corridors and in Port Valdez resulting in minor impacts.

4.5.6 Air Quality

Air quality impacts are generally additive along the route. Cumulative effects on air quality within the entire project area would likely be important only in Port Valdez. Particulates, NO_x, and SO_2 would likely increase slightly due to additional equipment, traffic, and on-site construction. Impacts along the right-of-way during construction would be short lived and moderate.

Cumulative air quality impacts of concern are interactive in the Valdez area. The Alaska Department of Environmental Conservation (DEC) is presently questioning whether the Valdez area is still an attainment zone for SO_2 since the number of oil tankers has almost doubled since 1980 due to increased oil flow through TAPS (W. MacLarence, pers. comm.).

Should all proposed projects proceed, there would be only minor construction impacts, but operational impacts to air quality of the combined facilities plus associated ship traffic could cause some pollutants to exceed established standards. Should this occur, all emissions sources would be required to meet "best available control technology" standards. This could possibly include use of scrubbers and bag houses, switching to low sulfur fuels for oil tankers while in port, and various other control technologies. Valdez would likely become a nonattainment zone for SO_2 if all projects were to proceed.

4.5.7 Solid Waste, Hazardous Materials and Sanitation

There would be no cumulative impacts due to solid and hazardous wastes if disposal is done in the manner prescribed by current EPA and DEC requirements. There might be some additive impacts due to liquid waste disposal if more than one discharge entered the same water body within a short distance or period of time. Since care would be taken to see that didn't occur, there would most likely be only minor or negligible impacts. Should multiple discharges occur, impacts would only be minor and local due to compliance with strict state and federal regulations.

4.5.8 Geology and Soils

Construction of proposed TAGS and authorized ANGTS along with associated access roads, construction camps, and compressor stations requires large amounts of borrow material. This resource is already greatly depleted in certain areas along the route, especially on the North Slope. Development of new borrow sources or additional extraction from existing sites could affect the supply available for highway and TAPS maintenance and for the construction of both authorized ANGTS and the proposed TAGS project. The use of more expensive techniques such as rock crushing or longer haul distance from convential fluvial gravel sources might be required. Use of geofabrics to reduce the amount of gravel needed to protect sensitive permafrost environments is another option as is use of snow/ice workpad construction that would reduce the amounts of mineral materials required for TAGS in areas where gravel is, or would be, in short supply.

The proposed routing of several pipelines through Atigun Pass and the relatively confined valleys of the Atigun and South Fork Koyukuk rivers, Phelan Creek, and Keystone Canyon could affect stability of the steep slopes. Cumulative impacts along the Yukon-Tanana Uplands could result from several pipelines passing through thermal degradation areas of relatively warm, ice-rich permafrost. There would be moderate impacts during construction and for that period prior to startup. Likewise, mass wasting and subsequent erosion and gullying could occur locally where more than one pipeline crosses highly developed solifluction slopes. Both of these situations would be localized to the construction area and would be mitigated once operation in the chilled mode occurred, with minor impacts.

Cumulative effects could also result from thermal degradation of fine-grained, discontinuously frozen soils at pipeline crossings and where permanent TAGS access roads would cross TAPS in the Copper River basin.

Along the Chugach Mountains segment, increased rates of erosion at the numerous stream crossings and mass wasting and instability of the steep slopes found in this segment could affect the structural integrity of other facilities and interact to yield major impacts. Careful design, use of proven techniques, and effective quality control would minimize the likelihood that any such impacts would occur.

4.5.9 Surface and Ground Water

Most potential impacts to ground or surface water resulting from the TAGS, TAPS, and authorized ANGTS projects are independent and additive. For surface water these would include such considerations as scour and erosion. For ground water, disturbance of flow, thermal degradation, and interference with recharge are the major concerns.

Major potential interactive impacts are those that would affect the thermal regime, aquifer flow, or the water supply for other projects. Critical areas would include those for which the pipeline projects are close to each other and areas for which water resources might be scarce.

Areas of potential concern include the Sagavanirktok River terraces, where gravel mining operations could adversely alter surface water flow near the TAPS river crossings and river training structures; alluvial fans and thawed gravels below the Atigun and Chandalar rivers where project activities could cause new or enlarged icings in streams near the 13 miles proximate to the authorized ANGTS and cause stream diversion and other possible problems; and stream crossings between the Yukon River and the Elliott Highway where increased erosion and sedimentation could change icings and impact TAPS, ANGTS, or the highway. These impacts would be moderate.

Cumulative impacts related to use of surface and ground water in the Valdez area would be minimal.

4.5.10 Marine Environment

Cumulative impacts of TAGS to the marine environment could develop from:

- Construction activities from all proposed projects that resulted in increased turbidity, loss of intertidal and subtidal benthic habitat and loss of nearshore habitat from use by marine mammals and birds.
- Additional pollutants from facility discharges.
- Increased potential for impacts via hydrocarbons or toxic or hazardous substance spills.
- Increased disturbance from combined facility operations and associated vessel traffic.
- Impacts from increased human population and ancillary developments. Construction of the proposed refineries would cause additive impacts in all areas.

Operations of the TAPS and TAGS terminal along with the two proposed refineries would increase tanker traffic in the Port of Valdez. This increase would be additive and would not preclude additional increases in tanker traffic.

Several factors concerning existing conditions in Port Valdez and characteristics of the proposed facility are particularly important in considering cumulative impacts of the TAGS project with existing and proposed projects. Of great importance is oceanographic information concerning the harbor; its size, circulation patterns, and flushing rate minimize the residence time of discharges into the western half of the port. Existing pollutant loading appears to be negligible, and the capacity of Port Valdez to dilute and remove additional pollutants in low concentration would probably not be exceeded with planned projects. The high existing sediment load in the eastern end of the port minimizes the likelihood that temporary dredging-related increases would have any significant negative impact. The location of the TAGS project in the western half of the port, away from important fisheries streams and bird concentration areas, suggests that this project would not have any impacts additive to those from projects in the eastern reaches of the port.

4.5.11 Fish

Cumulative impacts to local fish populations would be attributable to factors such as erosion, training walls, culvert placement, and washouts of buried crossings. The applicant's proposed mitigation measures related to timing of construction and use of appropriate stream crossing techniques should minimize the possibility major cumulatives impacts due to physical changes.

One of the most important types of cumulative impacts would occur from additional fishing pressure due to the TAGS project at stream access point along the entire corridor. Slow-growing indigenous fish populations can't withstand heavy fishing pressure, and the size and number of catchable fish declines. This has already occurred along the TAPS corridor and unless controlled, would result in additional impacts during TAGS construction. The addition of two buried pipelines to areas where there is already a single buried pipeline and perhaps a nearby road culvert could cause moderate cumulative impacts.

The most probable cause of cumulative impacts would be changes to stream flow and sedimentation due to dredging for buried stream crossings. Site-specific stream crossing stipulations would be prepared. Adherence to those stipulations would reduce or eliminate most cumulative impacts. Frequent inspection during construction and operations should identify potential erosion, siltation, or hydrological problems before they affect fisher habitat.

Some impacts to sensitive fish habitat such as spawning areas and overwintering locations already exist due to the highway system and TAGS. The approved ANGTS would add to these impacts and eventually the TAGS project would increase disturbance to these areas.

The potential for cumulative impacts to fish resources would be moderate during construction and minor during postconstruction.

4.5.12 Vegetation and Wetlands

Cumulative impacts to vegetation would be related primarily to the additive effects of habitat temporarily or permanently lost. Since there are no endangered plant species and the total vegetation area lost to all projects combined would not be large, the impacts would be minor. The areas disturbed during pipeline construction would be regraded and contoured to encourage natural replacement of the vegetative cover. These impacts would be additive for the disturbed areas and should not affect TAPS or authorized ANGTS.

Wetland impacts would be similar to those which occurred as a result of the TAPS and highway construction. Wetland impacts would include the drying up of some areas due to restriction of sheet flow volume or duration and possibly flooding of some wetlands, resulting in loss of some vegetation species and wildlife habitat. Cumulative impacts due to TAGS and authorized ANGTS would be prevented by disturbance of the smallest area possible, careful attention to drainage patterns, proper grading and culverting, and prompt revegetation to prevent erosion and maintain natural flows as nearly as possible.

4.5.13 Wildlife

Potential cumulative impacts to birds would be primarily derived from construction-related activity, including noise from heavy equipment and aircraft. The amount of total wildlife habitat lost after construction would be negligible. Seasonal restrictions would likely be imposed, preventing certain construction activities during summer months. This would alleviate most of the potential impacts that could occur to raptors and other birds during the nesting season.

Cumulative wildlife impacts to mammals would typically be additive. In most cases, there would be few direct effects leading to loss of animals except for collision with vehicles. Impacts could be absorbed without decrease to the local or regional population. Heightened stress would be expected on local wildlife populations by construction-related activities such as machinery operations and aircraft and vehicular traffic during sensitive periods such as lambing or calving. Sheep might be prevented from using certain mineral licks for a few months. These impacts would be shortlived and localized and therefore minor.

Postconstruction cumulative impacts of the buried pipelines would be negligible.

There would be some cumulative impacts to birds due to collisions with additional structures such as towers and buildings and due to additional vehicular traffic. These impacts would likely be minor.

4.5.14 Threatened or Endangered Species

All proposed projects emphasize avoidance of the nesting sites of endangered and threatened peregrine falcons, as well as bald eagles, gyrfalcons, and golden eagles. Little direct cumulative impact is anticipated since ANGTS and TAGS construction would not occur simultaneous. Increased access and increases in construction personnel along the pipeline corridor and in Valdez would result in a greater potential for disturbance to nesting raptors through recreational activites. Except during construction, the amount of disturbance would appear to be minor; increased recreation and construction activities should not result in the loss of individuals of any endangered or threatened species.

The addition of LNG tankers to the northern Prince William Sound area increases the change for accidental collisions between ships and endangered whale species. Such occurrences are unavoidable but extremely rare. Section 7 consultation on endangered species has begun, and initial correspondence from NMFS and USFW indicate there is no problem involving endangered species if agency guidelines are complied with.

4.5.15 Recreation, Aesthetics, and Wilderness

Along the northern portion of the TAGS route, cumulative impacts to aesthetics would in many cases be increased due to the overall space occupied by four separated, cleared rights-of-way in a single corridor. Construction activities and associated noise, traffic, and visual impacts would be greater in magnitude or duration given both the TAGS and ANGTS pipelines. There would be approximately twice the present number of surface facilities such as compressor stations along the corridor, as well as increased visual scars on the landscape from borrow pits and access roads. Cumulative impacts to aesthetics along the corridor would be moderate.

Increased access to lands for recreation would probably occur with both projects, and increased numbers of people employed along the pipeline routes would probably translate into some increased recreational use and stress, resulting in minor impacts.

Cumulative impacts to recreation and aesthetics in the Valdez area would result in considerably stressed recreational areas during construction periods, considering the major influx of workers. Over time, a permanent increase in the population of Valdez to support operation of the TAGS LNG facility and two refineries, there could be moderate increases in recreational use and pressure on limited recreational resources. Aesthetically, with the completion of the three facilities in addition to the Alyeska terminal, the appearance and character of Valdez would be changed in the direction of a modern industrialized port, resulting in moderate impacts.

4.5.16 Cultural

In assessing the potential effects of TAGS construction on the cultural resources along the pipeline corridor, the possible cumulative adverse effects of three pipelines, TAPS, TAGS and authorized ANGTS and a major highway being constructed in the same general corridor must be considered. Increasing the width of the impacted corridor area obviously would increase the chances that more archaeological sites would be affected.

The construction of two additional pipelines would increase the necessity to mine material source sites, or portions of such sites, which were not utilized during TAPS construction because of the presence of potentially significant cultural remains. Though acceptable alternate material sources might be found, some of them might also contain archaeological sites. Cumulative impacts to cultural sites if all projects were constructed, would probably be minor.

4.5.17 Subsistence

Since construction of the Dalton Highway, use of the area around Galbraith Lake and Atigun Gorge for fishing, hunting, trapping, and camping activities by Natives has become more infrequent (BLM 1987). Oil and gas development on the North Slope has impacted traditional subsistence use of the Prudhoe Bay area primarily due to access hunting restrictions. Increased access in the northern utility corridor and the Glennallen/Copper Center areas has resulted in increased sport hunting and fishing competition for subsistence resources. In the latter case, promulgation of new subsistence regulations were necessary to ensure the continuation of moose and caribou hunting opportunities and protect the animal populations (ADF&G 1985).

Construction of the TAGS project would create additive impacts on subsistence existing activities. These additive impacts would result primarily during construction, the period of greatest competition from the increased number of workers along the TAGS alignment. Some access problems could occurr due to restrictions placed on crosssing or shooting near the TAGS pipeline. Because the TAGS project would not involve major expansion of the existing Prudhoe Bay oil and gas complex, would follow a linear right-of-way adjacent to the existing TAPS line, and would use an LNG terminal near the existing Alyeska oil terminal, long-term cumulative impacts on subsistence activities resulting from the TAGS project would cause only minor restriction of subsistence activities.

4.5.18 Public Safety

The cumulative risk to public safety during construction of TAGS would be derived from the increased traffic in the air and on the highways of the state and from the intense construction activity within the highway and utility corridors. A cumulative interactive impact would result should TAGS construction activity disrupt or rupture the TAPS or the authorized ANGTS, if built. The probability of this occurring is remote because of the required separation distance of TAGS from both TAPS and authorized ANGTS. The increased probability reflects the general increase in transportation levels.

During operations, there is the additive potential for a pipeline rupture or leak, though remote, to occur on the TAGS system which could impact TAPS or the authorized ANGTS. TAGS operational procedures would be designed to respond to various types of potential accidents and include safety features such as emergency shutdowns, valve closures, block valves on either side of river crossings and fault lines, corrosion control and inspection procedures.

Cumulative increases in tanker traffic through Port Valdez and Valdez Arm and construction activities in the Valdez area would increase the potential for accidents, including some that could result in oil spills.

The Anderson Bay LNG plant site and marine terminal sites were selected to provide the greatest capacity to comply with the federal DOT regulations 49 CFR 193. An evaluation of the LNG plant thermal and vapor exclusion zones indicates that the Anderson Bay site provides an ample buffer zone and safe conditions outside of the site boundary at all times. The cumulative risk to public safety would be considered minor.

National security considerations, include the requirement for a continuous supply of energy, enhanced by the TAGS project independent of the authorized ANGTS or the proposed Valdez refineries. The common source of petroleum for TAPS, TAGS, and ANGTS; the proximity of pipelines at "pinch points"; and the proximity of TAPS and TAGS marine terminals means that a single terrorist incident could conceivably interrupt multiple facilities. Measures to protect against this are balanced by the fact that would be some measure of security due to their proximity as well.

4.6 MITIGATION MEASURES

Mitigating measures have been developed to alleviate the adverse impacts that were identified earlier in this subsection for the TAPS project, the highway system, and for the authorized ANGTS. Copies of the stipulations attached to the BLM's grants of right-of-way for the project are included as Appendix D and E. The BLM would develop similar stipulations for the TAGS project prior to issuance of the right-of-way grant. Likewise, the USACE would issue standard and specific mitigation measures with its permits for dredge and fill in wetlands of the United States. All other federal, state, and local agencies that are required to issue permits or approvals on either a generic or site-specific basis would be expected to ensure mitigation compliance prior to initiation of the action.

As identified in Subsection 2.8, YPC has developed and committed to various measures to prevent or mitigate major adverse impacts. Given the numerous mitigative measures, which are included in YPC's design, construction, and operation procedures and have been incorporated throughout this document, there would be only minor to moderate impacts.

Mitigation measures proposed by YPC were designed to accomplish the following purposes:

- Ensure that the pipeline is structurally sound to minimize the potential for accidents or leaks.
- Minimize the potential impacts to soil and permafrost integrity, including considerations of hydrology and vegetation.
- Conserve limited resources, including water and gravel, along the entire route.
- Minimize impacts to wildlife, marine, and aquatic habitat.
- Minimize environmental impacts due to spills, discharges, and waste disposal.
- Minimize potential for damage to existing structures, facilities, and operations.

The most critical mitigation measure to minimize environmental impacts would be the timing of construction. Though it is not possible to optimize construction timing along the entire route, it is possible to review and modify the construction schedule to reduce environmental impacts at the most sensitive areas.

4.7 UNAVOIDABLE ADVERSE IMPACTS

The construction and operation of the previously proposed El Paso pipeline system, LNG plant site, and marine terminal would result in certain unavoidable adverse environmental impacts similar to those for TAGS. These impacts are similar to those discussed for the El Paso project and are therefore adopted by reference where applicable for the TAGS project. (See FPC 1976, pages II-365 and II-367.)

Impacts during the construction phase would be, for the most part, of short-term duration and mitigatable. Most impacts associated with the operational life of the project would be less severe but of long-term duration. The following paragraphs discuss the adverse effects remaining after appropriate mitigative measures such as those discussed in Section 2.8 are applied.

The proposed TAGS project,with fewer employees than TAPS, would create an employment pattern similar to TAPS in that both resident Alaskans and job seekers from outside Alaska would vie for construction and operations employment. Job seekers coming to Alaska who do not find employment would have to rely on state social services. Large numbers of workers would be employed during the peak construction period. Once construction is completed, the existing job market would not be able to absorb those unemployed, and there would be an increase in unemployment.

Land-use impacts would include the temporary use of approximately 23,000 acres of directly disturbed area which would be cleared. This loss would be minimized since the proposed TAGS project would be constructed within an existing designated utility corridor, and this disturbance would not significantly modify local land use. Most existing land-use plans would apply to the TAGS project and would not have to be changed to accommodate the the proposed action.

Minor but long-term land-use impacts to the approximately 8,000 acres which occur in the pipeline right-of-way and area occupied by the associated facilities, including the LNG plant and terminal. The workpad, material sites, access roads, and right-of-way would be removed from present uses for the life of the project.

Construction activities, increased highway travel, construction equipment, compressor stations, the LNG tankers, and the LNG plant would all add incremental amounts of dust, nitrogen oxides, sulfur oxides, carbon monoxide, and particulates to the air. These emissions would typically be diluted over a very large area. Air quality degradation would be negligible except in the Valdez area, where more concentrated emissions would occur in an area already impacted by air emission from Alyeska Marine Terminal operations, including oil tankers.

Some surface and ground water would be used during the project. This amount would not constitute a serious loss to available supplies. Care will be taken to prevent dewatering of sensitive areas such as fish overwinter areas. Silts would enter the surface water from several sources, including melting of soil-rich ice in spoils deposits, erosion from access roads and camp/construction pads, and placement of culverts. Excavating streambeds for pipeline burial will temporarily result in possibly high levels of turbidity. These factors would lower water quality, at least on a temporary basis.

Frost bulb formation in streams, should it occur, could result in modification of springs and could change subsurface flow and flow regimes of surface waters.

Unavoidable spills of fuel and other contaminants would also result in some local water quality degradation. Discharge of wastewater effluents would result in a local decrease of dissolved oxygen and locally heavy nitrate and phosphate loading, thereby changing surface-water quality.

Ground water would probably not be affected except by depletion, given the applicant's mitigating proposals.

Construction of the marine terminal and dock would result in the loss of under 100 acres of benthic habitat. The LNG plant wastewater discharge would decrease marine water quality, at least in the mixing zone.

An undetermined amount of loss of seabird and waterfowl resting habitat would occur in Anderson Bay. The exclusion zone around the dock and facilities would result in loss of the some nearshore area to be used by commercial and sports fishermen. Monetary loss is possible but would probably be negligible. Existing uses of the upland ridge top areas of the Chugach National Forest at the LNG plant site is light and unquantified. For safety reasons, firearm discharge would be prohibited on about 1500 acres of public land.

There will be a direct loss of about 23,000 acres of vegetation along the right-of-way and the related facilities. Some of this area would be allowed to revegetate to low-growing species. This will be accomplished by both natural and artifical revegetation.

There would be a permanent or temporary loss or disturbance to approximately 3,200 acres of wetlands. Some changes to surrounding vegetation due to construction would be unavoidable. Disturbance of the vegetation cover and would result in soil erosion and thermokarsting, which would eventually stabilize. Vegetation near access roads would be affected by dust and thermal degradation of permafrost near the gravel. Spill of diesel, methanol, and lubricants would kill some vegetation and might sterilize the soil locally for years. Changes in surface sheet drainage patterns would result in the loss of some existing wetlands vegetation and change in species composition in other areas.

Some Dall sheep winter range and lambing habitat would be disturbed during construction, resulting in temporary avoidance of these areas. If satisfactory alternative habitat is available, no losses will occur, but winter range and lambing grounds are limited on the north slope of the Brooks Range.

Some direct displacement loss of riparian moose habitat would occur. Noise and human activity during construction would cause avoidance of certain areas, especially during calving. Traffic increases will result in increased moose fatalities due to collisions, especially during severe winters.

Additional project related traffic during construction would also result in direct mortalities to large game animals in the Delta area. Some direct loss of bison habitat and farmland would also occur in this area.

Human presence is essentially incompatible with wolf and wolverine populations. The project could result in legal and illegal shooting and collisions with vehicles. Other animals such as bear and fox are more tolerant of human intrusion and can become habituated to camps and work sites due to the presence of garbage and food handouts by employees. Such occurrences would result in human/carnivore interaction. The outcome would normally be the destruction of the problem animal. Animals were destroyed during the construction of TAPS. The Arctic National Wildlife Refuge, Alaska Coastal Plain Resource Assessment (1986) predicted the loss of one brown bear per year due to human/carnivore conflicts or accidents. It appears to be a reasonable number for the TAGS project as well.

Swans and loons are very sensitive to disturbance, especially by low-flying aircraft, during breeding and nesting periods. The project would result in some displacement loss of habitat for these birds during construction.

There would also be some loss of waterfowl nesting habitat during construction. Some species are very sensitive to and would possibly abandon the corridor during construction and possibly operation, resulting in some loss to these populations.

There would be some displacement habitat loss for and tundra-nesting shorebirds during construction. Many shorebirds avoid heavily traveled roads and dusty areas; this would reduce lose breeding and nesting habitat. There might be small losses to hawks and owls due to collisions with vehicles and structures.

Disturbance or displacement of endangered Arctic peregrine falcons and/or their prey could result from construction near occupied nesting sites. Several such sites are fairly close to the route.

Disturbance to protected bald eagle nests would be mitigated and avoided to the extent possible, but it is possible that some nests would be abandoned and some losses occur in some areas through noise, human activities, and collision with vehicles.

Wilderness and recreational opportunities and values would be lost or reduced in the area of the pipeline especially during construction There is no way to avoid these impacts. Though they are difficult to quantify, losses would occur essentially along the entire route of the pipeline and would be relatively short term. Some state 4(f) lands would be temporarily altered.

Aesthetic and wilderness values would be reduced for the area near the pipeline or its related facilities. There would be scars visible due to the buried pipeline berm, borrow pits, access roads, and compressor stations. These impacts are also unquantifiable but long term along the relatively narrow utility corridor.

There would be unavoidable impacts to subsistence resource during construction. Regulations governing use and crossing of the area during construction or operation could result in restriction of access to traditional subsistence areas. The short-term access to a cash economy would change subsistence use patterns for a short period for some Native communities.

In summary, there would be some unavoidable adverse impacts due to the projects. These impacts are similar to those incurred in construction of the TAPS project and those anticipated with the authorized ANGTS project. Impacts from TAGS somewhat less in severity due to the use of an already disturbed, designated industrial corridor, and an existing infrastructure.

4.8 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

In general, "short term" has been used throughout this EIS to mean the construction period and an operations duration of up to 20 years. "Long term" has been used to refer to that time beyond 20 years. However, for this subsection, the definition of long term relates to the life of the project, which is expected to be between 20 and 40 years.

Changes to the environment in the vicinity of the TAGS project and most impacts would be considered short term, with many of the greatest impacts occurring during the construction and early operational phases of the project. If these impacts were properly mitigated, their overall loss of productivity would be short term. These effects include air emissions, removal and disturbance to wildlife and vegetation, increased turbidity in surface waters, habitat loss in the marine system, disruption to local land traffic patterns and increased local populations centered around TAGS construction camp locations. The length of time for which these impacts would persist at a given point along the pipeline alignment would be minimal. Small oil spills from construction equipment and ensuing cleanup activities would also have short-term effects on productivity.

Short-term employment, especially for Alaskans, could result in long-term benefits to the state economy and work force and would increase the pool of highly trained instate workers. Use of state royalty gas would have a short-term effect on productivity but would have a long-term benefit to the state's Permanent Fund. In a similar manner, the increased economic activity would mean an influx of new residents and in the short term could impact the existing economic and social structure.

Biological productivity would be lost in the short term for almost 23,000 acres of vegetation and wetlands, but with proper management most of these areas directly disturbed could be returned to existing productivity levels. Though restoration efforts might not be entirely successful the overall loss would be minimal.

There would be a long-term commitment of the 33 million cubic yards of gravel material necessary for construction. This would be a significant long-term commitment since limited supplies of gravel exist within and near several portions of the corridor, and most of the gravel used for this project would not be available for reuse.

There would be a loss of the nonrenewable natural gas resources from Alaska's North Slope. This would be offset by a net reduction of the U.S. balance of payments deficit for the life of the TAGS project. There is a reasonable probability that this project would encourage exploration for and development of additional North Slope natural gas reserves in the future which could prolong the life of the project.

4.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

A decision to approve the construction and operation of the TAGS project would irreversibly and irretrievably commit several types of resources. An irreversible commitment of a resource is one that could not change once it has occurred, while an irretrievable commitment of resource is one that could not be recovered or reused. Table 4.9-1 summarizes irreversible and irretrievable impacts for the disciplines discussed.

Construction of the project would result in irretrievable use of fuels and lubricants as well as other construction related materials. During operation, there would be the irretrievable commitment of a daily average of 2.3 BCF of natural gas to Asian Pacific Rim markets.

Table 4.9-1 Commitment of Resources Resulting from the TAGS Project

Environmental Discipline	Irreversible	Irretrievable	Comment
Socioeconomics	No	No	No significant long-term commitment
Land Use	Yes	Yes	A commitment for long-term use of approximtely 8,000 acres of land area along the pipeline alignment, compressor station, and at the LNG plant site
Transportation	No	No	No significant long-term commitment
Noise	No	No	No significant long-term commitment
Meteorology/Air Quality	No	No	No significant long-term commitment
Solid Waste/Hazardous Materials and Sanitation	No	No	None is expected except, however, in the unlikely event of a major fuel spill at camps during construction or along roadways, some irreversible effects on soils, surface water, vegetation, and wildlife could result
Physiography, Geology, Soils, and Permafrost	No	Yes	The construction of TAGS would require 33 million cubic yards of gravel. Some of this material might be retrievable, but most would be irretrievably committed. Differential heave during thelife of the project would be irreversible
Surface and Ground Water	No	No	No significant long-term commitment
Marine Biology and within Port Oceanography	Yes	Yes	The 50 acres of subtidal habitat Valdez would be lost
Fish	No	No	No significant long-term commitment
Vegetation and Wetlands	Yes	Yes	Some significant long-term commitment
Wildlife	No	Yes	No significant long-term commitment
Threatened and Endangered	No	No	No significant long-term commitment
Recreation and Aesthetics	Yes	No	Construction of the pipeline and LNG plant site would affect aesthetics, resulting in irreversible commitment of resources
Cultural	Yes	Yes	For those sites located and salvaged, there would be an irreversible commitment of resources, while for those that could be accidently destroyed, there would be an irretrievable commitment of resources
Subsistence	No	No	No significant long-term commitment, increased competition for limited subsistence resources from construction workers at Glennallen and north of the Yukon River would cause short-term commitments.

SECTION 5
CONSULTATION AND COORDINATION

5.0 CONSULTATION AND COORDINATION

5.1 INTRODUCTION

Yukon Pacific Corporation (YPC) initiated the environmental review process for the proposed Trans-Alaska Gas System (TAGS) by filing application for the right-of-way permit with the U.S. Bureau of Land Management (BLM) and an application for permits to dredge and fill with the U.S. Army Corps of Engineers (USACE). As joint lead federal agencies, the BLM and USACE received cooperation and assistance from many organizations and individuals, both public and private, in developing and coordinating the Draft Environmental Impact Statement (DEIS) for the project.

5.2 ENVIRONMENTAL REVIEW PROCESS

The BLM, Alaska state office, and the USACE, Alaska District, were designated to be responsible for EIS preparation under the National Environmental Policy Act (NEPA). The State of Alaska elected to participate in this federal process rather than preparing a parallel state environmental assessment related to the granting of a right-of-way through state lands. The Governor's Office of Management and Budget, Division of Governmental Coordination, coordinated state input into the document.

The first step in the federal process was for BLM and USACE to publish in the Federal Register on November 17, 1986, a Notice of Intent (NOI) to prepare an EIS. The second step was to identify pertinent environmental issues and concerns related to the proposed action. This "scoping" process, as it is called, included a series of public meetings to solicit comments of concerned citizens and public and private organizations. Listed below are locations and dates of the six scoping meetings:

Location in Alaska	Date
Barrow	December 8, 1986
Fairbanks	" 9, "
Glennallen	" 10, "
Valdez	" 11, "
Soldotna	" 12, "
Anchorage	" 13, "

BLM and USACE held a workshop at each of these locations in the afternoon and a meeting in the evening to invite comments and suggestions on issues to be addressed in the DEIS. Section 1.8 of this document summarizes the issues raised by the 170 people who attended the scoping meetings. The DEIS addresses their concerns as well as those of the cooperating agencies.

The DEIS has been issued to federal, state, and local agencies and to the general public for a 60-day review period. A public hearing will be held during this time within the project area, as identified in the cover letter to this document. Agency and public comments received will then be incorporated into a Final EIS (FEIS).

5.3 CONTRACTS WITH OUTSIDE CONSULTING FIRMS

A contract for the preparation of a third-party EIS was executed with Harding Lawson Associates of Anchorage, Alaska (HLA). Working under the direction of the BLM, HLA was directed to collect, summarize, and synthesize relevant information and data, prepare analyses, and prepare the required documents. HLA attended scoping meetings and will be represented at future public meetings as well. HLA subcontractors include: Jon Isaacs and Associates of Anchorage, Alaska, Edwin S. Hall and Associates of Stony Brook, New York, and Alaska Biological Research of Fairbanks, Alaska. Other subconsultants and HLA staff with important project responsibilities are listed along with their qualifications and specific project responsibilities in Table 5.3-1.

5.4 OTHER AGENCY PARTICIPATION IN PREPARATION OF THE DEIS

The U.S. Fish and Wildlife Service has jurisdiction by law and special expertise related to the project and was designated as a cooperating agency (40 CFR 1501.6). Such an agency is to cooperate with and assist the lead agency in preparation of the document.

The following agencies are included as cooperating agencies (partial listing):

- Department of the Interior
  - Bureau of Indian Affairs
  - Bureau of Mines
  - Geological Survey
  - Fish and Wildlife
  - National Park Service
  - Minerals Management Service

- Department of Agriculture
  - U.S. Forest Service

- Department of Energy
  - Economic Regulatory Administration

- Department of Transportation
  - Federal Aid Highway Administration
  - Office of Pipeline Safety
  - U.S. Coast Guard

- State of Alaska

- Office of the Federal Inspector

As previously stated, the Governor's Office of Management and Budget, Division of Governmental Coordination, provided liaison with the State of Alaska. Other federal, state, and local agencies, organizations, and individuals were called upon to contribute their specific areas of expertise (see Subsections 5.5 to 5.7, as appropriate.

5.5 ARCHAEOLOGICAL COORDINATION

BLM by letter of February 10, 1987 initiated action to develop a memorandum of agreement with the Alaska State Historic Preservation Office should the project be approved.

5.6 INDIVIDUALS

A detailed list of individuals who received the DEIS is available on request from Mr. Jules Tileston, BLM, Alaska State Office, 701 "C" Street, Box 30, Anchorage, Alaska 99513.

5.7 DRAFT EIS AVAILABILITY

Copies of the DEIS are available for inspection at the following locations:

* TO BE INSERTED WHEN AVAILABLE *

Table 5.3-1 List of EIS Preparers

Name	Responsibility/Discipline
U.S. BUREAU OF LAND MANAGEMENT	
Jules V. Tileston	TAGS EIS project officer
U.S. ARMY CORPS OF ENGINEERS	
William M. Fowler	TAGS EIS project officer
HARDING LAWSON ASSOCIATES (Third-party TAGS EIS Consultant)	
Michael J. Sotak, M.S.	Project manager
Andrew J. McCusker, M.S.	Marine environment/assistant project manager
Gary G. Lawley, Ph.D.	Terrestrial/aquatic ecology
Steven A. Johnson, M.S.	Geology
Giles N. McDonald, B.A., P.E.	Hydrology
Jon Isaacs, M.S.	Subsistence
Edwin S. Hall, Ph.D.	Cultural resources
Susan R. Fison, B.A.	Socioeconomics
Jay M. England, P.E.	Geological, geotechnical, permafrost
Robert L. Baldwin, M.E., P.E.	Climate, air quality, noise
Ralph M. Isaacs, Ph.D., P.E.	Permafrost engineering
Frederick I. Cooper, B.S.	Air quality
Scott R. Briggs, Ph.D.	Coastal processes
Robert J. Ritchie, M.S.	Birds
Brian E. Lawhead, M.S.	Wildlife
M. Torre Jorgenson, M.S.	Vegetation, wetlands
Judith A. Brogan	Technical editing
Sara A. Reading	Word processing
Patty L. Martin	Word processing
Janet E. Tandy	Word processing
Cristal A. Fosbrook, B.S.	Engineering technician
Joseph A. Przeczewski	Drafting

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(Partial Listing)

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APPENDIXES

IN REPLY REFER TO

TAGS (983)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT

Alaska State Office
701 C Street, Box 30
Anchorage, Alaska 99513

MAR 20 1987

Memorandum

To: TAGS Project Officer

From: Chief, Branch of Pipeline Monitoring

Subject: Trans-Alaska Gas System (TAGS) Compatibility Evaluation

Attached is the preliminary compatibility evaluation for the TAGS project.

The Compatibility Review Team initially determined that the TAGS project would be compatible with foreign pipelines except for four important areas of concern. These concerns are addressed in Section II. D of the attached evaluation.

Subsequently on February 23, 1987 Yukon Pacific Corporation (YPC) submitted an amended application which included additional information in response to the Bureau of Land Management and Corps of Engineers request. YPC's responses to the four areas of concern are included as Appendix I of the attached report. The Compatibility Review Team believes an adequate response has been made to its concerns except for the Sukakpak Mountain area which will be dealt with at a later date.

Therefore, on a conceptual basis with the exception of the Sukakpak Mountain area, the proposed TAGS project would be compatible with foreign pipelines along the TAGS alignment.

Arlan H Kohl

Enclosure:
Compatibility Evaluation

APPENDIX A

COMPATIBILITY EVALUATION
OF THE PROPOSED
TRANS-ALASKA GAS SYSTEM
WITH
FOREIGN PIPELINES

Prepared January 1987 By

The Compatibility Review Team

Established By

Bureau of Land Management

Alaska State Office

Anchorage, Alaska

TABLE OF CONTENTS

I. INTRODUCTION:

A. Background: Yukon Pacific Corporation (YPC) filed an amended right-of-way application on December 5, 1986 for the construction of a 796 mile, 36-inch OD, 2220 psig chilled gas pipeline. The proposed pipeline begins in the Prudhoe Bay area on the North Slope of Alaska and terminates at a liquefied natural gas (LNG) plant and marine terminal complex at Anderson Bay in Port Valdez. The LNG is proposed to be exported to Pacific Rim markets.

B. Scope: Technical considerations identified as being pertinent to pipeline compatibility are the focus of this report. No known confidential or proprietary information was used as a basis for the conclusions of this report. The conclusions are based on a review and analysis of the TAGS December 1986 Project Description submitted by Yukon Pacific Corporation to BLM. In this analysis it is recognized that the TAPS project has been constructed and the ANGTS is authorized but unconstructed. The project description used for ANGTS is Appendix F as referenced by the Office of the Federal Inspector (OFI) on October 3, 1986. The pipeline is located, as shown, on Revision 4 of the ANGTS alignment sheets.

C. Purpose: This report is being prepared to determine if the Trans-Alaska Gas System (TAGS) is compatible, in accordance with 43 CFR 2881.1-1, with foreign pipelines e.g., Trans-Alaska Pipeline System (TAPS) and Alaska Natural Gas Transportation System (ANGTS).

II. DISCUSSION:

The following definition, criteria and assumptions as established by the review team were used for the purpose of this report.

A. Definition:

Compatibility: Construction, operation, and maintenance of TAGS will not interrupt or adversely impair the operation and maintenance of foreign pipelines in any manner which is unreasonable.

B. Criteria:

1. During Construction:

The construction and initial start up activities of TAGS will not cause interruption of flow in foreign pipelines.

The construction activities of TAGS will not interrupt or adversely impair the maintenance of foreign pipelines.

The stability of the foundation and earth structures of the foreign pipelines can and will be protected from damage which could be caused by construction activities of TAGS.

2. Operations and Maintenance:

The operations and maintenance activities of TAGS will not cause the interruption of the flow in foreign pipelines.

The operation and maintenance activities of TAGS will not interrupt or adversely impair the operation and maintenance of foreign pipelines.

TAGS operation and maintenance activities will be conducted in a manner which will not endanger the stability of the foundation and earth structures of the foreign pipelines.

The integrity of the TAGS pipeline will be protected and maintained so that it will not cause damage to foreign pipelines.

C. Assumptions Used for Compatibility Determination:

1. Alaska Northwest Gas Transportation System will be in place and operational as shown on ANGTS alignment sheets, Revision 4, when TAGS is constructed. When constructed ANGTS will have features as described in Appendix F of this report as provided by the OFI letter of October 3, 1986, and the supplemental EIS dated September 1976.

2. TAGS is compatible with TAPS where separation between the two pipelines is 200 feet or more. (This assumption is consistent with the DOI Grant of Right-of-way for ANGTS which stipulates a separation of 200 feet or more from TAPS, a pipeline operated at elevated temperatures and ANGTS which would be operated below 32°F as is proposed for TAGS.)

3. A minimum acceptable separation between two chilled pipelines operating under Arctic conditions has not been established by technical evaluation.

D. Compatibility Issues: The compatibility review considered the effect and consequences of the procedures and mitigation measures proposed in the Trans-Alaska Gas System Project Description within the context of the definition of compatibility, and criteria and the parameters established by the review team.

Of special concern are three of the Special Construction Areas (section 5.2.17), namely Atigun Pass, Sukakpak Mountain Area, TAPS Oil Terminal and the section dealing with Foreign Pipeline Crossings (section 5.2.8). The three special areas and section 5.2.8, as presented in the Project Description, are not considered compatible with TAPS and ANGTS.

1. Atigun Pass (Section 5.2.17.1):

The level of detail reasonably expected at this stage of the project is that which is required to make a compatibility determination on a conceptual basis.

Compatibility among TAGS, ANGTS and TAPS cannot be assured based on the narrative information and graphic configuration (Figure 5.24) presented in the project description. The TAGS project description does not accurately represent the actual proposed location of the ANGTS pipeline with respect to the existing highway cross section.

The major compatibility concerns through Atigun Pass relating to proximity are: Construction activities, i.e., blasting, heavy equipment working over an existing buried pipe and interrupting highway traffic; excavation of frozen soils around the buried pipe if necessary for repairs; and effects of frost bulb development on the highway.

While a final compatibility determination can be made only after a detailed design has been developed for the area, it is the Compatibility Team's opinion that it is possible to develop reasonable engineering solutions to construct two buried, chilled gas pipelines through Atigun Pass in a manner that would make them compatible with each other, with TAPS and with the Dalton Highway.

To assure compatibility the engineering design solution for two chilled gas pipelines through the pass must be coordinated among all parties concerned prior to construction of the first gas pipeline to be built.

2. <u>TAPS Oil Terminal</u> (Section 5.2.17.7):

The project description does not identify pipeline and construction work done within the Alyeska Terminal Area. Alyeska's position not to allow pipeline construction through the TAPS terminal, requires TAGS to locate a primary route around the terminal. State-of-the-art design and construction procedures do exist and could be applied to achieve access to the TAGS marine terminal complex in a manner compatible with the TAPS marine terminal.

3. <u>Sukakpak Mountain Area</u> (Section 5.2.17.2):

The project description identifies conditions in the Sukakpak Mountain area as basically unsuitable for construction and operation of the TAGS pipeline. Until a suitable route has been selected a compatibility determination of this portion of TAGS can not be made.

4. <u>Foreign Pipeline Crossings</u> (Section 5.2.8):

The typical crossing of a buried foreign pipeline by TAGS, as depicted in Figure 5.12, does not comply with compatibility criteria II. B(2) of this report. The crossing depicted in Figure 5.12 is to be revised to insure safe trafficability on foreign pipeline work pads.

III. CONCLUSION:

The TAGS stated goal is not to construct within 200 feet of TAPS or ANGTS unless physical, environmental or safety constraints indicate the need to construct closer. A 200 foot minimum separation could generally satisfy the major issues of frost bulb interaction, blasting, protecting the integrity of TAGS, TAPS and ANGTS and preclude impairment of operation and maintenance. TAGS having satisfied the deficiencies identified above is capable on a conceptual basis of achieving compatibility with foreign pipelines. At locations closer than 200 feet, specific designs will be required prior to construction to demonstrate no adverse effect to foreign pipelines will occur.

APPENDIX A

CONTRIBUTORS:

Edward Chacho: Research Civil Engineer (Hydrology) Cold Regions Research and Engineering Laboratory (CRREL), Fairbanks, AK
Northern Technical Services contract with Northwest Pipeline 1980-81
CRREL, Fairbanks, AK 1981-87

Perry Francis: General Engineer, Bureau of Land Management, Branch of Pipeline Monitoring, Anchorage, Alaska
Authorized Officer's Field Representative (AOFR), TAPS 1981-87

Arlan Kohl: Bureau of Land Management, Chief, Division of Pipeline Monitoring, Anchorage, Alaska
Pipeline Staff, Washington, D.C. and Alaska 1971-79
BLM, Chief, Branch of Pipeline Monitoring 1979-87

John Santora: Bureau of Land Management, Ass't. District Manager for Energy and Minerals, Ukiah, California 1985-1987
Authorized Officer's Field Representative (AFOR), TAPS 1974-76
Project Manager, National Petroleum Reserve, Alaska 1976-80
Alaska Manager of Government Affairs, Northwest Alaska Pipeline Company, 1980-83

Francis Sayles: Research Civil Engineer (Geotechnical), Cold Regions Research and Engineering Laboratory (CRREL), Hanover, N.H.
Office of the Federal Inspector, Irvine, California 1981-1983
CRREL, Hanover, N.H. 1962-1981, 1983-1987

Lloyd Ulrich: General Engineer, Department of Transportation, Office of Pipeline Safety, Washington, D.C.
DOT, Drafting Gas and Liquid Pipeline Regulations 1966-68
DOT, Oversight for Design and Construction, TAPS 1971-78
DOT, Authorized Officer to OFI, ANGTS 1980-87

APPENDIX B

Chronology of Compatibility Review Team Activities:

Date	Location	Purpose and Attendees
10-27-86	Yukon Pacific Corp	Compatibility Review Process Briefing YPC: Noah, Webb, Metz Gov't: Kohl, Francis,
10-28-86	Federal Building DSD Minerals Office	Compatibility Review Process Briefing APSC: Moses and Legg Gov't: Kohl, Francis,
10-31-86	Alyeska Pipeline Co.	Compatibility Review Process Briefing APSC: Brelsford, Harle and Prendeville Gov't: Kohl and Francis
11-5-86	Federal Building FAA Bid Room	Compatibility Review Process Briefing OFI: Berman, Black, Ellis and Kari Other Gov't: Tileston, Kohl, Francis, Santora, Ulrich and Sayles
11-5-86	Yukon Pacific Corp.	TAGS Project Briefing YPC: Noah, Webb, Metz, Lowenfells OFI: Berman, Black, Ellis and Kari Other Gov't: Tileston, Kohl, Francis, Santora, Ulrich and Sayles
11-6-86	Federal Building E-278	Receive Draft Project Description Various Federal, State and Private Agencies
1-5-87	Alyeska Pipeline Co.	Review of Compatibility Comments APSC: Brelsford, Harle, Prendeville, Hilliker and Johnson Gov't: Tileston, Kohl and Francis
1-6-87	Federal Building Arctic Room	Review of Compatibility Comments OFI: Kari and Ellis NWA: Moses, Moles, and Legg Other Gov't: Tileston, Kohl, Francis, Santora, Sayles, Ulrich, and Chacho
1-7-87	Yukon Pacific Corp	Review Project Description YPC: Noah, Webb, and Metz Gov't: Tileston, Kohl, Francis, Santora, Ulrich, Sayles and Chacho

United States of America
Before the
Federal Energy Regulatory Commission

Docket No. CP80-

APPLICATION
FEDERAL REGISTER NOTICE
OVERALL TABLE OF CONTENTS
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Volume I

Application of
ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

For a Final Certificate of Public Convenience and Necessity
Pursuant to Section 7 (C) of the Natural Gas Act, as
amended, and Section 9 of the Alaska Natural Gas
Transportation Act of 1976 to construct and
operate the Alaska Segment of the Alaska
Natural Gas Transportation System.

July 1, 1980

UNITED STATES OF AMERICA

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION OF

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

AT DOCKET NO. CP80-

FOR A FINAL CERTIFICATE OF PUBLIC CONVENIENCE
AND NECESSITY AUTHORIZING THE CONSTRUCTION
AND OPERATION OF THE ALASKA SEGMENT OF THE
ALASKA NATURAL GAS TRANSPORTATION SYSTEM

APPENDIX A

UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY)	DOCKET NO. CP80-

APPLICATION OF ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY FOR A FINAL CERTIFICATE OF PUBLIC CONVENIENCE AND NECESSITY AUTHORIZING THE CONSTRUCTION AND OPERATION OF THE ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Alaskan Northwest Natural Gas Transportation Company ("Applicant" or "Alaskan Northwest") hereby submits its application for a final unconditional certificate of public convenience and necessity authorizing construction and operation of the Alaska segment of the Alaska Natural Gas Transportation System (ANGTS), pursuant to Section 7(c) of the Natural Gas Act, 15 U.S.C. §717f(c), Section 9 of the Alaska Natural Gas Transportation Act of 1976 (ANGTA), 15 U.S.C. §719g, and Part 157 of the Commission's Regulations. This application supplements that previously filed by Alcan Pipeline Company 1/ in Docket Nos. CP76-433 and RM77-6.

1/ Effective January 1, 1978, the name Alcan Pipeline Company was changed to Northwest Alaskan Pipeline Company.

Specifically, Alaskan Northwest proposes to construct and operate a 48-inch diameter natural gas pipeline, with a maximum operating pressure of 1260 psig, and related facilities, including seven compressor and two meter stations, extending approximately 743 miles from the Prudhoe Bay area of Alaska to a point of interconnection with the facilities of Foothills Pipe Lines (Yukon) Ltd. on the Alaska-Yukon border. Alaskan Northwest proposes to initially transport through these facilities up to an average daily volume of 2.0 Bcf of natural gas.

Alaskan Northwest is a partnership organized and existing under the laws of the State of New York. Participants in the partnership are all affiliates of major natural gas transmission companies. 2/ These companies represent a major segment of the natural gas industry in the United States and supply gas ultimately consumed in 39 states and the District of Columbia. In 1979, these companies, through their affiliates, sold in excess of 25 percent of all natural gas sold in the United States.

Northwest Alaskan Pipeline Company ("Northwest Alaskan") has been selected by the Alaskan Northwest partnership to be its operating partner. Northwest Alaskan is authorized to do business in the States of Alaska, Utah, Montana, California, Idaho and in the District of Columbia. Northwest Alaskan's principal place of business is 136 East South Temple, P.O. Box 1526, Salt Lake City, Utah 84110.

2/ Members of the partnership include Northwest Alaskan Pipeline Company - an affiliate of Northwest Pipeline Corporation and a subsidiary of Northwest Energy Company; American Natural Alaskan Company - an affiliate of Michigan-Wisconsin Pipe Line Company and a subsidiary of American Natural Resources, Inc.; Calaska Energy Company - an affiliate of Pacific Gas Transmission Company and a subsidiary of Pacific Gas and Electric Company; Northern Arctic Gas Company - an affiliate of Northern Natural Gas Company and a subsidiary of InterNorth, Inc.; Pacific Interstate Transmission Company (Arctic), an affiliate of Pacific Interstate Transmission Company and a subsidiary of Pacific Lighting Corporation; Pan Alaskan Gas Company - an affiliate of Panhandle Eastern Pipe Line Company; and United Alaska Fuels Corporation - a subsidiary of United Gas Pipe Line Company.

The names, titles, and mailing addresses of the persons to whom all correspondence and communications concerning this application should be addressed are as follows:

For Alaskan Northwest Natural Gas Transportation Company:	John G. McMillian Chairman of the Board of Partners Alaskan Northwest Natural Gas Transportation Company P. O. Box 1526 Salt Lake City, Utah 84110
	Rush Moody, Jr.* Akin, Gump, Hauer & Feld 1333 New Hampshire Ave., N. W. Suite 400 Washington, D.C. 20036
	David K. Watkiss* Watkiss & Campbell 310 N. Main Street, Suite 1200 Salt Lake City Utah 84110
For Northwest Alaskan	Darrell B. MacKay* Vice President, Regulatory and Governmental Affairs Northwest Alaskan Pipeline Company 1801 K Street, N.W., Suite 901 Washington, D.C. 20006
	Cuba Wadlington, Jr.* Director, Regulatory Affairs Northwest Alaskan Pipeline Company 1801 K Street, N.W., Suite 901 Washington, D.C. 20006

* Designated to receive service under Section 1.17(c) of the Commission's Regulations.

I. APPROVALS REQUIRED FOR FINAL CERTIFICATION

On September 22, 1977 the President, pursuant to Section 7 of ANGTA, 15 U.S.C. §719e, issued his Decision and Report on the Alaska Natural Gas Transportation System in which he selected the Alcan proposal as the ANGTS. 3/ This decision followed the discovery in 1968 of the largest accumulation of natural gas reserves in the United States at Prudhoe Bay, Alaska; the filing of competitive applications with the Federal Power Commission pursuant to Section 7 of the Natural Gas Act for authority to transport these reserves to the lower 48 states; the passage of ANGTA by Congress; two years of formal evidentiary hearings before the Federal Power Commission; the formal recommendation to the President by that Commission; comments to the President by all interested governmental agencies and departments on such recommendation; and, execution of the Agreement on Principles between the United States and Canada.

On December 16, 1977, the Federal Energy Regulatory Commission issued to the ANGTS Sponsors certificates of public convenience and necessity authorizing the construction and operation of the ANGTS, conditioned upon satisfaction of the relevant terms and conditions contained in the President's Decision and Report and resolution of related matters including variable rate of return provisions, system design and pipe selection, capital cost estimates, and tariffs.

In the subsequent two and one-half years since issuance by the Commission of conditional certificates, there have been many delays in the ANGTS, largely outside the control of the Applicant. During this time, however, the governments of both Canada and the United States have established a structure under which the ANGTS can now be successfully completed. Also, numerous regulatory approvals required for construction and operation of the ANGTS have now been obtained, including: approval of the Alaskan Northwest partnership agreement; approval of the Alaskan Northwest tariff; establishment of the incentive rate of return (IROR) mechanism; establishment of the Alaska segment design specifications; approval of pre-building of a portion of the southern Canada and lower 48 state portions of the ANGTS; and the establishment of technical and environmental stipulations for construction of the system. In addition, the Office of the Federal Inspector has been established pursuant to Reorganization Plan No. 1.

3/ The President's Decision was ratified by a Joint Resolution of Congress on November 2, 1977. (H.R.J. Res. 621, Pub. Law No. 95-108, 91 Stat. 1268).

This application requests approval of the following three matters yet to be resolved, which require the submission of further information by the Applicant prior to issuance of a final unconditional certificate of public convenience and necessity: (1) approval of the remaining parameters necessary to implement the incentive rate of return mechanism - specifically, the Certification Cost Estimate (CCE) and the Center Point; (2) approval of Applicant's plan for the private financing of the Alaska segment of the ANGTS; and, (3) a determination that the Project costs are not unreasonably different from those considered as part of the President's Decision and Report and, therefore, that the Project continues to be in the national and public interest. 4/

By this Application Alaskan Northwest further requests (1) that the labor index or indices used to deflate actual project labor costs be those explicity defined in the terms and conditions of the Project Labor Agreement; and, (2) that the CCE be adjusted to reflect the actual third-party monitoring and other government-related costs in establishing the Cost Performance Ratio.

Finally, Applicant requests the Commission to separately docket this Application and establish a new restricted service list. Applicant asks that a new restricted service list be compiled because of the burden and expense of serving the voluminous materials associated with this filing upon the hundreds of parties in Docket No. CP78-123 et al, who have not actively participated in these proceedings.

4/ The Applicant is filing concurrently herewith an application for a Presidential Permit, pursuant to Executive Order 10485, authorizing the construction, connection, operation, and maintenance of facilities on the International Boundary between Canada and the United States. In addition, the following matters will require Commission action prior to construction of the Alaska segment: establishment of the carbon dioxide content of the gas to be transported; and final resolution of Commission Order No. 45, which found that the construction and operation of the Prudhoe Bay gas processing facilities remain the responsibility of the Alaska North Slope producers. Finally, the following matters related to the construction and operation of the Alaska segment will be the subject of future filings: approval of shipper tariffs; approval of downstream transportation and exchange agreements; any necessary approvals-to export and import Alaskan gas; and certification of the remaining portions of the ANGTS Eastern and Western Legs not previously certificated in the prebuild proceedings.

Applicant recognizes that the Commission can take no action at this time concerning approval of a plan for the private financing of the Alaska segment and the comparison of the 1977 and 1980 capital cost estimates. The financing plan cannot be submitted at this time because Applicant recently entered into both a Cooperative Agreement and a Joint Statement of Intention with the principal North Slope producers - Exxon Corporation, Atlantic Richfield Company, and Sohio Alaska Petroleum Company. The Cooperative Agreement provides for a joint sharing of the costs of finalizing the engineering and design of both the ANGTS Alaska segment and the Prudhoe Bay gas processing facilities. The Joint Statement of Intention defines the process to develop a financing plan for the Alaska segment, including significant producer participation. Execution of these agreements will facilitate completion of the final financing arrangements necessary for construction and operation of the Alaska segment.

Additionally, as part of its financial exhibits, Alaskan Northwest will submit pro forma statements of operating revenues, expenses, and income for the first five years of operation at full capacity, the projected cost of service for the Alaska segment, and an analysis of the marketability of Alaskan gas during the life of the project. Thus, the Commission determination that the ANGTS continues to be in the national and public interest, and therefore should be finally certificated, cannot be made until the above-described material has been submitted for review and approval. Accordingly, the Commission must defer its comparison of the 1977 and 1980 cost estimates pending review of such materials. Nonetheless, Applicant believes that the magnitude of the data in the instant filing, and the mandate of Section 9 of ANGTA requiring issuance of all ANGTS approvals as soon as practicable, requires submission of its CCE and Center Point request at this time. This will facilitate their timely consideration while Applicant simultaneously finalizes and submits its financing plan and related materials for later Commission review and approval.

II. THE CERTIFICATION COST ESTIMATE AND CENTER POINT REQUEST

The Certification Cost Estimate and risk analyses which support the Center Point requested are submitted herewith as Exhibits K and Z-7.

To aid in the understanding of the CCE and the Center Point request, and to ensure the expeditious approvals of both, Applicant is also submitting, as exhibits herewith, the location and description of the facilities to be constructed; flow diagrams;

alignment sheets; design criteria; and an environmental engineering manual. 5/

The following are brief summaries of these latter exhibits, which are introductory to the more detailed description of the exhibits containing the CCE and the Center Point risk analyses.

A. Location and Description of Facilities To Be Constructed

1. Pipeline

The Alaska segment of the ANGTS will commence at the discharge side of the gas plant facilities in the Prudhoe Bay field. 6/ The processing facilities will receive the gas from the production fields and treat and compress it to a delivery pressure of 1260 psig with a temperature of approximately 25° to 30° F. The gas to be transported will be provided to the pipeline from the gas plant with a gross heating value of 1100 Btu/SCF.

The pipeline itself will have a 48-inch outside diameter, and a pipe wall thickness which will vary from 0.600 to 0.864 inches, depending upon location. Internal pipe coating and a thin film external pipe coating will be applied to all sections of the pipeline as needed. With the exception of three aerial crossings, the pipe will be installed in the buried mode at depths of from 5 to 16 feet. The pipeline operating temperature of the gas will be between 0° F and +32° F under normal conditions.

The pipeline has been designed to minimize the effects of frost heave through insulation of the pipe, overexcavation, and/or rerouting to avoid soil problems. Such additional initial capital costs will reduce operation and maintenance costs over the Project life.

5/ On certain exhibits - G, G-1, K and Z-6 - there appears a statement that the information contained therein is deemed by Applicant to be confidential and/or proprietary. Applicant hereby waives confidentiality but preserves its proprietary rights to such information.

Additionally, while certain other materials may require review and/or approval by the Office of the Federal Inspector pursuant to the President's Decision and Report, they are submitted herewith for informational purposes and as background to the CCE and Center Point requests.

6/ These facilities will include unit processes for carbon dioxide and water removal; natural gas liquids extraction, separation, and selective blending; and sales gas compression and refrigeration. The plant design and construction, as well as the operation plans and engineering and economic estimates proposed in the R.M. Parsons studies, and submitted by Atlantic Richfield Company for Commission review in Docket No. RM79-19, are adopted by reference for purposes of this application.

The pipeline will parallel the Trans Alaska Pipeline System (TAPS) in a southerly direction to Milepost 274 near Prospect Creek, Alaska. The pipeline will then follow TAPS in a southeasterly direction to Milepost 535 at Delta Junction. At this point the pipeline will diverge from the TAPS route, continuing in a southeasterly direction to the Alaska-Yukon border at approximately Milepost 743, where it will interconnect with the Canadian segment of the ANGTS. The specific pipeline route utilizes existing transportation corridors and maximizes use of existing facilities such as workpads, access roads, and material and disposal sites. The route avoids, to the greatest extent possible, TAPS and other pipeline crossings, highway crossings, frost-susceptible areas, and other sensitive areas, to minimize adverse impacts to the environment and on the socioeconomic structure adjacent to the route.

The pipeline will cross 24 major streams requiring special construction considerations, such as heavy-wall pipe, continuous concrete coating, or set-on concrete weights. At three major streams, aerial crossings will be utilized. Additionally, there will be 38 uncased road crossings, 35 road crossings with 56-inch casings, and ten road crossings with 66-inch casings. Furthermore, the pipeline will cross TAPS at 23 locations and the TAPS fuel gas line at ten locations.

Section 13(b) of ANGTA, 15 U.S.C. §719k(b), provides that the State of Alaska may transport its royalty gas in the ANGTS and withdraw such gas within Alaska. Both the Applicant and the Office of Pipeline Coordinator, State of Alaska, have made analyses of the existing, potential, and projected gas markets within the State and the alternate fuel availability in these markets. Based upon these studies the Applicant has concluded that six intermediate gas taps should initially be provided in the State of Alaska. 7/

Exhibits F, F-I, F-II, F-III, F-IV, and G describe in greater detail the location of facilities, the rights-of-way, flow diagrams, and flow rates. Exhibit Z-6 contains the alignment sheets. Exhibits Z-9.0 and Z-9.1 set forth in greater detail the pipeline and civil design.

2. Compressor and Meter Stations

To provide the initial design flow rate capacity of 2.0 Bcfd, seven compressor stations will be required, each rated at 26,500

7/ While these market areas demonstrate the highest probability of future need for gas deliveries, the Applicant will consider adding additional points to the extent other points can be justified. When there is a specific proposal for gas service, Applicant will then file for the additional authorizations necessary to provide deliveries, including authorizations for any additional facilities required.

horsepower. 8/ Two refrigeration units will be installed at each compressor station to maintain the pipeline gas temperature within the temperature range of 0° to 32° F. Gas heaters will be installed at Compressor Stations No. 2 and No. 4 to assure that gas temperatures will be maintained above the hydrocarbon dew point of the mixture under all operating conditions. Each compressor station will include buildings for the compressors, refrigeration equipment, utilities, flammable liquids storage, gas scrubber units, pumps, and living quarters.

Two metering stations will be provided, one to measure the quantity of gas supplied to the pipeline from the Prudhoe Bay gas processing facilities, and the other to measure the gas delivered to the Canadian segment at the Alaska-Yukon border.

Exhibit Z-9.2 sets out in greater detail the compressor and meter stations design.

3. Other Facilities

In addition to the pipeline and the compressor and meter stations, there will be a supervisory control system, a communications system, operation and maintenance facilities, and temporary facilities. The supervisory control system will operate the pipeline, perform related system balancing, and coordinate functions with the gas processing plant and the Canadian segment. The supervisory control system master station will be located in Fairbanks at the Operations Control Center. This center will include the dispatcher console, which will provide the monitoring and control equipment necessary for centralized operation of the Alaska segment of the Project. Backup control facilities will be provided at Compressor Station No. 11.

A communications system will be installed to support the supervisory control system, and will include voice and data transmission systems, a mobile radio system, and a records communications system. The data communications system will intertie with all other pipeline segments of the ANGTS, both in Canada and the United States.

Operation and maintenance facilities will be located at four sites along the pipeline and will include warehouses for storing project spare parts, as well as garages, maintenance shops, offices, and living quarters.

Temporary facilities will include those facilities required to support the construction phase activities, including seventeen pipeline construction camps with approximately 15,000 beds, seven

8/ With the future installation of nine additional stations the segment flow rate capacity could be expanded to 3.2 Bcfd in the future.

compressor station construction camps with approximately 1,800 beds, 12 airfields, access roads, approximately 300 material and disposal sites, and a pipe yard to receive mainline pipe for the coating, welding, and insulating of such pipe.

Exhibits Z-9.3, Z-9.4 and Z-9.5 describe in greater detail the supervisory control system, the communications system, operations and maintenance facilities, and the temporary facilities.

4. Environmental Safeguards

Applicant has carried out an extensive planning program on means to minimize the potentially adverse environmental consequences of construction, resulting in the development of an environmental engineering manual. This has been developed by examination of potential environmental problems that could be encountered during all phases of construction on all facilities to be constructed, including temporary facilities. Applicant will define the mitigative measures that must be taken by all contractors regarding protection of all species of fish, wildlife, and vegetation affected by construction.

Additionally, air and water quality plans, liquid and solid waste discharge plans, noise mitigation plans, hazardous substance plans, pesticides, herbicides and chemical plans, and petroleum hauling and spill plans will be developed. To insure that these plans are followed, specific environmental control standards will be incorporated into the contracts with all execution contractors.

The environmental engineering manual is in Exhibit Z-1.1.

B. Certification Cost Estimate

The Certification Cost Estimate for the Alaska segment was prepared in accordance with the President's Decision and Report, the directions of the Commission in Conditions Nos. 7 and 8 of Order No. 31, the Certification Cost Estimate format criteria developed by the Alaskan Delegate, 9/ and Section 157.14(a)(13) of the Commission's regulations, 18 C.F.R. §157.14(a)(13).

Under Finance Condition No. 2 of the President's Decision and Report, the CCE filing must allow a comparison of the 1980 estimate with the estimate filed by Alcan in March 1977. In order to allow this comparison, the Certification Cost Estimate filing format criteria developed by the Alaskan Delegate requires the recasting of the March 1977 estimate into the same format and the same base year dollars as the CCE. Alaskan Northwest's certification cost filing fully complies with these requirements.

9/ Alaskan Delegate's Report on Cost Estimate Formats noticed August 6, 1979 in Docket Nos. CP78-123 et al.

The CCE is submitted in January 1980 dollars. The estimate is a complete estimate for the purposes of obtaining a final certificate of public convenience and necessity from the Commission and of serving as the basis for the incentive rate of return determinations. Alaskan Northwest believes that this is the most accurate estimate that could be prepared for submittal with this application. However, as contemplated by the President's Decision and Report, this estimate will not be the final cost estimate. The engineering, design, and alignment of the Alaska pipeline were "frozen" as of April 30, 1980 in order to prepare this certification cost filing in accordance with a procedural timetable which will allow the issuance of a final certificate to Alaskan Northwest by early 1981. Further design and engineering will take place between April 30, 1980 and the time that Alaskan Northwest presents its final design cost estimate and construction schedule to the Federal Inspector (i.e., prior to the commencement of construction), in accordance with Condition No. I-5 of the President's Decision and Report. Any changes in the cost estimate resulting from design changes after April 30, 1980 will be submitted to the Federal Inspector pursuant to the President's Decision and Report and Condition No. 9 of Order No. 31.

The cost estimates submitted herewith reflect costs associated with numerous changes in the design of the facilities that have taken place since the President's Decision and Report, resulting from increased government requirements, the delays in scheduling that have occurred since such Decision, which have been largely outside the control of Applicant, the organizational changes that have been made as a result of that Decision and Reorganization Plan No. 1, and other factors enumerated in Exhibit K.

The Certification Cost Estimate submitted herewith was prepared and premised on the following assumptions: (1) all governmental approvals are obtained in the time frame included in the major milestone schedule; (2) the final design is acceptable for Notice to Proceed applications and construction bid inquiries; (3) market conditions at the time of placement of major purchase orders are generally the same as assumed in the CCE; (4) an adequate supply of a competent and trained work force will be available; (5) competitive fixed unit-rate bids can be obtained; (6) an adequate supply of contractor-owned construction equipment will be available to minimize the effects of competition between contractors in obtaining such equipment; (7) a Project Labor Agreement 10/ can be executed which contains the same terms and conditions regarding work rules, justification, and rates of

10/ The Project Labor Agreement is expected to apply to all of the various labor unions whose members work on the Project.

pay currently in effect in Alaska, with escalation to be held within the current Presidential wage guidelines; and (8) a construction work schedule of 10 hours per day, 7 days per week will be in effect.

The CCE for the total Alaska segment is $7.9 billion. This includes $4.1 billion for pipeline and civil work, $887 million for temporary facilities and services, $693 million for compressor and metering stations, $97 million for communications and supervisory systems, $53 million for operation and maintenance facilities, $1.2 billion for project directorate, including Project Management Contractor (PMC) costs, and $846 million for the normal contingency allowance. 11/ These costs are in January 1980 dollars and exclude any finance charge or an allowance for funds used during construction.

C. Center Point Justification

In Order Nos. 31 and 31-B the Commission provided that the ANGTS Sponsors could use either a formula approach for establishing the appropriate Center Point, or could request a Center Point without reference to the formula "...if a major change had occurred in the project which would result in a total estimated cost for the project, including likely overruns, that exceeded the estimates in the [President's] *Decision*." Order No. 31-B at 4. In Order No. 31-B the Commission further provided that "[t]he exhibit dealing with the Center Point should assess the likelihood of abnormal events that could increase costs which are not covered under the Change in Scope mechanism and the impact on costs that these events would have. This information will be used to set a Center Point that compensates for the possibility of abnormal events increasing costs." Order No. 31-B at 8.

Because of both the design changes and schedule delays that have taken place since issuance of the President's *Decision*, the Applicant has chosen to request a Center Point without reference to the CCE. The Center Point requested, 1.292, is based upon risk analyses of abnormal or unlikely events that could affect Project costs, and events examined in such analyses specifically do not include those contemplated by either the change in scope or design change mechanisms.

11/ This normal contingency allowance represents the expected value of the distribution of Project costs resulting from in-scope estimating uncertainties associated with the base cost estimates. In-scope estimating uncertainty is defined as the variation in Project costs and schedules resulting from: accuracy of material quantities estimates; human productivity assumptions; equipment reliability assumptions; engineering/design development; accuracy of scheduled durations; and accuracy of bid specifications based on current Project definitions.

To develop the cost impact of abnormal events, Applicant first defined over 100 possible events, each of which was assigned to one of the three Order No. 31-B categories: abnormal events, design changes, and scope changes. Applicant then defined the occurrence probability for each event classified as abnormal, the range of cost impact, and the schedule impact.

Three values were established for each cost: the most likely value; the value representing a 10 percent probability that costs will be less than the value; and the value representing a 10 percent probability that costs will be greater than the value. A similar range of schedule delays was developed for those events that could affect Project schedule. From these analyses a range of cost impacts was determined which formed the basis for the selection of the Center Point requested.

Applicant also has prepared a list of those events which will qualify as either a design change or change in scope and which were specifically excluded from the abnormal events examined in the Center Point risk analyses. 12/

III. OTHER IROR MATTERS

In addition to the uncertainties associated with the CCE and the Center Point, Applicant has identified two other issues that affect the IROR procedure: the appropriate labor cost indices used to deflate actual Project labor costs; and the treatment of third-party monitoring and other government-related costs.

A. Labor Indices

In Order No. 31 the Commission stated that the actual capital cost (the sum of direct construction costs actually incurred in constructing the pipeline) should be adjusted to eliminate the effects of general inflation prior to calculating the Cost Performance Ratio and the IROR. 13/ For this purpose, the Commission provided an inflation adjustment mechanism to deflate direct construction costs (excluding interest during construction) to base-year prices for comparison with the CCE.

12/ This list is found at Exhibit Z-7, Section 5.0.

13/ Order No. 31 at 111.

Applicant, in accordance with the Commission's invitation in Order No. 31-B, 14/ proposes that the proper labor cost index component to the composite index for the inflation adjustment mechanism should be that index or indices which are explicitly defined in the terms and conditions of the Project Labor Agreement. The adoption of a labor index or set of indices by Applicant prior to negotiating actual wage rates and escalation clauses in the terms and conditions of the Project Labor Agreement will severely limit Applicant's ability to reduce costs. Such predetermined indices will establish an artificial floor for wage rate discussions and thus constrain its negotiating position. This will undoubtedly result in higher Project labor costs than if the labor indices were not predetermined.

B. Third Party Monitoring Costs

Under the terms of the Mineral Leasing Act and certain other federal and state statutes, Applicant is obligated to reimburse federal and state agencies for certain categories of expenditures involving the Project. In preparing the CCE, Applicant requested and received an estimate of reimbursable costs that would be incurred by various federal and state agencies. Applicant has not made an independent evaluation of the validity of these estimates. For submission purposes, these costs have been included in the CCE. However, Applicant proposes that the CCE be adjusted to equal the actual capital costs for third-party monitoring and other government-related costs for the determination of the Cost Performance Ratio. Applicant should not be required to accept a Cost Performance Ratio based in part on cost estimates or the subsequent actual costs that were not prepared under its supervision or control. 15/

14/ In Order No. 31-B the Commission stated as follows:

In order to allow the sponsors to more fully develop detailed proposals for the labor cost portion of the composite index within the general framework established in Order No. 31, and for the Commission to review these proposals, the Commission will reserve a final decision on the exact specifications of the labor component of the composite index until the sponsors have filed their Certification Cost and Schedule Estimates. With the filing of the Certification Estimates, the Commission expects the sponsors to specify in detail the quarterly or annual cost categories for labor and the measure of labor wage rates for each cost category that they propose. After reviewing the specific proposals submitted by the sponsors concerning labor cost indices, the Commission will approve or modify these proposals in conjunction with its consideration of the Certification Estimates.

Order No. 31-B at 30.

15/ Examples of the costs included are a $50,000,000 Community Impact Contingency Fund, training expenses to upgrade the skills of local welders, and $22,000,000 to construct a jail and expand a hospital wing.

CONCLUSION

Wherefore, for all the foregoing reasons, Applicant, Alaskan Northwest Natural Gas Transportation Company, a partnership constituted as shown herein, respectfully requests the Commission to: (1) expeditiously review and approve the Certification Cost Estimate, as submitted herein, and a Center Point of 1.292; (2) permit the use of the index or indices in the Project Labor Agreement for deflation of direct construction labor costs; (3) provide for adjustment of the CCE to reflect actual third-party monitoring and other government-related costs in computing the Cost Performance Ratio; (4) defer its comparison of the 1977 and 1980 cost estimates pending submission of Applicant's financing plan and related materials; and, (5) issue to Applicant a final unconditonal certificate of public convenience and necessity after review and approval of Applicant's financing plan.

Respectfully submitted,

Alaskan Northwest Natural Gas Transportation Company

/s/ John G. McMillian

JOHN G. McMILLIAN
Chairman of the Board of Partners

Dated at Washington D.C.
This 30th day of June, 1980

Docket No. CP80-
Exhibit F
Hearing Exhibit No.

EXHIBIT F

LOCATION OF FACILITIES

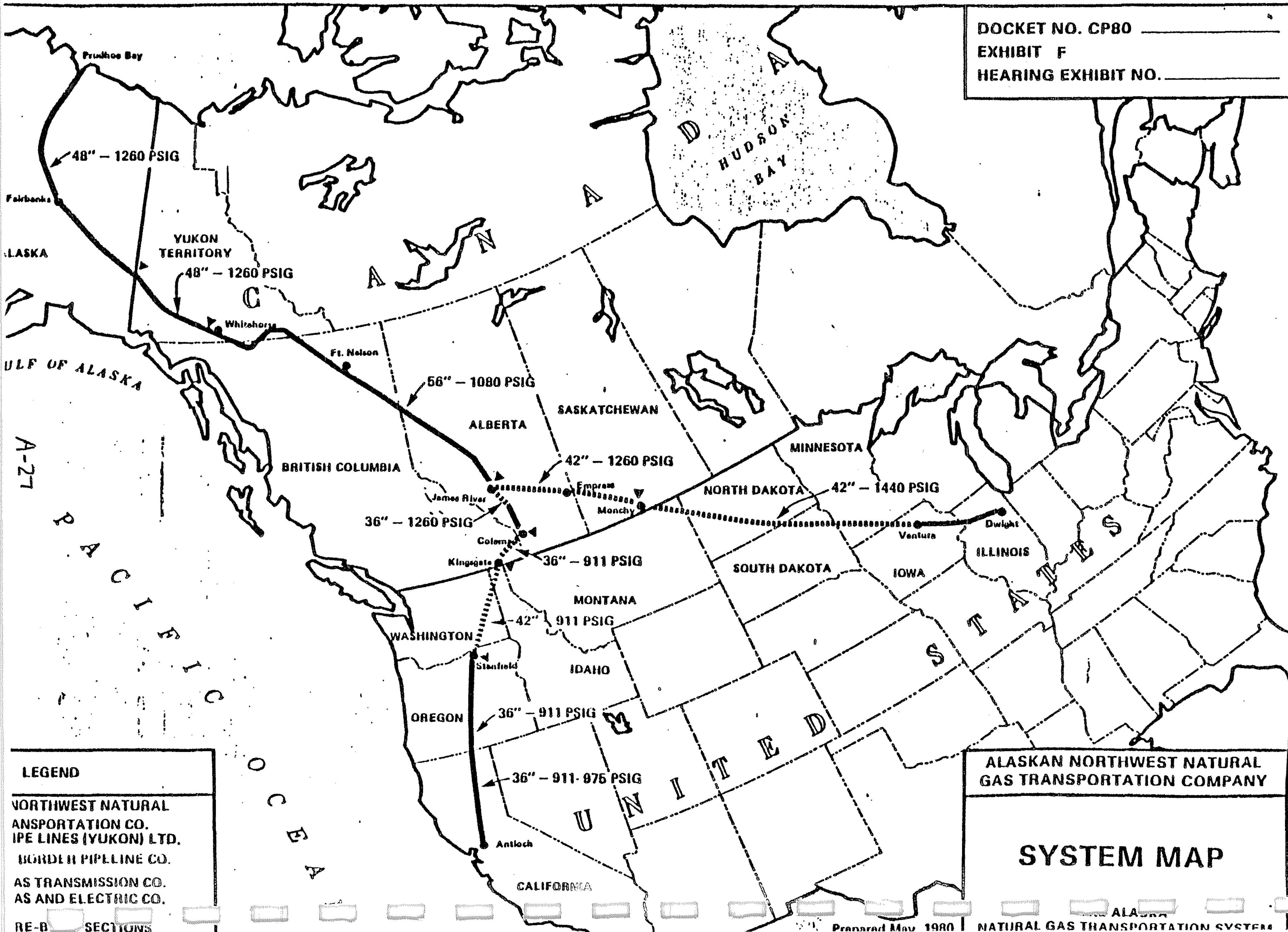
The location of the proposed pipeline and related facilities to be constructed are generally described in this Exhibit. These facilities constitute the Alaska Segment of the Alaska Natural Gas Transportation System (ANGTS), extending from Prudhoe Bay to the Alaska/Yukon border.

1.0 RELATIONSHIP TO THE ANGTS

Figure F-1-1 displays the total ANGTS, including the Alaska Segment, the Canadian Segment, and the two Lower 48 Segments (Eastern Leg and Western Leg). This map shows the relationship of the Alaska Segment, consisting of about 743 miles of pipeline, to the total ANGTS, which extends over a route of approximately 4,800 miles.

The pipeline system is designed for an initial annual average flowrate of 2,000 million standard cubic feet per day (MMSCFD) of natural gas from the Prudhoe Bay field, with 70 percent of the gas delivered to the Eastern Leg, and 30 percent to the Western Leg.

The Alaska Segment can transport up to 3,200 MMSCFD through the addition of nine intermediate compressor stations.


DOCKET NO. CP80
EXHIBIT F
HEARING EXHIBIT NO.
Prudhoe Bay
48" – 1260 PSIG
Fairbanks
ALASKA
YUKON TERRITORY
48" – 1260 PSIG
Whitehorse
Ft. Nelson
GULF OF ALASKA
56" – 1080 PSIG
ALBERTA
SASKATCHEWAN
BRITISH COLUMBIA
42" – 1260 PSIG
Empress
Monchy
James River
36" – 1260 PSIG
Coleman
Kingsgate
36" – 911 PSIG
HUDSON BAY
CANADA
MINNESOTA
NORTH DAKOTA
42" – 1440 PSIG
Ventura
Dwight
ILLINOIS
IOWA
SOUTH DAKOTA
MONTANA
42" 911 PSIG
WASHINGTON
Stanfield
IDAHO
OREGON
36" – 911 PSIG
36" – 911-975 PSIG
Antioch
CALIFORNIA
UNITED STATES
PACIFIC OCEAN
LEGEND
NORTHWEST NATURAL
ANSPORTATION CO.
IPE LINES (YUKON) LTD.
BORDER PIPELINE CO.
AS TRANSMISSION CO.
AS AND ELECTRIC CO.
SECTIONS
ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY
SYSTEM MAP
Prepared May 1980
NATURAL GAS TRANSPORTATION SYSTEM

APPENDIX A

Docket No. CP80-
Exhibit F
Hearing Exhibit No.

2.0 ALASKA SEGMENT FACILITIES

Figure F-2-1 displays a map of the Alaska Segment of the ANGTS, indicating the proposed general pipeline route, and highlighting the major planned facilities. Additional details are contained in the exhibits noted below concerning the facilities to be constructed or acquired, and the effects on existing facilities as a consequence of the proposed construction.

- o Exhibit Z-1 discusses the environmental considerations that relate to location of the proposed facilities.
- o Exhibit Z-9 discusses the engineering and design criteria that relate to the route selection and facility design.

2.1 PIPELINE GENERAL DESCRIPTION

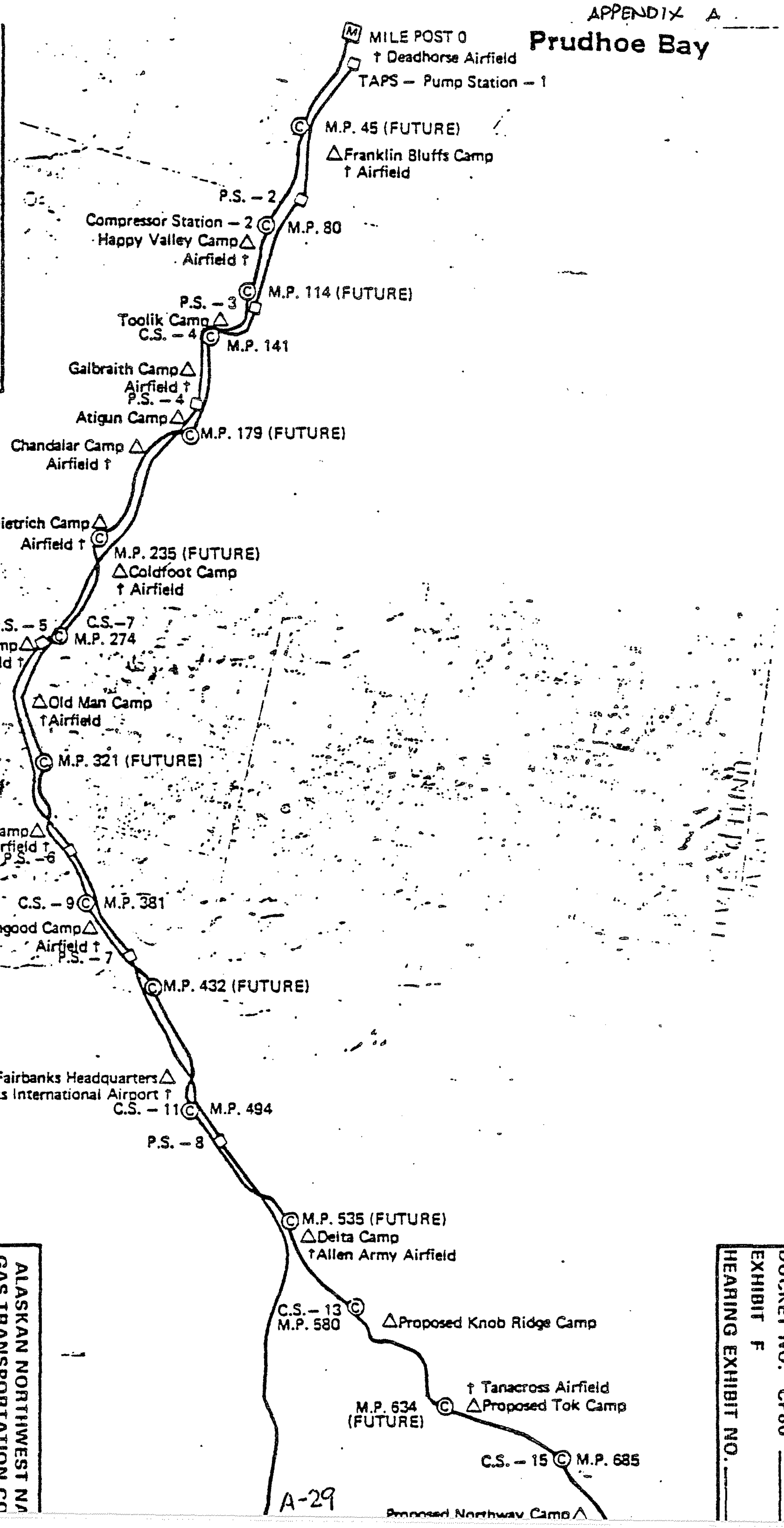
The map in Figure F-2-1 shows the proposed pipeline route, originating at Prudhoe Bay in northern Alaska corresponding to Milepost 0. The pipeline connects at this originating point to the Prudhoe Bay gas conditioning plant through the metering station at this location.

The pipeline route runs adjacent to the Trans Alaska Pipeline System (TAPS) in a southerly direction to about Milepost 274 near Prospect Creek. The pipeline then turns in a southeasterly direction to about Milepost 535 at Delta Junction.

At Delta Junction the line diverges from the TAPS route, and continues in a southeasterly direction to the Alaska/Yukon border at about Milepost 743. At this point at the Yukon metering station, the Alaska Segment of the pipeline connects to the Canadian Segment.

The total pipeline length is approximately 743 miles, consisting of 48-inch O.D. pipe operating at 1260 psig design pressure. The pipeline will be buried except for 3 aerial crossings.

APPENDIX A



LEGEND

Existing TAPS Oil Pipeline and Pump Stations.

Proposed Gas Pipeline (with Key Mileposts), Compressor Stations and Metering Stations.

Construction Camps and Airfields, Existing and Proposed.

Prepared May 1980

ALASKAN NORTHWEST NA
GAS TRANSPORTATION CO

LOCATION
OF
FACILITIES

ALASKA SEGMENT OF THE A
NATURAL GAS TRANSPORTATIO

FIGURE F-2-1

DOCKET NO. CP80 ______
EXHIBIT F
HEARING EXHIBIT NO.______

Docket No. CP80-
Exhibit F
Hearing Exhibit No.

2.2 COMPRESSOR STATIONS

The map in Figure F-2-1 displays the locations for the compressor stations. In order to transport the design flow rate of 2,000 MMSCFD, seven compressor stations are planned as shown (Stations 2, 4, 7, 9, 11, 13, and 15). Nine other compressor station sites are also identified on the map, representing locations for future system expansion, providing a total of sixteen locations as shown on the map.

Additional design data concerning the compressor stations is provided in Exhibits G, G I and G II, including their locations and size (rated horsepower).

Also shown are the connections at the Prudhoe Bay purchase point and the sales point at the Alaska/Yukon border, together with the location of intermediate points of connection within Alaska.

2.3 METER STATIONS

Meter stations are provided at two locations; the gas receipt point at Prudhoe Bay and the delivery point to the Canadian Segment at the Yukon border. Exhibits G and Z-9.2 provide additional data concerning the Meter Station design.

2.4 OTHER PLANNED FACILITIES

The map in Figure F-2-1 also shows the location of other planned facilities, including the construction camps and airfields, commercial and military airfields, and the Fairbanks Headquarters.

The Operations Control Center (OCC) will be located at Fairbanks, and will monitor and control pipeline operation from that point.

Other related facilities are discussed in the other exhibits referenced in 2.0 above, including the communications system, material sites, pipeline double-jointing facilities, material storage yards, and Operating and Maintenance Facilities.

EXHIBIT F-I
FACTORS CONSIDERED IN USE OF JOINT RIGHTS-OF-WAY

APPENDIX A

Docket No. CP80-
Exhibit F-I
Hearing Exhibit No.

EXHIBIT F-I

FACTORS CONSIDERED IN USE OF

JOINT RIGHTS-OF-WAY

Consistent with good pipelining practice, in order to minimize ecological disturbances in the area of the pipeline, to facilitate the acquisition of rights-of-way, and to ease or eliminate pipeline construction and operating difficulties, existing rights-of-way and areas adjacent to existing rights-of-way will be utilized to the maximum extent practical.

1.0 PIPELINE ROUTE

Exhibit Z-1 (Environmental Engineering Manual), Exhibit Z-6 (Alignment Sheets) and Exhibit Z-9 (Design Manual) of this application provide a detailed description of the rights-of-way which will be used, and contain alignment drawings and maps showing other facilities in the area including unrelated pipelines, electric power lines, highways and railroads.

The route of the proposed pipeline was selected so that the line will be constructed adjacent to the existing Trans Alaska Pipeline System (TAPS), the Prudhoe Bay Haul Road and the Golden Valley Electric Association's power line, where feasible, from Prudhoe Bay to Delta Junction, a distance of approximately 548 miles. From Delta Junction, the pipeline will generally follow the Alaska Highway and the Haines Pipeline corridor to the Alaska/Yukon border, a distance of approximately 195 miles.

2.0 USE OF EXISTING RIGHTS-OF-WAY

The proposed joint use of rights-of-way includes the Haines Pipeline and portions of the TAPS anticipated permanent right-of-way. The primary reason for their use is to utilize the existing utility corridor and to avoid the proliferation of right-of-way "scars" across the landscape. Joint use of these rights-of-way also reduces cost by utilizing existing clearing and grading.

3.0 USE OF EXISTING FACILITIES

Use of existing facilities is described in detail in the Exhibits referenced in Paragraph 1.0, Pipeline Route. A summary of these facilities follows:

- The existing right-of-way for the Haines Pipeline will be used in selected locations south of Fairbanks, and also south of Delta.
- The Prudhoe Bay Haul Road will be used for regional access north of the Yukon River.
- The Elliott Highway will be used for regional access north of Fairbanks.
- The Richardson Highway will be used for regional access south of Fairbanks.
- The Alaska Highway will be used for regional access south of Delta.
- The existing workpad, built for the TAPS oil pipeline, or new extensions thereto, will be used for construction adjacent to the TAPS pipeline where possible.
- The gas pipeline will cross the Yukon River utilizing the existing bridge.
- Existing secondary roads will be used for pipeline access to the greatest extent possible.
- Existing gravel pits, if available, will be used for a source of construction materials.
- Existing camps along the proposed gas pipeline route will be used for temporary construction facilities to the greatest extent posssible.

3.0 USE OF EXISTING FACILITIES (Continued)

- o Fort Wainwright will be used for temporary construction facilities.
- o Airstrips and material storage yards from the TAPS facilities will be utilized to the greatest extent possible.
- o South of Fairbanks, existing airfields at Tanacross and Northway will service the Sears Creek, Tok and Northway camps. The military airfield at Fort Greely (Allen Army Airfield) will service the Delta camp. The Fairbanks International Airport will be used as the project central airfield for major traffic operations. Commercial air carriers will be used whenever possible.
- o The existing Alaskan infrastructure will be utilized to the maximum practical extent, including use of existing highways, railroads, road transport services, commercial communication systems and seaports such as Seward, Anchorage, Valdez and Prudhoe Bay.

4.0 ROUTING DEVIATIONS

Applicant intends to use the rights-of-way and facilities as described as of the date of this filing, or amendment or supplement thereto. However, it is understood that the actual construction of the proposed facility may require deviations because of unanticipated obstacles or difficulties, including those encountered due to terrain features, environmental and cultural resource considerations, socio-economic or other events that may occur subsequently.

APPENDIX A

Docket No. CP80-
Exhibit F-II
Hearing Exhibit No.

EXHIBIT F-II

FACTORS CONSIDERED IN LOCATING FACILITIES IN SCENIC HISTORIC RECREATIONAL OR WILDLIFE AREAS

Applicant states that the proposed Alaska Segment of the Alaska Natural Gas Transportation System, as proposed, will be routed through the northern edge of the Tetlin National Wildlife Refuge. This particular routing was planned prior to the establishment and dedication of the Refuge, and there is no reasonable alternative available. Any other routing for the pipeline to bypass the Refuge, would involve substantial additional environmental damage (i.e., longer access roads, more pad materials and encroachment into undisturbed areas) because the pipeline would not then be making use of existing rights-of-way through the area. These rights-of-way include the Alaskan Highway and the former Haines-Fairbanks oil pipeline corridor, within which the gas pipeline will be constructed. The Department of Interior, which has jurisdiction over this area has been consulted. In a letter to Northwest dated January 11, 1980 (AL01.0101), Interior's Authorized Officer, Mr. William M. Toskey, stated: "It is the intent of the Department to act as expeditiously as possible to issue a right-of-way grant for the construction of the proposed pipeline across the proposed Tetlin National Wildlife Refuge...." Applicant believes that the extensive stipulations for environmental protection to be attached to the right-of-way grant by the Department, and made applicable to other pipeline construction activities in Alaska, are adequate to encompass construction in the Tetlin Refuge. These stipulations, worked out over a two-year period with all concerned Federal agencies--and specifically including the U.S. Fish and Wildlife Service--are one of the bases for applicant's cost estimate and other planning. Site-specific stipulations, specifically for the Refuge, are not expected to impose any highly unusual requirements, and the general nature of construction in that area should be essentially the same as elsewhere.

APPENDIX A
Docket No. CP80-
Exhibit F-III
Hearing Exhibit No.

EXHIBIT F-III

STATEMENT ON ADOPTION OF GUIDELINES CONCERNING RIGHTS-OF-WAY AND CONSTRUCTION ACTIVITIES

Applicant states that the guidelines concerning the right-of-way and construction activities set forth in Section 2.69 of Chapter I, Title I, 18 C.F.R. have been adopted by the applicant, that the relevant portions thereof will be issued to planning, construction personnel, contractors, and subcontractors on a continuing basis throughout the life of the project.

The Section 2.69 guidelines are similar in many respects to the draft Department of the Interior (DOI) stipulations expected to be attached to the Federal grant of right-of-way to be issued to Applicant with respect to Federal lands in Alaska. These stipulations provide detailed guidelines dealing with inter alia, environmental and technical matters. Applicant does not perceive any conflicts between these stipulations and the Section 2.69 guidelines. The DOI stipulations, in general, may be viewed as a more detailed elaboration of the Section 2.69 guidelines.

Several of the draft DOI stipulations, which the Applicant has adopted for planning purposes, are particularly germane to the manner in which environmental protection requirements will be implemented with respect to construction personnel and contractors.

A pertinent example is as follows:

"1.2.1 The following conditions shall apply to the design construction, operation, maintenance, and termination of the PIPELINE SYSTEM. Unless clearly inapplicable, the requirements and prohibitions imposed upon the COMPANY by these Stipulations are also imposed upon the COMPANY'S agents, employees, contractors, and subcontractors, and the employees of each of them.

(1) The COMPANY shall ensure compliance with these Stipulations by its agents, employees, and contractors (including subcontractors at any level), and the employees of each of them.

(2) Failure or refusal of the COMPANY'S agents, employees, contractors, subcontractors, ~~or~~ their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the COMPANY.

(3) Where appropriate the COMPANY shall require its agents, employees, contractors, subcontractors to include these Stipulations in all contracts and subcontracts which are entered into by any of them, together with a provision that the other contracting party, together with its agents, employees, contractors and subcontractors, and the employees to each of them, shall likewise be bound to comply with these Stipulations."

It is the Applicant's intention to require its employees, contractors, subcontractors, and other associated personnel to observe the same high standards of environmental protection at all locations--regardless of land ownership.

APPENDIX A
Docket No. CP80-
Exhibit F-IV
Hearing Exhibit No.

EXHIBIT F-IV

STATEMENTS BY THE APPLICANT CONCERNING THE REQUIREMENTS OF THE NATIONAL ENVIRONMENTAL POLICY ACT OF 1969, PUBLIC LAW 91-190, 83 STAT. 852, TITLE I, SECTION 102

The President of the United States, in his Decision and Report to Congress on the Alaskan Natural Gas Transportation System submitted September 22, 1977, made the following statement:

> "The President hereby determines pursuant to the direction of Section 8 (e) of ANGTA (The Alaskan Natural Gas Transportation Act of 1976), that the required environmental impact statements relative to an Alaska natural gas transportation system have been prepared, that they have been certified by the CEQ and that they are in compliance with the National Environmental Policy Act of 1969.
>
> Consequently the enactment of a joint resolution approving the Decision shall be conclusive as to the legal and factual sufficiency of the final environmental impact statements as provided by Section 10 (c) (3) of ANGTA."

Subsequently, on November 8, 1977, a joint resolution of the Congress was enacted (Pub. L. 95-158) which reads as follows:

> "Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, that the House of Representatives and Senate approve the Presidential decision on an Alaska natural gas transportation system submitted to the Congress on September 22, 1977, and find that any environmental impact statements prepared relative to such system and submitted with the President's decision are in compliance with the Natural Environmental Policy Act of 1969."

As a result of the extensive planning actions and data-gathering field programs conducted since November, 1977, Applicant has encountered nothing that would invalidate or tend to invalidate any of the fundamental conclusions reached in the environmental review process, cited above, that resulted in the President's Decision and the joint resolution by Congress.

APPENDIX A
Docket No. CP80-
Exhibit F-IV
Hearing Exhibit No.

Accordingly, Applicant believes that no additional regulatory action is required by FERC pursuant to the requirement of the National Environmental Policy Act of 1969, Public Law 91-190, 83 Stat. 852, Title I, Section 102, pursuant to Title 18 CFR, Section 157.14(a)(6-d).

APPENDIX A

United States of America
Before the
Federal Energy Regulatory Commission

Docket No. CP80-

Exhibit G

FLOW DIAGRAMS SHOWING DAILY DESIGN CAPACITY AND REFLECTING OPERATION WITH AND WITHOUT PROPOSED FACILITIES ADDED

VOLUME I

1986/1987 Heating Season

Revised to reflect latest gas composition and flow rates from the Prudhoe Bay Gas Conditioning Plant, an improved thermal model for gas temperature calculations along the pipeline and Pipeline Alignment (Rev. 3).

Application of
ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

For a Final Certificate of Public Convenience and Necessity Pursuant to Section 7 (C) of the Natural Gas Act, as amended, and Section 9 of the Alaska Natural Gas Transportation Act of 1976 to construct and operate the Alaska Segment of the Alaska Natural Gas Transportation System.

October 1981
Revised and Restated

APPENDIX A
Docket No. CP80-
Exhibit G
Hearing Exhibit No.
October 1981

EXHIBIT G

FLOW DIAGRAMS SHOWING DAILY DESIGN CAPACITY AND REFLECTING OPERATION WITH AND WITHOUT PROPOSED FACILITIES ADDED

1.0 FLOW DIAGRAMS

Three flow diagrams are presented for the purpose of illustrating pipeline capacity in Prudhoe Bay flowrates:

1. Summer Average at 2104.9 MMSCFD
2. Winter Average at 2098.5 MMSCFD
3. Winter Maximum at 2512.3 MMSCFD

An engineering analysis of the system concluded that for these flowrates, the installation of seven compressor stations is required at an average spacing of ninety-eight miles. Each compressor station will be equipped with a single pipeline gas turbine/ compressor unit, pipeline gas refrigeration units and on-site power generation. Compressors (both gas and refrigerant) and generators will be driven by gas turbine prime movers. Stations 2, 4 and 7 will have a spare turbine/compressor unit installed.

1.1 SUMMER AND WINTER AVERAGE FLOWRATES

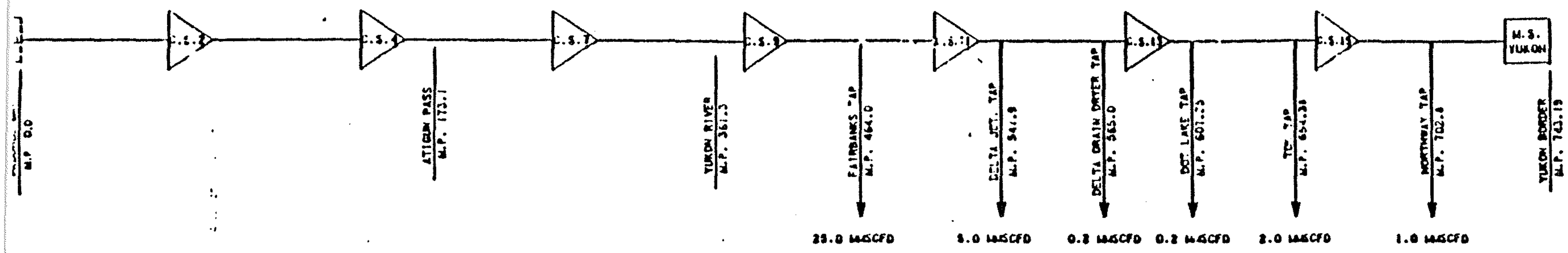
The Alaska Segment operating conditions at 2104.9 MMSCFD during summer and 2098.5 MMSCFD during winter average flow from the Prudhoe Bay gas conditioning plant are presented on the following two pages (Drawing Numbers 4680-10-00-0-001 and 4680-10-00-0-002). Summer and winter operating conditions are illustrated respectively on these drawings. These drawings show gas temperature, pressure and flowrate at every station. In addition, mainline compressor and refrigeration loads and station fuel consumptions are presented. The station fuel consumptions include the fuel requirements for the mainline turbo-compressor, refrigeration equipment, electric power generator and support facilities.

1.2 SUMMER AND WINTER MAXIMUM FLOWRATES

The Alaska Segment winter maximum capacity operating conditions with seven stations are shown on the following page (Drawing Number 4680-10-00-004). The segment maximum capacity of the initial system was determined by the availability of gas from the Prudhoe Bay gas conditioning plant.

The Segment is capable of receiving 2104.9 MMSCFD gas during summer and 2512.3 MMSCFD gas during winter from Prudhoe Bay. Under these conditions, the gas delivery capability to the Alaksa-Yukon border will be 2038.1 MMSCFD during summer and 2440.2 MMSCFD during winter.

APPENDIX A



" O.D. PIPELINE, WALL THICKNESS = 0.6 INCH MINIMUM

ATION DESIGNATION	PB GAS COND PLANT	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	C.S. 11	C.S. 12	C.S. 13	C.S. 14	C.S. 15	C.S. 16	M.S. YUKON
LEPOST (MILES)	0.0		79.98		141.25			273.83		380.82		494.06		578.55		684.94		741.0
EVATION (FEET)	21		825		3050			1315		880		715		1300		2000		2050
ATION INLET VOLUME (MMSCF/D)			2104.90		2100.76			2096.50		2091.54		2061.57		2050.93		2044.23		2038.09
TAL FUEL (MMSCF/D)			4.14		4.26			4.96		4.97		5.44		4.50		5.14		
T VOLUME TO PIPELINE (MMSCF/D)	2104.90		2100.76		2096.50			2091.54		2086.57		2056.13		2046.43		2039.09		2038.09
ATION SUCTION PRESSURE (PSIG)			1061.4		1049.0			1057.7		1060.9		1033.8		1076.4		1037.2		1142.2
ATION SUCTION TEMPERATURE (°F)			19.7		17.4			27.0		27.6		25.2		26.9		24.7		29.8
ATION DISCHARGE PRESSURE (PSIG)	1260.0		1260.0		1249.0			1254.0		1252.0		1260.0		1260.0		1251.0		1138.2
ATION DISCHARGE TEMPERATURE (°F)	30.0		32.0		30.7			31.2		30.8		32.0		31.9		31.0		29.6
MPRESSION RATIO			1.188		1.199			1.193		1.188		1.227		1.178		1.214		
RSEPOWER REQUIRED			13610		14194			14460		14075		16451		13034		15414		
RSEPOWER SPARE			12560		10116			10950		11425		9269		12186		9326		
RSEPOWER INSTALLED-SITE RATED			26170		24310			25410		25500		25720		25220		24740		
. OF UNITS INSTALLED			2		2			2		1		1		1		1		
ANDARD ISO RATING OF UNITS			26500		26500			26500		26500		26500		26500		26500		
MPRESSOR SUCTION PRESSURE (PSIG)			1061.4		1043.0			1051.7		1054.8		1027.8		1070.4		1031.2		
MPRESSOR SUCTION TEMPERATURE (°F)			19.3		17.0			26.7		27.2		24.8		26.5		24.3		
MPRESSOR DISCHARGE PRESSURE (PSIG)			1264.0		1253.0			1258.0		1256.0		1264.0		1264.0		1255.0		
MPRESSOR DISCHARGE TEMPERATURE (°F)			41.2		40.0			49.6		49.6		51.2		47.7		49.4		
OLING LOAD (TONS)			2675		2697			5210		5368		5413		4442		5144		
FRIGERATION HORSEPOWER REQUIRED			1994		2025			4292		4635		4566		3692		4278		

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2 (WNG & SPARE TURBINE/COMPRESSOR UNIT).

4	REVISED NO. OF UNITS INSTALLED
3	FOR REVISED FERC FILING
2	REVISED FOR DESIGN BASIS
1	APPROVED FOR FERC FILING

FLUOR
PROJECT MANAGEMENT CONTRACTOR

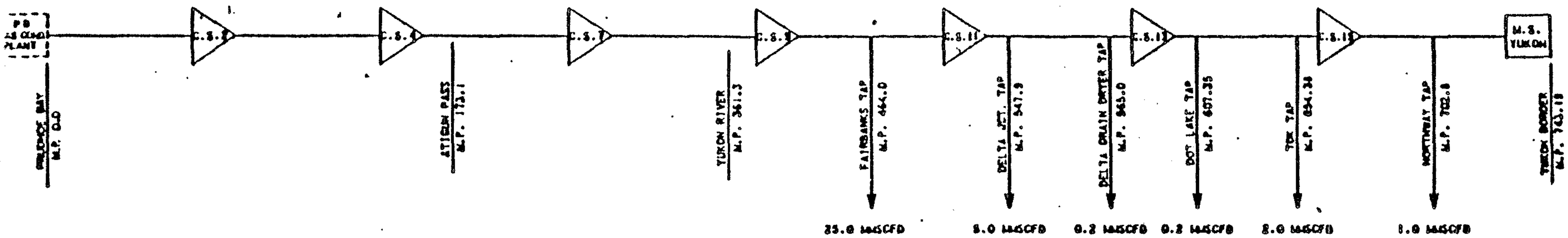
ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

PIPELINE FLOW DIAGRAM
ALASKAN SECTION OF THE ANGTS
SUMMER 2104.9 MMSCFD AVERAGE FLOW

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

D. O'DELMITO 3-10-80

NONE 4680-10-00-0-001 4



40" O.D. PIPELINE, WALL THICKNESS = 0.6 INCH MINIMUM

	STATION DESIGNATION	P.B. GAS COND PLANT	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	C.S. 11	C.S. 12	C.S. 13	C.S. 14	C.S. 15	C.S. 16	M.S. YUKON
STATION	MILEPOST (MILES)	0.0		79.90		141.25			273.83		380.82		494.06		579.55		684.94		741.0
	ELEVATION (FEET)	21		825		3050			1315		880		715		1300		2000		2050.8
	STATION INLET VOLUME (MMSCF/D)			2098.50		2095.24			2091.83		2088.55		2059.91		2050.54		2044.81		2039.89
	TOTAL FUEL (MMSCF/D)			3.26		3.41			3.28		3.64		4.17		3.63		3.92		0.10
	NET VOLUME TO PIPELINE (MMSCF/D)	2098.50		2095.24		2091.83			2088.65		2084.91		2055.74		2047.01		2040.89		2039.79
	STATION SUCTION PRESSURE (PSIG)			1074.2		1051.2			1080.3		1067.8		1039.9		1078.6		1041.8		1145.0
	STATION SUCTION TEMPERATURE (°F)			3.8		2.0			14.7		19.3		18.2		20.8		15.7		23.0
	STATION DISCHARGE PRESSURE (PSIG)	1260.0		1260.0		1247.0			1254.0		1252.0		1260.0		1260.0		1252.0		1141.0
	STATION DISCHARGE TEMPERATURE (°F)	30.0		23.4		22.8			31.0		31.0		32.8		32.0		31.0		22.8
COMPRESSION	COMPRESSION RATIO			1.181		1.194			1.169		1.181		1.219		1.176		1.210		
	HORSEPOWER REQUIRED			11922		12688			11823		12994		15390		12479		14433		
	HORSEPOWER SPARE			15148		12772			15377		14886		13010		15371		12227		
	HORSEPOWER INSTALLED-SITE RATED			27070		25460			27200		27880		28400		27850		26660		
	NO. OF UNITS INSTALLED			2		2			2		1		1		1		1		
	STANDARD ISO RATING OF UNITS			26500		26500			26500		26500		26500		26500		26500		
	COMPRESSOR SUCTION PRESSURE (PSIG)			1068.2		1037.2			1074.3		1061.1		1033.9		1072.6		1035.8		
	COMPRESSOR SUCTION TEMPERATURE (°F)			3.4		1.5			14.3		18.9		17.8		20.4		15.3		
	COMPRESSOR DISCHARGE PRESSURE (PSIG)			1264.8		1251.0			1258.0		1256.0		1264.0		1264.0		1256.0		
	COMPRESSOR DISCHARGE TEMPERATURE (°F)			23.6		23.1			33.7		40.0		43.1		41.1		39.3		
REFRIG.	COOLING LOAD (TONS)			0		0			746		2584		3152		2558		2338		
	REFRIGERATION HORSEPOWER REQUIRED			0		0			166		576		699		567		521		

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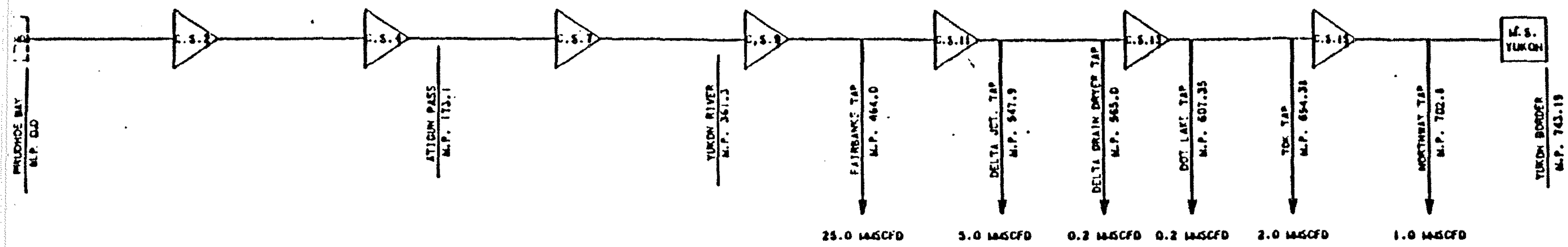
4	REVISED NO. OF UNITS INSTALLED AND AS NOTED
3	FOR REVISED FERC FILING
2	APPROVED FOR FERC FILING

FLUOR
PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

PIPELINE FLOW DIAGRAM
ALASKAN SECTION OF THE ANGTS
WINTER 2098.5 MMSCFD AVERAGE FLOW

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM



8" O.D. PIPELINE, WALL THICKNESS = 0.6 INCH MINIMUM

TATION DESIGNATION	P.B. LAB COND PLANT	C.S. 1	C.S. 2	C.S. 3	C.S. 4	C.S. 5	C.S. 6	C.S. 7	C.S. 8	C.S. 9	C.S. 10	C.S. 11	C.S. 12	C.S. 13	C.S. 14	C.S. 15	C.S. 16	M.S. YUKON
ILEPOST (MILES)	0.0		79.94		141.25			273.83		380.82		494.08		578.55		684.94		741.0
LEVATION (FEET)	21		825		3050			1315		880		715		1300		2000		2050
TATION INLET VOLUME (MMSCF/D)			2512.30		2507.81			2503.28		2497.36		2466.29		2454.97		2447.05		2440.31
OTAL FUEL (MMSCF/D)			4.49		4.53			5.92		6.07		6.12		5.72		5.74		0.10
ET VOLUME TO PIPELINE (MMSCF/D)	2512.30		2507.81		2503.28			2497.36		2491.29		2460.17		2449.25		2441.31		2440.21
TATION SUCTION PRESSURE (PSIG)			1001.2		998.1			933.0		939.7		920.1		966.8		949.4		1114.6
TATION SUCTION TEMPERATURE (°F)			1.5		4.5			12.1		12.9		11.2		15.6		10.0		20.7
TATION DISCHARGE PRESSURE (PSIG)	1260.0		1260.0		1251.0			1236.5		1245.5		1230.9		1260.0		1253.0		1108.8
TATION DISCHARGE TEMPERATURE (°F)	30.0		29.9		31.0			31.0		31.0		32.0		32.0		31.0		20.4
OMPRESSION RATIO			1.271		1.266			1.329		1.338		1.351		1.316		1.332		
ORSEPOWER REQUIRED			21081		21074			27200		27880		28400		25890		26442		
ORSEPOWER SPARE			5989		4386			0		0		0		1960		218		
ORSEPOWER INSTALLED-SITE RATED			27070		25460			27200		27880		28400		27850		26660		
O. OF UNITS INSTALLED			2		2			2		1		1		1		1		
TANDARD ISO RATING OF UNITS			26500		26500			26500		26500		26500		26500		26500		
OMPRESSOR SUCTION PRESSURE (PSIG)			993.2		990.6			931.0		931.7		912.1		958.8		941.4		
OMPRESSOR SUCTION TEMPERATURE (°F)			0.9		3.9			11.5		12.3		10.6		15.0		9.5		
OMPRESSOR DISCHARGE PRESSURE (PSIG)			1266.0		1257.0			1242.5		1251.5		1236.9		1266.0		1259.0		
OMPRESSOR DISCHARGE TEMPERATURE (°F)			30.2		33.1			47.9		49.6		49.2		50.3		46.0		
OOLING LOAD (TONS)			0		628			5740		6314		5690		6095		5002		
EFRIGERATION HORSEPOWER REQUIRED			0		140			1279		1406		1262		1352		1114		

IF HAVE A SPARE TURBINE/COMPRESSOR UNIT

4	REVISED NO OF UNITS INSTALLED
3	FOR REVISED FERC FILING
2	REVISED FOR DESIGN BASIS
1	APPROVED FOR FERC FILING
0	FOR CLIENT REVIEW

FLUOR PROJECT MANAGEMENT CONTRACTOR

ALASKAN NORTHWEST NATURAL GAS TRANSPORTATION COMPANY

PIPELINE FLOW DIAGRAM
ALASKAN SECTION OF THE ANGTS
WINTER 2512.3MMSCFD FLOW

ALASKA SEGMENT OF THE ALASKA NATURAL GAS TRANSPORTATION SYSTEM

W. O'BELMITO 3-10-80

SCALE: NONE

4680-10-00-0-004 REV. 4

A-43

APPENDIX H

References Used

1. Grant of Right-of-Way for ANGTS, December 1, 1980

2. Agreement and Grant of Right-of-Way for TAPS, January 23, 1974

3. Mineral Leasing Act, Public Law 93-153

4. Rights-of-Way Under the Mineral Leasing Act 43 CFR 2880

5. Trans-Alaska Gas System, Project Description, December 1986

6. Alaska Natural Gas Transportation Act of 1976, Public Law 94-586

APPENDIX I

Yukon Pacific Corporation's responses to the four compatibility issues addressed on pages 2 and 3 of the Compatibility Evaluation are as follows.

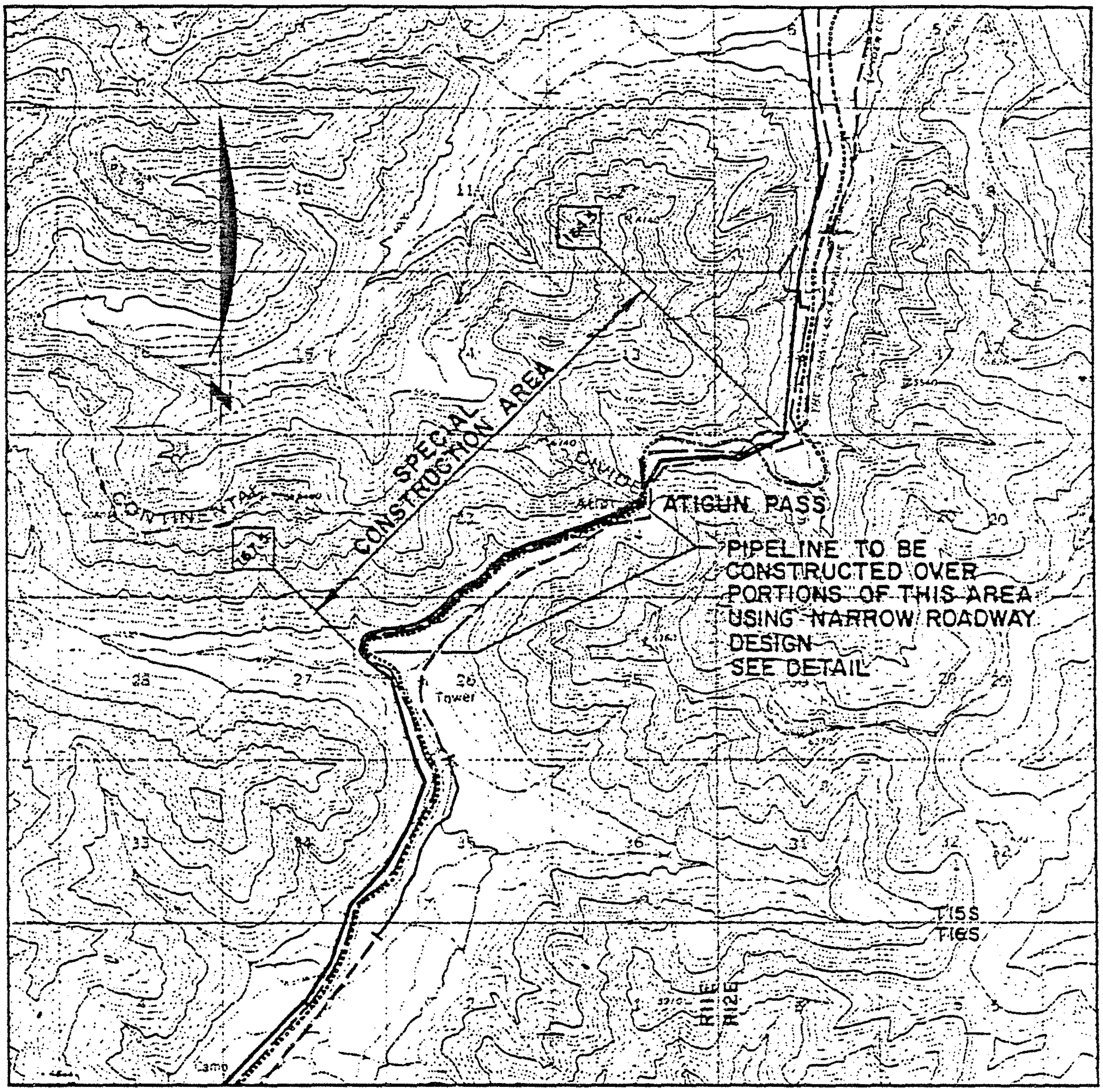
1. Clarify how TAGS proposes to cross Atigun Pass, taking into account the approved Revision 4 location of ANGTS.

The TAGS pipeline route over Atigun Pass is viewed by Yukon Pacific Corporation (YPC) as a special design area meriting site specific discussion since it is a narrow "pinch point" where up to three pipelines and the Dalton Highway must be accommodated. The Atigun Pass special construction area is discussed in detail in Section 5.2.17.1 of the TAGS Project Description; additional information concerning the Atigun Pass area is provided here to supplement information in the Project Description.

The TAGS pipeline route ascends the upper Atigun River valley on the west side of the Dalton Highway and crosses the TAPS pipeline at the base of Atigun Pass. The route then ascends the north side of Atigun Pass, crossing the highway (approximately highway Milepost 247.9), TAPS, and ANGTS right-of-way. The TAGS route then ascends roughly parallel to TAPS to the continental divide, where a second crossing of the highway and the ANGTS right-of-way is made. The TAGS route then descends the south side of the pass proximate to the west side of the ANGTS right-of-way and the highway to the base of the pass. At the base of the south side of Atigun Pass, the route crosses the upper Chandalar River, and parallels the west side of the highway to the Chandalar shelf. The closest proximity to TAPS is at the top of Atigun Pass where TAGS encroaches to within approximately 120 feet of the TAPS pipeline.

An error on Figure 5.23 of the Project Description placing approximately 1000 feet of the TAGS pipeline along the west side of the Dalton Highway on the north side of Atigun Pass has been corrected, as shown on Figure 4.

In the TAGS Project Description, Figure 5.24 (Atigun Pass Construction Area, Narrow Roadway Section) assumed a 30 foot roadway width east of and adjacent to the ANGTS pipeline at the narrow roadway section on the south approach to



SCALE 1:63360

3000 0 3000 6000 9000 12000 15000 18000 21000 Feet

CONTOUR INTERVAL 100 FEET

LEGEND

EXISTING DALTON HIGHWAY

PROPOSED TAGS PIPELINE (B/G)

EXISTING TAPS PIPELINE (A/G)

EXISTING TAPS PIPELINE (B/G)

TRANSITION, TAPS (A/G) TO (B/G)

PROPOSED ANGTS PIPELINE (B/G)

164.5 TAGS MILEPOST

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM

ATIGUN PASS
CONSTRUCTION AREA

Figure 4

FEB. 9, 1987

Atigun Pass. This working width is consistent with roadway conditions in the pass shortly after completion of the TAPS pipeline. Over the years, continued maintenance of the highway has widened the roadway and shifted the roadway ditchline further into the hillside, thus widening the roadway slightly. Figure 5.24 represents the wider roadway conditions which were observed in the summer of 1986.

It was assumed that ANGTS has not accounted for the shift in the roadway ditch that has occurred through the years of roadway maintenance. However, maps recently received from the Alaskan Northwest Natural Gas Transportation Company indicate a late change (9-9-85) in routing on the south approach to the Continental Divide. Although the nature of the change is unclear on the map sheets, YPC has assumed that the change in ANGTS alignment takes the current ditchline at the pinch points into account.

YPC has re-evaluated the Atigun Pass special construction area in light of this new information received from the Alaskan Northwest Natural Gas Transportation Company, and has developed a sightly modified plan which allows construction of both pipelines without moving the ANGTS pipeline centerline form its 9-9-85 roadway ditch location.

A reinforced earth fill structure, with wall, will be constructed on the downslope side of the roadway in the two areas of most severe roadway constriction where additional upslope cutting must be kept to a minimum. These two areas identified by field reconnaissance are located near the top of and about half way down the south side of the pass, and total approximately 6, 250 feet in length. The reinforced earth fill base will be constructed to a height of 15.0 feet, thus increasing the roadway width and the roadway elevation by 5.0 feet. A new typical section for the proposed specially reinforced earth fill supported highway is shown in Figure 5. It is based on information obtained during site reconnaissance of the narrowest section of roadway and on recent information concerning the location of the ANGTS pipeline near the top of Atigun pass. The increase in roadway width created by the reinforced earth fill structure and the increase in roadway elevation

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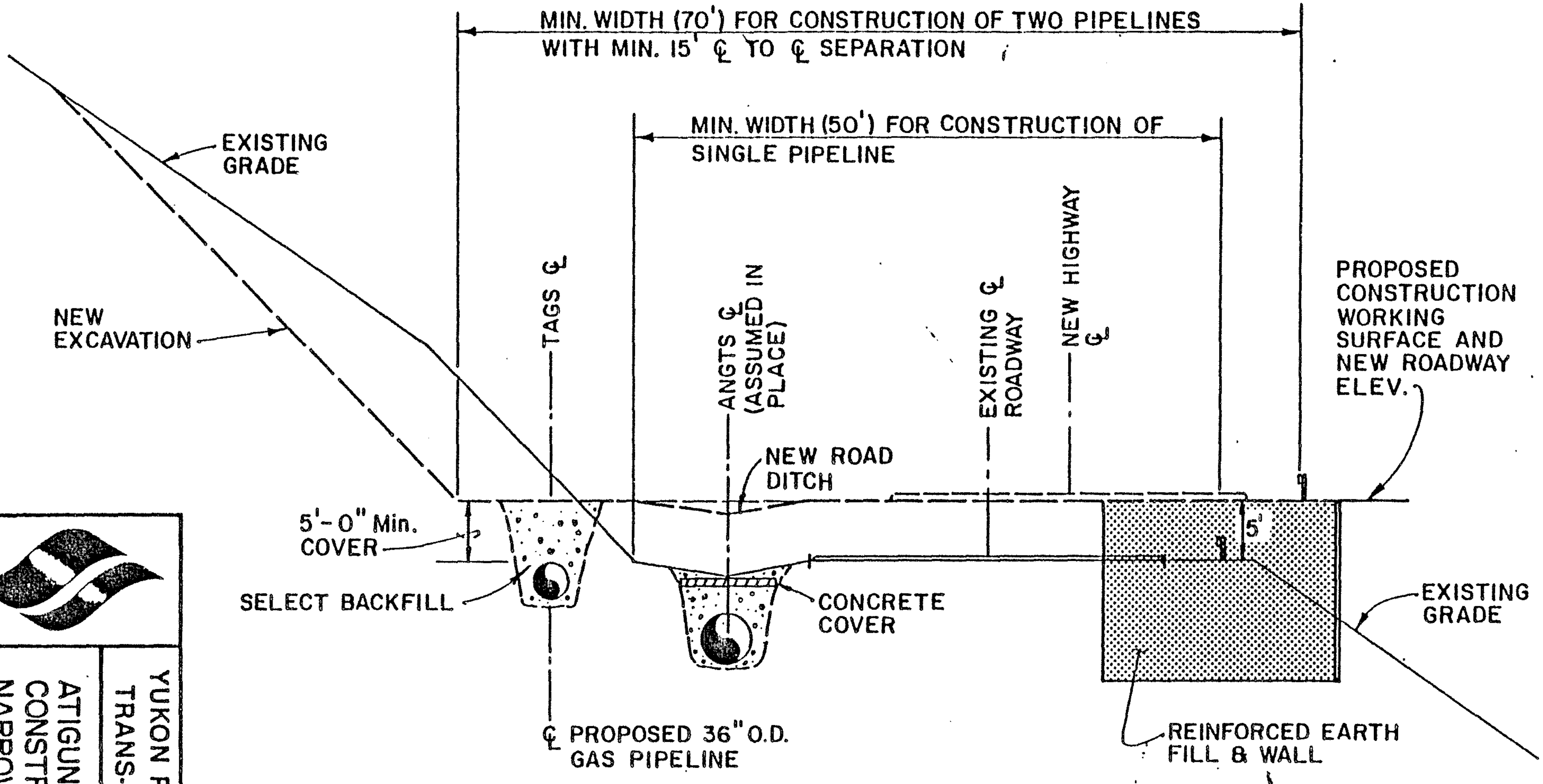
A-48



NOTE

ANGTS REPRESENTS 48" O.D. GAS PIPELINE PROPOSED BY NORTHWEST ALASKA PIPELINE COMPANY AND ASSUMES CURRENT ROADWAY DITCH IS ANGTS CENTERLINE.

TYPICAL NARROW ROADWAY CONSTRUCTION

DALTON HIGHWAY-SOUTH APPROACH TO ATIGUN PASS

Section View Looking North

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM

ATIGUN PASS
CONSTRUCTION AREA
NARROW ROADWAY SECTION
Figure 5

APPENDIX A

will provide most of the additional width required for TAGS pipeline construction and for one future pipeline. A small cut on the uphill side of the roadway will provide the additional width for the minimum separation distance.

The remaining 4,500 feet of roadway will be widened by increasing the uphill cut and downslope fill and raising the roadway elevation. The roadway elevation will be raised to match the added elevation of the reinforced fill-supported sections. The added roadway elevation will be "feathered" at the top and base of the Highway section to prevent any significant increase in current roadway grade.

Detailed design and construction plans will be coordinated with the State Highway Department, Alyeska Pipeline Service Company, and the Northwest Alaskan Pipeline Company in order to consider in-place facilities and Rights-of-Way. Design and construction will be accomplished to assure facility compatibility.

Operations and maintenance of TAGS will also be coordinated with the State Highway Department, Alyeska and Northwest to assure continued facility compatibility through the life of the project. In the event that excavation of TAGS pipeline is ever required at a location where the two pipelines are spaced relatively close, special techniques will be employed. Hand excavation methods assisted by thawing techniques would most likely be utilized to expose the pipeline after formation of a frost bulb.

Where pipelines and highway facilities are proximate, precise as-built location data will be necessary. As-built data must be coordinated between companies, and companies should share common survey benchmarks where practical.

2. <u>Identify TAGS route for Sukakpak Special Construction Area on scale of 1:63,300. Give special attention to proximity to TAPS and ANGTS alignments.</u>

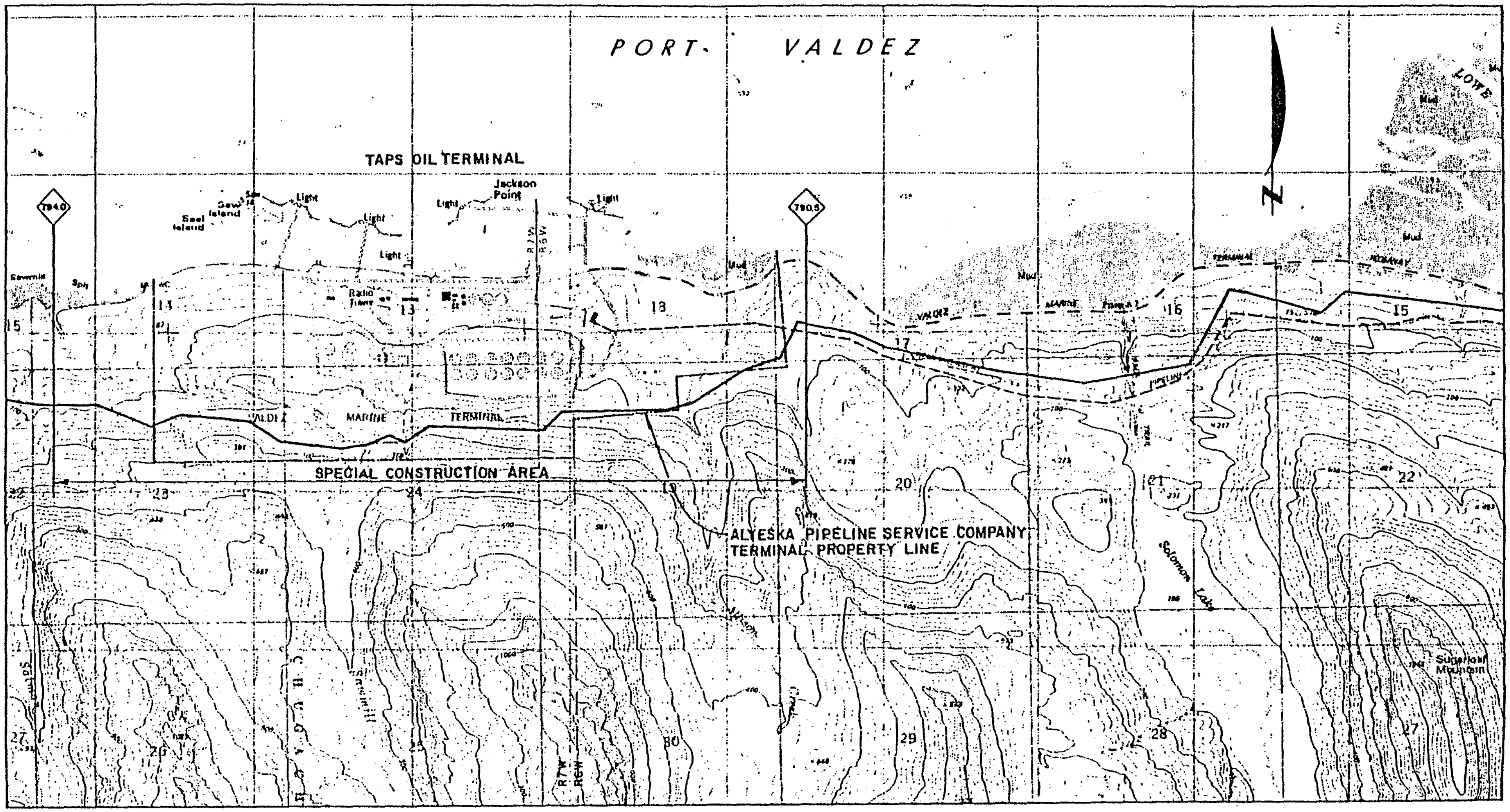
Yukon Pacific Corporation (YPC) is currently considering optional pipeline routes in the area of Sukakpak Mountain. There are a number of factors which the company feels must be considered in the routing of the pipeline in this area, including: 1) visual quality of the area; 2) constraints related to construction near TAPS of the ANGTS ROW; 3) constraints related to placement of the pipeline within the active floodplain of the Koyokuk River; and 4) the slope of Sukakpak Mountain. YPC will conduct a detailed evaluation of these factors after completion of 1987 summer field investigations. Until these detailed analyses are conducted, YPC cannot provide a complete response to your comment.

3. Provide routing of TAGS alignment around TAPS terminal, taking into account issues raised in the letter of November 23, 1986, by Alyeska Pipeline Service Company (APSC).

The TAGS alignment along the south side of Port Valdez will require a routing south of the TAPS Oil Terminal site. This pipeline segment is considered as a special construction area due to the proximity of the pipeline to TAPS facilities. The total length of this special construction section is approximately 18,500 feet.

The feasibility of preliminary routing alternatives in the area of the TAPS terminal site has been evaluated. A proposed route for the TAGS pipeline has been identified between the Fort Liscum Area (M.P. 790.5) and the mouth of Sawmill Creek (M.P. 794.0). Further route evaluation and alignment design in this area will involve coordination with the Alyeska Pipeline Service Company. Selection of a specific route location in the area of the terminal will be the result of detailed evaluation of available alternatives, design requirements, and construction procedures. Proposed TAGS operating and maintenance requirements will also affect specific route selection.

Figure 8 shows the proposed TAGS route between the Fort Liscum area and the mouth of Sawmill Creek based on initial feasibility evaluations. The TAGS alignment crosses a belowground taps section at approximately milepost 790.5



LEGEND

- PROPOSED TAGS PIPELINE (BELOW GROUND)
- EXISTING TAPS PIPELINE (BELOW GROUND)
- PROPERTY LINE
- 790.5 TAGS MILEPOST

SCALE 1:25,000

1000 0 1000 2000 3000 4000 5000 Feet

CONTOUR INTERVAL 20 METERS

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM

TAPS OIL TERMINAL
CONSTRUCTION AREA

Figure 8

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APPENDIX A

to provide a routing south of all TAPS terminal facilities. The TAGS pipeline route generally maintains a horizontal separation greater than 1,000 feet from facilities at the TAPS terminal.

Soil conditions to the south of the TAPS oil terminal are expected to be predominately glacial till over bedrock. Local areas on glacially eroded terraces are expected to have thick organic cover over the glacial tills. After workpad grading is completed, however, it is expected that the TAGS pipeline will be buried in bedrock over most of its length. A warm gas pipeline operating mode is planned for this area.

The construction of the TAGS pipeline around the TAPS terminal is estimated to require two summers of work. Civil work related to the clearing and grading of the right-of-way will be completed during the first summer in preparation for pipeline installation during the second summer. Care will be taken from the onset of construction to avoid the diversion of natural surface drainage which could affect existing drainage controls on the TAPS terminal site. Temporary, and where possible, permanent erosion control measures will be established during the first summer working season.

Preparatory work during the first summer season on this segment will begin in the Allison Creek area and proceed to the west.

Construction of the workpad and preparation of the right-of-way will be restricted to daylight operations when work is upslope of TAPS facilities. Clearing and grubbing of the right-of-way will be followed by cut and fill construction of the workpad/construction zone.

Pipeline construction in the second summer will proceed from east to west through this area with a typical construction spread. Precautions and restrictions will be similar to those for the civil construction.

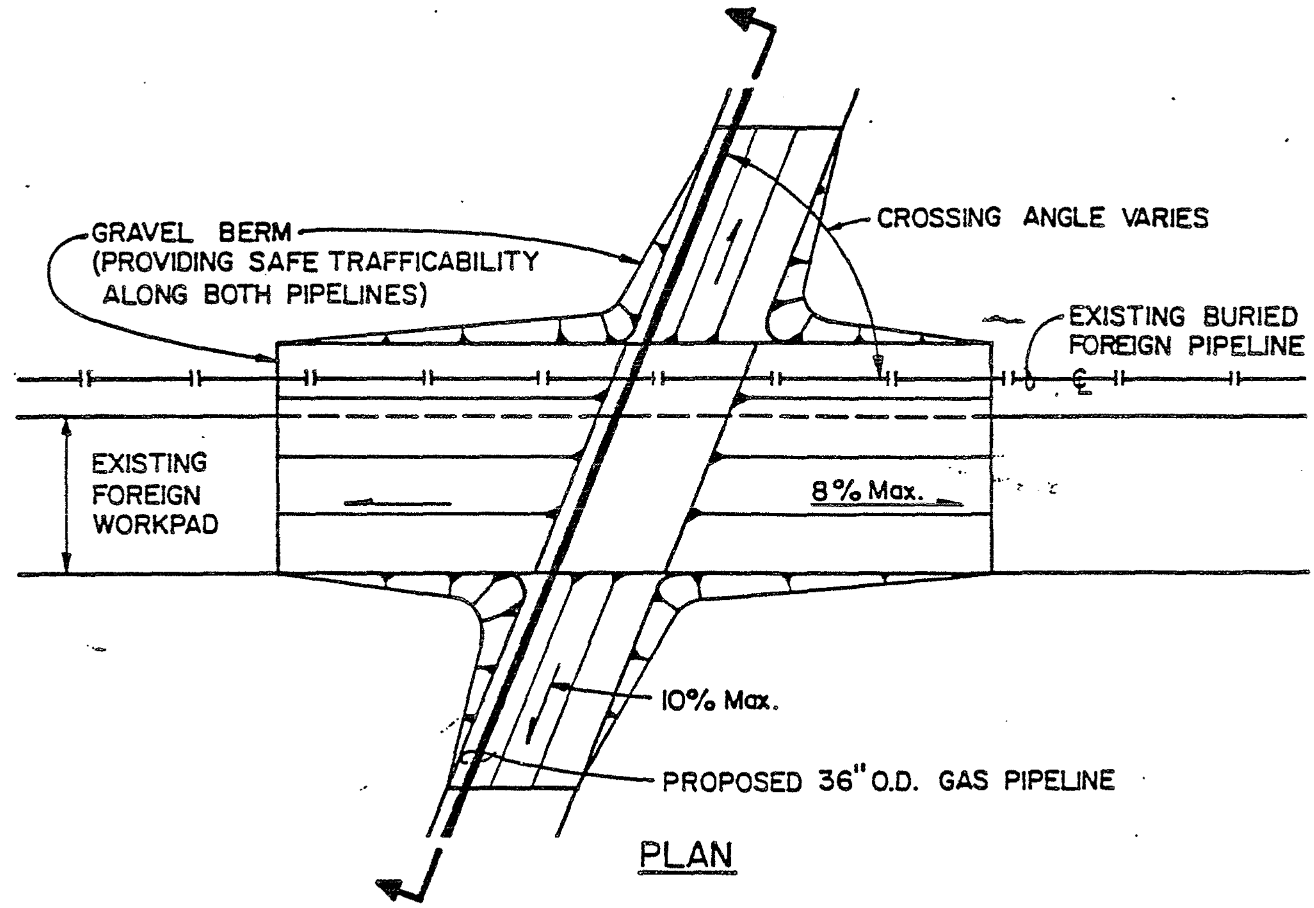
Detailed design and construction plans for this segment will be coordinated with the Alyeska Pipeline Service Company during the final design phase and before start of construction activities. Coordination between the two companies will continue throughout construction.

During operation of TAGS, the construction workpad through this segment will be utilized only for monitoring and maintenance activities, and will not be used for permanent access to the LNG Plant/Marine Terminal.

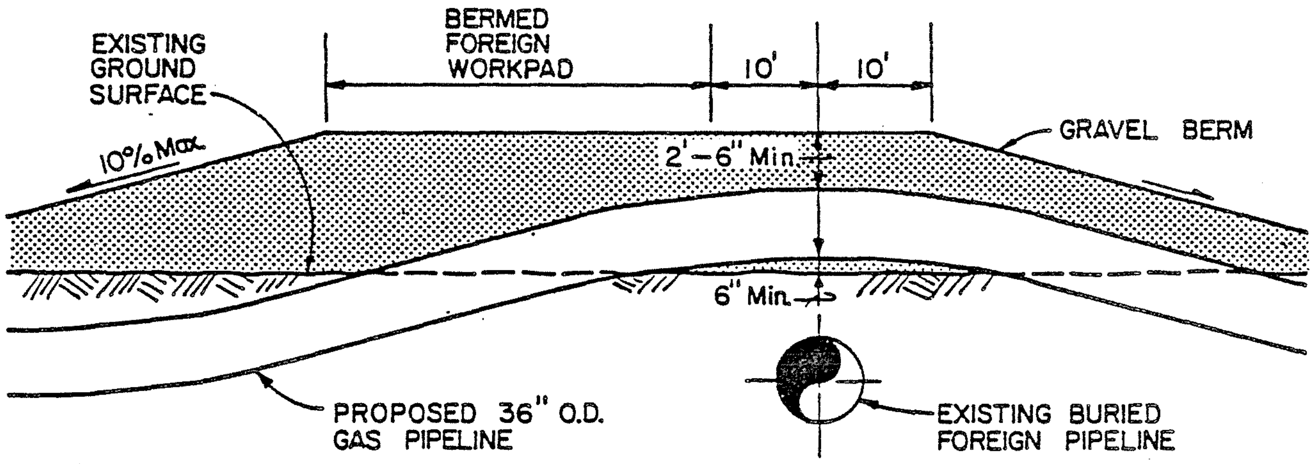
4. <u>Clarify how the TAGS proposed typical crossing of foreign buried pipelines will accommodate access needs along those foreign pipelines by their respective operators. The typical drawing on page 5-86 shows a configuration that will not accommodate large vehicular traffic along the foreign pipeline.</u>

Figure 5-12 of the <u>Project Description</u> showing a typical TAGS crossing of a buried foreign pipeline has been revised, and is shown as Figure 10. The revised scheme will accommodate large vehicular traffic along the foreign pipeline as well as along the TAGS pipeline.

In order to provide permanent access through the TAGS foreign pipeline crossing points, ramped gravel berms will be constructed. Existing foreign pipeline workpads will be ramped over the TAGS pipeline at grades of 8 percent or less. The ramped foreign pipeline workpad will be constructed so that the existing workpad width is not reduced. Placement and compaction of gravel material will be accomplished as required to provide a permanently serviceable structure. Each crossing location will require site specific evaluation of geotechnical and hydrological conditions for design. It will be necessary to coordinate design, including specific location, construction and long term maintenance efforts with existing foreign pipeline operators.



PLAN



SECTION

NOTES

1. TYPICAL FOR CROSSING OF EXISTING TAPS OR PROPOSED ANGTS BELOWGROUND PIPELINES.
2. SITE SPECIFIC DESIGNS MAY BE REQUIRED TO FACILITATE SURFACE DRAINAGE.

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM

TYPICAL CROSSING OF
BURIED FOREIGN PIPELINE
(TAGS BERMED ABOVE)

Figure 10

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YPC PROPOSED ACCESS ROADS

TAGS Access Roads

Milepost	Description	Estimated Length
22.5	new	3.1 miles
34.3	new	1.2 miles
46.3	new	0.6 miles
66.5	new	1.3 miles
71.8	new	0.1 miles
74.2	new	0.1 miles
77.4	new	0.1 miles
81.9	new	0.1 miles
88.1	new	0.1 miles
92.1	new	1.2 miles
115.0	reuse	0.5 miles
121.5	new	0.1 miles
125.5	reuse	0.2 miles
140.0	reuse	2.1 miles
148.6	reuse	0.9 miles
	new	0.3 miles
173.9	new	0.5 miles
176.5	reuse	0.3 miles
183.5	new	0.1 miles
191.4	new	0.1 miles
195.0	new	0.1 miles
198.5	new	0.2 miles
203.0	new	0.1 miles
208.2	reuse	0.2 miles
213.9	new	0.2 miles
218.5	new	0.1 miles
223.0	new	0.1 miles
224.3	reuse	0.1 miles
231.0	reuse	0.1 miles
236.2	reuse	0.1 miles
238.6	reuse	0.1 miles
246.0	reuse	0.4 miles
252.1	new	0.1 miles
253.4	reuse	0.1 miles
256.9	reuse	0.1 miles
261.6	reuse	0.3 miles
264.0	new	0.1 miles
270.5	reuse	0.7 miles
	new	0.2 miles
272.3	reuse	0.7 miles
	new	0.6 miles
277.6	reuse	0.9 miles
	new	0.2 miles
281.0	reuse	0.7 miles
	new	0.5 miles
283.3	reuse	0.4 miles
286.0	reuse	0.2 miles
290.1	reuse	1.1 miles
	new	0.6 miles
291.2	reuse	2.2 miles
	new	0.4 miles

TAGS Access Roads (continued)

Milepost	Description	Estimated Length
293.2	reuse	1.7 miles
	new	0.4 miles
294.2	reuse	1.2 miles
	new	0.2 miles
296.3	reuse	0.3 miles
298.9	reuse	0.1 miles
300.0	reuse	0.1 miles
304.9	new	0.1 miles
309.0	reuse	0.2 miles
312.0	reuse	0.2 miles
313.8	new	0.1 miles
315.8	new	0.1 miles
317.8	new	0.1 miles
319.6	reuse	0.1 miles
324.5	new	0.1 miles
325.7	reuse	0.4 miles
328.4	reuse	0.8 miles
	new	0.2 miles
330.3	new	1.8 miles
335.7	new	1.6 miles
340.2	reuse	0.8 miles
342.8	reuse	0.2 miles
	new	0.3 miles
345.3	reuse	0.5 miles
348.9	reuse	0.2 miles
349.4	reuse	5.5 miles
	new	1.0 miles
355.5	reuse	0.2 miles
357.0	reuse	0.6 miles
	new	0.7 miles
360.2	reuse	0.1 miles
362.1	new	0.1 miles
363.9	reuse	0.5 miles
369.7	reuse	0.1 miles
371.5	reuse	0.1 miles
374.1	reuse	1.0 miles
379.5	new	2.4 miles
385.7	reuse	2.0 miles
386.9	reuse	0.6 miles
391.0	reuse	0.3 miles
	new	0.3 miles
400.5	reuse	8.5 miles
	new	0.5 miles
408.5	reuse	0.3 miles
410.6	reuse	0.5 miles
415.2	reuse	0.1 miles
417.2	reuse	0.1 miles
418.4	reuse	0.7 miles
420.9	reuse	0.2 miles
425.7	reuse	2.8 miles
428.5	reuse	1.6 miles
430.1	reuse	3.5 miles

TAGS Access Roads (continued)

Milepost	Description	Estimated Length
432.7	reuse	2.9 miles
436.1	reuse	2.4 miles
486.0	new	4.5 miles
512.2	reuse	0.5 miles
517.9	reuse	0.8 miles
548.5	reuse	2.8 miles
551.0	reuse	3.4 miles
556.1	reuse	0.4 miles
561.7	reuse	0.5 miles
562.2	new	0.8 miles
564.6	reuse	0.3 miles
568.3	reuse	0.2 miles
569.6	reuse	0.3 miles
572.3	reuse	0.2 miles
580.0	new	0.1 miles
581.8	new	0.2 miles
590.6	reuse	1.8 miles
591.4	new	0.9 miles
607.1	new	0.3 miles
609.0	new	0.2 miles
620.3	reuse	0.4 miles
623.0	reuse	0.1 miles
624.6	reuse	0.3 miles
632.2	reuse	0.2 miles
634.4	reuse	0.7 miles
635.1	reuse	0.2 miles
639.1	new	0.5 miles
642.6	reuse	1.0 miles
664.0	reuse	3.5 miles
671.7	reuse	1.2 miles
674.0	reuse	0.3 miles
680.5	reuse	1.6 miles
688.7	reuse	0.9 miles
689.0	reuse	0.6 miles
691.1	reuse	0.4 miles
695.2	new	0.6 miles
699.7	new	2.0 miles
707.2	reuse	0.5 miles
	new	0.6 miles
715.0	reuse	0.2 miles
720.6	reuse	0.4 miles
731.1	reuse	0.3 miles
734.6	reuse	0.1 miles
737.1	reuse	0.3 miles
755.5	reuse	0.2 miles
757.2	reuse	1.1 miles
759.4	reuse	0.3 miles
768.6	reuse	0.3 miles
769.6	reuse	0.1 miles
775.3	reuse	1.8 miles
784.1	reuse	1.1 miles

DETERMINATION OF ACCEPTABILITY OF THE EL PASO ROUTE

Section 1106 of ANILCA and 43 CFR Part 36.7 states that for a transportation or utility system (TUS) to be permitted in a conservation system unit (CSU) of which Denali National Park and Preserve is considered, it must be compatible with the purposes for which the CSU was established and there is no other economically feasible and prudent alternative route for the system or an alternative route that would result in fewer or less severe adverse impacts on the CSU. A Congressional approval would be required to traverse the CSU and no other federal permits including the BLM's grant of right-of-way could be issued until such action occurs.

A proposal similar to the proposed TAGS project for the El Paso Alaska Company (El Paso) project was filed in 1974 before the Federal Power Commission (now the Federal Energy Regulatory Commission) to transport natural gas from Prudhoe Bay to Prince William Sound.

The Federal Power Commission staff in the Supplement to the Final Environmental Impact Statement for the Alaska Natural Gas Transportation System (ANGTS) stated that "the overall projects as proposed by Arctic Gas, El Paso, and Alcan are each considered to be acceptable, presuming that the mitigating measures proposed by the applicants and those that will be developed by the federal agencies will be implemented and successfully enforced"[1]. In the conclusion of the Initial Decision to the proposed Alaska Natural Gas Transportation System proposals, El Paso Alaska Company, Docket No. CP75-96, et al., the Federal Power Commission's Presiding Administrative Law Judge Nahum Litt states in his finding summary that "El Paso too has a viable plan which technically can be built in an environmentally sound manner...it could be certified...thus, if Arctic Gas (Alaskan Arctic Gas Pipeline Company) is unable to accept a certificate; this record supports findings that El Paso's proposal, as required to be modified by the findings above, would also meet the present and future public convenience and necessity"[2]. This determination was rendered

following the close of more than 150 days of public testimony, 53 volumes of transcript, approximately 1,000 exhibits and innumerable items by reference.

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1 Federal Power Commission, Supplemental Final Environmental Impact Statement for the Alaska Natural Gas Transportation Systems, September 1986, page 389.

2 Federal Power Commission, Initial Decision on Proposed Alaska Natural Gas Transportation Systems, El Paso Alaska Company, Docket No. CP75-96, et al., February 1, 1977, page 429.

The project Judge Litt identified as the El Paso proposal is similar to that proposed by the Yukon Pacific Corporation for construction of the Trans-Alaska Gas System (TAGS). The pipeline alignment is almost similar for the first approximately 750 miles, to the point just north of Thompson Pass. The TAGS line continues to follow the Trans-Alaska Pipeline System (TAPS) oil line to the Valdez terminus, whereas, the El Paso pipeline would have proceeded south at this point through a roadless section of the Chugach National Forest to an isolated site at Point Gravina on Prince William Sound.

The Commission's recommendation was for an overland system but stated that "in the absence of timely and acceptable agreements with the Canadian Government to make a route available for an overland system, a United States pipeline and tanker system can be built and can deliver gas to the contiguous United States at an economical price, and the El Paso project should be selected"[3]. The Commission further states that "In reaching these conclusions, we have exhaustively considered the massive record compiled here and material outside the record"[4].

The Commission, in its summary of major comparative advantages and disadvantages, states "we find that El Paso's construction through the Chugach National Forest and its potential thermal impacts on Prince William Sound would also be environmentally acceptable with proper mitigative measures"[5]. Further, the Commission states that "we believe we have compiled with the National Environmental Policy Act (NEPA) in exploring alternatives"[6].

The Council on Environmental Quality, which was also required to submit a report to the President pursuant to ANGTS, agrees with the Commission and states that "we have concluded that the environmental impact statements are legally and factually sufficient under NEPA and they provide an adequate basis for selecting the corridor and the basic technology for an Alaska gas transportation system"[7].

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3 Federal Power Commission, Recommendation to the President, for the Alaska Natural Gas Transportation Systems, May 1, 1977, page 2.

4 Ibid, page 3.

5 Ibid, page I-61.

6 Ibid, page I-30.

7 Council on Environmental Quality, Report to the President on the Environmental Impacts of the Proposed Alaska Gas Transportation Corridors, July 1, 1977, page 14.

Air Quality Impact Screening Analysis
Yukon Pacific Corporation
Gas Conditioning Facility
Prudhoe Bay Unit

Dames & Moore
January 1987

103.0/4-COV

1.0 INTRODUCTION

This technical note will present the results of a screening analysis to determine the potential air quality impacts of a Gas Conditioning Plant (GCF) to be located at Drill Site No. 7 within the Prudhoe Bay Unit (PBU). Previous modeling studies conducted for similar sources within the PBU have indicated that the PSD increment levels and Alaskan Ambient Air Quality Standards (AAAQS) would be maintained (e.g., Dames & Moore 1978, Radian 1982, Radian 1983). While these studies considered all the primary pollutants, the primary pollutant of concern was found to be nitrogen dioxide (NO_2). The purpose of the present analysis was to determine the potential annual NO_2 impacts associated with the GCF based on preliminary design information and conservative dispersion modeling assumptions.

2.0 EMISSIONS ESTIMATES

Annual nitrogen oxide (NO_x) emission rates and stack parameters were estimated using a conservative set of criteria in lieu of specific design information concerning the GCF. NO_x emissions were calculated for the sources at the GCF based on rated break horsepower, natural gas heating value (where applicable), and applicable emission factors. The emission rates and stack parameters used in the dispersion modeling analysis are shown in Table 1.

The natural gas-fired turbine emission calculations conservatively assumed the lower heating value provided in previous studies involving the Alaska Gas Conditioning Facility (AGCF) (Table B-1, Radian 1982). The emission factor for the gas-fired turbines was derived based on mass balance, assuming the same turbine gas composition as for the AGCF and an emission limit of 100 ppmv NO_x at 15 percent oxygen on a dry basis. The calculated emission factor was then 202 lb NO_x/MMSCF. The turbines were assumed to operate at full load, all year.

The glycol heater NO_x emissions were based on an emission limit of 0.08 lb NO_x/MMBTU. The NO_x emissions from the diesel-fired equipment were calculated using EPA published AP-42 emission factors and the rated break horsepower of each engine. Annual emissions were based 100 percent load, operating all year for each piece of equipment.

103.0/4-1

Stack parameters for the various equipment types were selected based on previous modeling studies (Dames & Moore 1978, Radian 1982). The sources contained in these studies were surveyed for similarity to the GCF sources based on engine type, size, and use. Generally, when there were two or more pieces of similar equipment, the more conservative set of stack parameters were selected.

3.0 SCREENING ANALYSIS

The screening analysis employed dispersion modeling techniques to provide conservative estimates of the annual NO_2 concentrations that could be expected around the GCF. Concentrations were predicted utilizing the ISCLT model (UNAMAP version 6), the EPA-preferred model for evaluating dispersion from complex source configurations involving building wake effects (EPA 1986). The following elements were assumed in the analysis:

- due to a lack of engineering details regarding the facility, emission rates and stack parameters were estimated using the conservative assumptions discussed in Section 2.0 above;

- the GCF sources were conservatively assumed to be co-located;

- building wake effects were simulated assuming rectangular, adjacent structures approximately the same height as the release points;

- the regulatory default options for ISCLT were employed in the analysis. Note, tests of the model using the GCF sources, indicated that the results were not sensitive to the selection of individual program options.

- the meteorological data used in the modeling was comprised of an annual joint frequency distribution of wind speed, wind direction, and stability class obtained from the Prudhoe Bay area monitoring network during April, 1979 through March 31, 1980 (Radian 1981);

- the background level for O_3 was assumed to be 51 ug/m^3 (Radian 1981); and

- NO_x concentrations from existing sources and permitted sources near Drill Site No. 7 were estimated as approximately 40 ug/m^3 from contour plots contained in the air quality impact analysis for the AGCF (Radian 1982).

The results of the annual NO_x modeling for the GCF sources are presented in Table 2. Receptors were placed along a irregularly spaced rectangular grid out to 1000 m, with all the GCF sources located in the center. The highest annual NO_x concentration of 311 ug/m^3 was predicted approximately 110 m west-southwest of the sources. This location aligns with the direction of the most frequent high wind velocities which were required to induce the building wake effects. Similar modeling runs assuming no building wake effects resulted in a much lower ground level concentration of 68 ug/m^3, at 300 m west-southwest of the sources.

In order to convert the NO_x concentrations to NO_2 for comparison to the AAAQS, the Ozone Limiting Method (OLM) was applied (Cole and Summerhays 1979). The OLM assumes a 10 percent instack conversion to NO_2 with the remainder of the conversion limited by the ambient O_3 concentration (assumed to be 51 ug/m^3). In addition, the contribution of other existing and permitted sources to the NO_x concentrations near the proposed site was assumed to be approximately 40 ug/m^3. When this background value is considered and the OLM applied, the maximum annual NO_2 becomes 83 ug/m^3, below the applicable AAAQS of 100 ug/m^3. Note, that the OLM method depends heavily on the O_3 background value, which at the PBU has been shown to be dependent on the intrusion of stratospheric O_3 during storms (Evans 1982). Higher annual O_3 background values would produce corresponding higher NO_2 predictions.

4.0 DISCUSSION

A screening analysis was applied to predict annual NO_2 concentrations associated with a proposed GCF near Drill Site No. 7. The sources were assumed to be co-located and emission rates were based on a conservative set of criteria. The results of the ISCLT modeling and the application of the OLM method indicated that annual NO_2 concentrations would be below the AAAQS. Considering the conservative nature of the analysis and provided the O_3 background concentrations assumed are representative, it is unlikely that the NO_x emissions would not be a limiting factor in the placement of the GCF at this location.

5.0 REFERENCES

Cole, H.S. and J.E. Summerhays, 1979:
A Review of Techniques Available for Estimation of Short-Term NO_2 Concentrations. JAPCA, Vol. 29, pp812-817.

Dames & Moore, 1978:
PSD Permit Application for Construction of Additional Facilities at the Prudhoe Bay Oil Field, Prudhoe Bay Alaska. Permit No. PSD-X79-05.

EPA, 1986:
Guideline on Air Quality Models (Revised). USEPA, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, Report No. EPA-450/2-78-027R.

Evans, R.J., 1982:
Ozone Transport in Northern Alaska. In PrePrints of the AMS/APCA Third Joint Conference on Applications of Air Pollution Meteorology, January 12-15, 1982, San Antonio, Texas, American Meteorology Society, 1982.

Radian, 1983:
Technical Note: Air Quality Analysis of the Enhanced Oil Recovery/Central Compressor Plant Engineering Refinement to the Prudhoe Bay Unit. Submitted to the USEPA Region X, and the Alaska Dept. of Environmental Quality. December 9, 1983.

Radian, 1982:
Air Quality Control Permit to Operate Application for Alaska Gas Conditioning Facility, Prudhoe Bay, Alaska. Submitted to: Alaska Dept. of Environmental Quality, July 15, 1982.

Radian, 1981:
Air Quality and Meteorological Monitoring Study at Prudhoe Bay, Alaska, April 1, 1979 - March 31, 1980, Final Report. Submitted to the Prudhoe Bay Unit Operators, January, 1981.

TABLE 1

Annual NO_x Emission Rates and Stack Parameters
Yukon Pacific Corporation
Gas Conditioning Facility, Prudhoe Bay Unit

Source	#Units	Emission Rate (g/s)	Height (m)	Stack Parameters Diameter (m)	Exit Vel. (m/s)	Temp. (K)
Gen. Turb. (50,330 Bhp)	2	51.7	24	4.8	15.2	700
Gas Comp. (34,470 Bhp)	5	88.6	13	2.5	20.1	644
Gas Comp. (35,635 Bhp)	4	73.2	13	2.5	20.1	644
Gas Comp. (34,905 Bhp)	3	53.8	13	2.5	20.1	644
Glycol Heater (160 MMBtu/hr)	1	1.6	14	1.0	10.7	611
Emergency Gen, (3,500 Bhp)	1	10.7	7	.5	18.3	660
Air Comp. (200 Bhp)	1	0.8	8	.5	18.3	421
NGL/EOR Comp. (34,750 Bhp)(1)	1	17.9	13	2.5	20.1	644

(1) The booster turbine retro-fitted at the NGL/EOR was not included in the modeling analysis.

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TABLE 2

Annual ISCLT NOX (ug/m3) Predictions
Screening Analysis for
Yukon Pacific Corporation
Gas Conditioning Facility, Prudhoe Bay Unit

x(m)

y(m)	-1000	-750	-500	-300	-200	-100	-50	50	100	200	300	500	750	1000
1000	2.60	2.38	1.99	1.89	1.96	2.03	2.06	2.41	2.73	3.34	3.90	5.48	7.84	9.31
750	4.31	3.16	2.76	2.16	2.25	2.35	2.41	3.08	3.67	4.69	5.55	8.84	11.22	11.23
500	6.72	6.15	4.13	3.30	2.60	2.92	3.07	4.66	6.04	8.28	12.13	16.26	14.88	13.79
300	13.59	10.79	10.55	6.35	5.32	4.11	4.50	8.28	11.44	21.01	26.30	25.41	19.18	14.12
200	19.28	20.77	17.05	14.79	8.21	5.58	5.25	12.61	21.47	37.80	39.95	31.51	18.45	13.40
100	25.29	31.85	44.42	43.84	28.85	11.09	8.38	40.48	74.61	74.26	53.46	29.16	17.57	12.59
50	28.35	37.46	59.35	87.88	98.52	52.15	17.68	147.64	158.96	76.11	48.39	27.21	16.62	12.18
-50	31.11	42.97	72.80	128.10	190.48	311.17	144.31	20.17	34.04	36.78	31.21	21.38	14.25	11.01
-100	30.76	42.67	70.42	118.54	147.41	78.52	40.68	14.04	12.90	20.70	21.64	17.87	12.92	10.28
-200	30.11	40.11	63.67	69.37	45.86	23.74	16.75	12.68	11.06	9.30	11.88	11.26	10.24	8.85
-300	29.44	37.67	45.22	32.83	24.63	13.09	12.86	11.14	9.98	8.26	7.00	8.20	7.79	7.48
-500	25.63	25.11	21.12	14.26	8.58	8.43	8.28	7.65	7.16	6.12	5.46	4.45	5.32	5.42
-750	18.16	15.33	12.11	7.57	7.22	6.89	6.72	6.27	5.96	5.36	4.83	4.12	3.39	3.87
-1000	12.71	10.90	7.88	6.36	6.14	5.91	5.79	5.47	5.26	4.84	4.42	3.74	3.18	2.73

103.0/4-T2

EXHIBIT D

Stipulations for the Agreement and Grant of Right-of-Way for the Trans-Alaska Pipeline

EXHIBIT D

Stipulations for the Agreement and Grant of Right-of-Way for the Trans-Alaska Pipeline

Table of Contents

1. GENERAL

1.1. Definitions

1.1.1. As used in these Stipulations and elsewhere in this "Agreement and Grant of Right-of-Way for Trans-Alaska Pipeline", the following terms have the following meanings:

1.1.1.1. "Access Roads" means the roads constructed or used by Permittees within, or for ingress to and egress from, the Pipeline System. It does not include the proposed State highway from the Yukon River to Prudhoe Bay, Alaska, or any other State highway.

1.1.1.2. "Affiliate" means (a) a Subsidiary of a Parent, or (b) the Parent of the Subsidiary, or (c) in the case of a corporate Subsidiary, one or more corporations that share the Parent with the Subsidiary by reason of the fact that all of the outstanding capital stock of each of the corporations that share the Parent is owned directly or indirectly by the Parent, or (d) in the case of Sohio Pipe Line Company, any corporation of which all of the outstanding capital stock is owned directly or indirectly by The Standard Oil Company, an Ohio corporation, or The British Petroleum Company, Limited, a United Kingdom corporation, or both.

1.1.1.3. "Authorized Officer" means the employee of the Department, designated by the Secretary, to whom the Secretary delegates the authority to act on behalf of the Secretary pursuant to this Agreement or such other Person to whom the Authorized Officer redelegates his authority pursuant to the delegation of authority to the Authorized Officer from the Secretary.

1.1.1.4. "Business Entity" means an artificial legal entity, formed to conduct one or more ventures for profit, or not for profit, that is duly authorized and empowered to sue and be sued, and to hold the title to property, in its own name.

1.1.1.5. "Category 1(c) Lands" means lands selected by the State and not tentatively approved and not withdrawn under section 11(a)(2) of the Alaska Native Claims Settlement Act.

1.1.1.6. "Category 1(d) Lands" means lands selected by the State and not tentatively approved and which were withdrawn under section 11(a)(2) of the Alaska Native Claims Settlement Act but which are not available for village or regional selection under section 22(1) of the Alaska Native Claims Settlement Act, 85 Stat. 713, 43 U.S.C. § 1621 (1970).

1.1.1.7. "Commissioning" means the acceptance and custody by Permittees of the first Oil tendered for shipment through the Pipeline after provision for line fill and tank bottoms. Permittees shall, by written notice, promptly advise the Authorized Officer of the date upon which such acceptance and custody takes place.

1.1.1.8. "Construction Mode" means the type of construction to be employed generally with regard to the Pipeline (e.g., whether the pipe will be buried or elevated).

1.1.1.9. "Construction Segment" means a portion of the Pipeline System that constitutes a complete physical entity or stage, in and of itself, which can be constructed, independently of any other portion or stage of the Pipeline System, in a designated area or between two given geographical points reasonably proximate to one another. It is not to be construed as referring to the entirety of the Pipeline or of the Pipeline System.

1.1.1.10. "Construction Subdivision" means any one of approximately six (6) large, lineal sections of the route of the Pipeline as determined by the Authorized Officer after consulting with Permittees.

1.1.1.11. "Department" means the Department of the Interior of the United States, or any successor department or agency.

1.1.1.12. "Final Design" comprises completed design documents. It shall include contract plans and specifications; proposed Construction Modes; operational requirements necessary to justify designs; schedules; design analysis (including sample calculations for each particular design feature); all functional and engineering criteria; summaries of tests conducted and their results; and other considerations pertinent to design and project life expectancy.

1.1.1.13. "Involuntary Passage of Title" means a Transfer that is made by the exercise of a power of sale primarily for the benefit of creditors, or in accordance with the judgment, order or decree of a court in bankruptcy, eminent domain or other similar proceedings, or pursuant to any act or resolution of a sovereign legislative body directing a lawful taking of property.

1.1.1.14. "Mapping Segment" means a Construction Subdivision, or any part thereof, as determined by the Authorized Officer; *provided, however*, that with respect to a pump station, basic communication site, remote control valve site, mechanical refrigeration equipment site and any other like Related Facility, a Mapping Segment means the entire site.

1.1.1.15. "Notice to Proceed" means a permission to initiate Pipeline System construction that is issued in accordance with Stipulation 1.7.

1.1.1.16. "Oil" means unrefined liquid hydrocarbons, including gas liquids.

1.1.1.17. "Parent" means a Person or Business Entity whose direct or indirect legal or beneficial ownership interest in, or with respect to, a Transferee or Permittee enables that Person or Business Entity to control the Transferee's or the Permittee's management or policies.

1.1.1.18. "Permittee" means any one of the Permittees.

1.1.1.19. "Permittees" means the Original Permittees, or their respective successors or assigns holding an undivided ownership interest in the Right-of-Way to the extent sanctioned by the Secretary in accordance with the provisions of this Agreement.

1.1.1.20. "Person" means a natural person.

1.1.1.21. "Persons" means more than one Person.

1.1.1.22. "Pipeline System" means all facilities located in Alaska used by Permittees in connection with the construction, operation, maintenance or termination of the Pipeline. This includes, but is not limited to, the Pipeline, storage tanks, Access Roads, communications sites, airfields, construction camps, materials sites, bridges, construction equipment and facilities at the origin station and at the Valdez terminal. This does not include facilities used in connection with production of oil or gathering systems, nor does it include such things as urban administrative offices and similar facilities which are only indirectly involved.

1.1.1.23. "Preliminary Design" means the establishment of project criteria (i.e., construction, including design, and operational concepts) necessary to delineate the project to be constructed. As a minimum it includes the following: design criteria and project concepts; evaluation of field data used to establish the design criteria; drawings showing functional and technical requirements; reports of all test data compiled during the data collection and preliminary design evaluation; standard drawings (if applicable) or drawings to support structural design concepts of each typical facility or structure; proposed Construction Modes; outline project specifications; sample computations to support the design concepts and bases for project siting.

1.1.1.24. A. "Related Facilities" means those structures, devices, improvements, and sites, the substantially continuous use of which is necessary for the operation or maintenance of the Oil transportation pipeline, including:

(1) line pipe and supporting structures;
(2) pump stations, including associated buildings, heliports, structures, yards and fences;
(3) valves and other control devices, and structures housing them;
(4) monitoring and communications devices, and structures housing them;
(5) surge and storage tanks, and related containment structures;
(6) bridges;
(7) terminals, including associated buildings, heliports, structures, yards, docks, and fences;
(8) a gas fuel line and electrical power lines necessary to serve the Pipeline;
(9) retaining walls, berms, dikes, ditches, cuts and fills, including hydraulic control structures;
(10) storage buildings and structures, and areas for storage of supplies and equipment;
(11) administrative buildings;
(12) cathodic protection devices;
(13) mechanical refrigeration equipment; and
(14) such other facilities as the Authorized Officer shall determine to be Related Facilities.

B. "Related Facilities" not authorized by this Agreement include roads and airports. Authorizations for such Related Facilities shall be given by other instruments.

C. "Related Facilities" does not mean those structures, devices, improvements, sites, facilities or areas, the use of which is temporary in nature such as those used only for construction purposes. Among such are: temporary camps; temporary landing strips; temporary bridges; temporary Access Roads; temporary communications sites; temporary storage sites; disposal sites; and construction use areas.

1.1.1.25. "Secretary" means the Secretary of the Interior of the United States, his delegate or lawful successor.

1.1.1.26. "Secretary of Labor" means the Secretary of Labor of the United States, his delegate or lawful successor.

1.1.1.27. "Subsidiary" means a Business Entity, that may or may not be a Permittee; the management and policies of which are controlled by a Parent directly or indirectly through one or more intermediaries.

1.1.1.28. "Transfer" means the passage of any right, title or interest in property (real, personal or mixed) by sale, grant, assignment, operation of law or otherwise, and whether voluntary or not.

1.1.1.29. "Transferee" means any Person, Business Entity or governmental or quasi-governmental body or authority in which there is, or there is proposed to be, vested any right, title, or interest of a Permittee in the Agreement or the Right-of-Way pursuant to a Transfer.

1.1.1.30. "Transferor" means any Permittee that makes, or that seeks to make, a Transfer of any right, title or interest in this Agreement or the Right-of-Way.

1.1.2. Terms defined elsewhere in this Agreement:

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1.2. Responsibilities

1.2.1. Except where the approval of the Authorized Officer is required before Permittees may commence a particular operation, neither the United States nor any of its agents or employees agrees, or is in any way obligated, to examine or review any plan, design, specification, or other document which may be filed with the Authorized Officer by Permittees pursuant to these Stipulations.

1.2.2. The absence of any comment by the Authorized Officer or any other agent or employee or contractor of the United States with respect to any plan, design, specification, or other document which may be filed by Permittees with the Authorized Officer shall not be deemed to represent in any way whatever any assent to, approval of, or concurrence in such plan, design, specification, or other document or of any action proposed therein.

1.2.3. With regard to the construction, operation, maintenance and termination of the Pipeline System: (1) Permittees shall ensure full compliance with the provisions of this Agreement, including these Stipulations, by their agents, employees and contractors (including subcontractors of any tier), and the employees of each of them. (2) Unless clearly inapplicable, the requirements and prohibitions imposed upon Permittees by these Stipulations are also imposed upon each Permittee's agents, employees, contractors, and subcontractors, and the employees of each of them. (3) Failure or refusal of a Permittee's agents, employees, contractors, subcontractors, or their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the Permittee. (4) Each Permittee shall require its agents, contractors and subcontractors to include these Stipulations in all contracts and subcontracts which are entered into by any of them, together with a provision that the other contracting party, together with its agents, employees, contractors and subcontractors, and the employees of each of them, shall likewise be bound to comply with these Stipulations.

1.2.4. Permittees shall make separate application, under applicable statutes and regulations, for authorization to use or occupy Federal Lands in connection with the Pipeline System where the lands are not within the Right-of-Way granted by this Agreement.

1.3. Authorized Officer

1.3.1. For purposes of information and review, the Authorized Officer may call upon Permittees at any time to furnish any or all data related to construction, operation, maintenance and termination activities undertaken in connection with the Pipeline System.

1.3.2. The Authorized Officer may require Permittees to make such modification of the Pipeline System, without liability or expense to the United States, as he deems necessary to: protect or maintain stability of geologic materials; protect or maintain integrity of the Pipeline System; prevent serious and irreparable harm to the environment (including but not limited to fish or wildlife populations, or their habitats); or remove hazards to public health and safety.

1.4. Common Agent of Permittees

1.4.1. Permittees, and each of them, have appointed Alyeska Pipeline Service Company as their common agent to design and construct the Pipeline System under and pursuant to an agreement entitled "Agreement for the Design and Construction of the Trans Alaska Pipeline System," dated August 27, 1970, and intend to appoint Alyeska Pipeline Service Company as their common agent to operate, maintain and terminate the Pipeline System under and generally pursuant to an Operating Agreement referred to in Section 5.1 of the "Trans Alaska Pipeline System Agreement," dated August 27, 1970. A Power of Attorney has been filed with the Department of the Interior by each Permittee appointing Alyeska Pipeline Service Company the true and lawful agent and attorney-in-fact on behalf of each Permittee with full power and authority to execute and deliver any and all instruments in connection with the design, construction, or operation of the Pipeline System. Within the scope of such contractual authority, such agent shall represent Permittees, and each of them, with respect to this Agreement. Such agent is and shall be empowered on behalf of Permittees, and each of them, to accept service of any process, pleadings or other documents in connection with any court or administrative proceeding relating in whole or in part to this Agreement or to all or any part of the Pipeline System and to which the United States shall be a party.

1.4.2. Permittees shall maintain a common agent for the construction, operation, maintenance and termination of the Pipeline System at all times during this Agreement. Such agent shall be a citizen of the United States, or if a corporation, a domestic corporation. Such agent shall be a resident of Alaska, or if a corporation, shall be duly authorized to conduct business in Alaska. Permittees shall cause such agent to maintain in the City of Anchorage, Alaska, at all times during this Agreement an office for the delivery of all documents, orders, notices and other written communications, as provided for in Stipulations 1.4.1. and 1.6.

1.4.3. In the event Permittees substitute a new common agent at any time, Permittees shall give prompt written notice to the Authorized Officer of such substitution, the name and office address in Anchorage, Alaska, of the new agent, and a copy of Permittees' agreement with the new agent. The United States shall be entitled to rely on each appointment until such time as a notice of the substitution of a new common agent takes effect. Each such notice shall not take effect until two (2) full working days after (and not including) the date that it was received by the Authorized Officer.

1.4.4. Upon the Transfer by any Permittee of any right, title or interest of Permittee in the Right-of-Way or this Agreement, the Transferee shall promptly execute and deliver to the Authorized Officer such documents as may be required to evidence the Transferee's appointment and ratification of the then-acting common agent.

1.5. Authority of Representatives of Authorized Officer and Common Agent; Orders of Authorized Officer.

1.5.1. No order or notice given to Permittees on behalf of the Secretary by the Authorized Officer or any other Person shall be effective as to Permittees unless prior written notice of the delegation of authority to issue such order or notice has been given to Permittees in the manner provided in Stipulation 1.6.

1.5.2. Permittees shall comply with each and every lawful order directed to them and that is issued by the Secretary, the Authorized Officer or by any duly authorized representative of the Authorized Officer.

1.5.3. Permittees shall cause the common agent of Permittees to maintain a sufficient number of its duly authorized representatives to allow for the prompt delivery to Permittees, or any of them, of all notices, orders and other communications, written or oral, of the Secretary or Authorized Officer. Each of the said representatives shall be registered with the Authorized Officer, and shall be appropriately identified in such manner and on such terms as the Authorized Officer shall prescribe. Permittees shall cause the common agent of Permittees to consult with the Authorized Officer at any time regarding the number and location of such representatives of the common agent.

1.6. Orders and Notices

1.6.1. All decisions, determinations, authorizations, approvals, consents, demands or directions that shall be made or given by the Secretary or the Authorized Officer to any one or more of Permittees in connection with the enforcement or administration of this Agreement, any applicable law or regulation, or any other agreement, permit or authorization relating in whole or in part to all or any part of the Pipeline System shall, except as otherwise provided in Stipulation 1.6.2. of this Stipulation, be in the form of a written order or notice.

1.6.2. If, in the judgment of the Secretary or the Authorized Officer, there is an emergency that necessitates the immediate issuance to any one or more of Permittees of an order or notice, such order or notice may be given orally, *provided, however*, that subsequent confirmation of the order or notice shall be given in writing as rapidly as is practicable under the circumstances.

1.6.3. All written orders, notices or other written communications, including telegrams, relating to any subject (and regardless of whether they do or do not relate to the design or construction of the Pipeline System) that are addressed to any one or more of Permittees shall be deemed to have been delivered to and received by the addressee or addressees when the order, notice or other communication has been delivered: (1) either by messenger during normal business hours or by means of registered or certified United States mail, postage prepaid, return receipt requested, to the office of the common agent of Permittees at 1815 South Bragaw Street, Anchorage, Alaska 99504, or (2) personally to any authorized representative of the common agent.

1.6.4. All written notices and communications, including telegrams, of any one or more of Permittees that are addressed to the Secretary shall be deemed to have been delivered to and received by the Secretary when the notice or communication has been delivered, either by messenger during normal business hours or by means of registered or certified United States mail, postage prepaid, return receipt requested, to the Secretary personally or to Office Room No. 6151 in the Department of the Interior Building, 18th & C Streets, Northwest, Washington, D.C. 20240.

1.6.5. All written notices and communications of any one or more of Permittees that are addressed to the Authorized Officer shall be deemed to have been delivered and received by the addressee when the notice or communication has been delivered, either by messenger during normal business hours or by means of registered or certified United States mail, postage prepaid, return receipt requested, to the Authorized Officer personally or to Office Room No. 405, 555 Cordova Street, Anchorage, Alaska 99504.

1.6.6. The United States or Permittees, by written notice to the other, may change the office address to which written notices, orders, or other written communications may be addressed and delivered thereafter, subject, however, to the provisions of Stipulation 1.4.

1.6.7. The regulations of the Department relating to notices or other communications by mail (43 CFR 1810.2) shall not be applicable to this Agreement.

1.7. Notices To Proceed

1.7.1. Permission to construct.

1.7.1.1. Permittees shall not initiate any construction of the Pipeline System without prior written permission of the Authorized Officer. Such permission shall be given solely by means of a written Notice to Proceed issued by the Authorized Officer. Each Notice to Proceed shall authorize construction only as therein expressly stated and only for the particular Construction Segment therein described.

1.7.1.2. The Authorized Officer shall issue a Notice to Proceed only when in his judgment the construction (including design) and operation proposals are in conformity with the provisions of these Stipulations.

1.7.1.3. By written notice, the Authorized Officer may revoke in whole or in part any Notice to Proceed which has been issued when in his judgment unforeseen conditions later arising require alterations in the Notice to Proceed in order to: protect or maintain stability of geologic materials; protect or maintain integrity of the Pipeline System; prevent serious and irreparable harm to the environment (including but not limited to fish or wildlife populations, or their habitats); or remove hazards to public health and safety.

1.7.1.4. Prior to submission of any Preliminary Designs or applications for any Notice to Proceed, Permittees and the Authorized Officer shall agree to a schedule for the time, scope and quantity of such submissions and applications. The purpose of such schedule is to assure that Permittees' submissions and applications shall be reasonable in scope, and filed in a reasonable time frame, insofar as the workload thereby imposed on the Authorized Officer is concerned. Submittals and applications shall be filed in accordance with said schedule, and the Authorized Officer may refuse to consider any that are not so filed. The schedule may be reviewed and revised from time to time as may be agreed upon by Permittees and the Authorized Officer.

1.7.2. Preliminary Design Submissions

1.7.2.1. Prior to applying for a Notice to Proceed for any Construction Segment, Permittees shall submit the Preliminary Design for that Segment to the Authorized Officer for approval. Where appropriate, each submission shall include the criteria which justify the selection of the Construction Modes. The Authorized Officer shall expeditiously review each submission and shall do so within thirty (30) days from the date of his receipt of the submission. The Authorized Officer may request additional information if he deems it necessary.

1.7.2.2. In appropriate cases, the Authorized Officer may waive the requirement that a Preliminary Design be submitted. In this circumstance, Permittees may proceed to apply for a Notice to Proceed in accordance with Stipulation 1.7.4.

1.7.3. Summary Network Analysis Diagram

1.7.3.1. Prior to Final Design submissions, Permittees shall submit a summary network analysis diagram for the entire project to the Authorized Officer. The summary network analysis diagram shall be time-scaled and shall include all activities and contingencies which may reasonably be anticipated in connection with the project. The summary network analysis diagram shall include:

(1) Data collection activities;
(2) Submittal and approval activities;
(3) Pre-construction, construction and post-construction activities; and
(4) Other pertinent data.

1.7.3.2. The summary network analysis diagram shall be updated at thirty (30) day intervals, as significant changes occur, or as otherwise approved in writing by the Authorized Officer.

1.7.4. Application for Notice to Proceed

1.7.4.1. Permittees may apply for a Notice to Proceed for only those Construction Segments for which the Preliminary Design has been approved in writing by the Authorized Officer or a waiver pursuant to Stipulation 1.7.2.2 has been issued in writing by the Authorized Officer.

1.7.4.2. Before applying for a Notice to Proceed for a Construction Segment, Permittees shall, in such manner as shall be acceptable to the Authorized Officer, by survey, locate and clearly mark on the ground the proposed centerline of the line pipe to be located in the Mapping Segment within which the Construction Segment is to be constructed and the location of all Related Facilities proposed to be constructed in the Mapping Segment.

1.7.4.3. Each application for a Notice to Proceed shall be supported by:

(1) A Final Design.
(2) All reports and results of environmental studies conducted or considered by Permittees.
(3) All data necessary to demonstrate compliance with the terms and conditions of these Stipulations with respect to that particular Construction Segment.
(4) A detailed network analysis diagram for the Construction Segment, including: Permittees' work schedules; consents, permits or authorizations required by State and Federal agencies and their interrelationships; design and review periods; data collection activities; and construction sequencing. The detailed network analysis diagram shall be updated as required to reflect current status of the project.
(5) A map or maps, prepared in such manner as shall be acceptable to the Authorized Officer, depicting the proposed location in the Mapping Segment within which the Construction Segment is to be constructed of: (1) the boundaries of all contiguous temporary use areas, and (2) all improvements, buried or aboveground, that are to be constructed within the Mapping Segment. The Authorized Officer shall not issue a Notice to Proceed with construction until he has approved all relevant locations on the ground and temporary boundary markers have been set by Permittees to the satisfaction of the Authorized Officer.
(6) Such other data as may be requested by the Authorized Officer either before submission of the application for a Notice to Proceed or at any time during the review period.

1.7.4.4. During review of an application for a Notice to Proceed, the relevant portion of the route of the Pipeline may be modified by the Authorized Officer, if, in his judgment, environmental conditions or new technological developments warrant the modifications. If, during construction, adverse physical conditions are encountered that were not known to exist, or that were known to exist but their significance was not fully appreciated when the Authorized Officer issued a Notice to Proceed for the portion of the Mapping Segment in which the physical conditions are encountered, the Authorized Officer may authorize deviations from the initially approved location of the Pipeline to another location along the same general route of the Pipeline at the point or points where the physical conditions are encountered, including adequate room for structurally sound transition. A deviation shall not be constructed without the prior written approval of the Authorized Officer and, if so approved, shall conform in all respects to the provisions of the approval.

1.7.4.5. The Authorized Officer shall review each application for a Notice to Proceed and all data submitted in connection therewith within ninety (90) days. Said ninety (90) day period shall begin from the later of the following dates:

(1) Date of receipt by the Authorized Officer of an application for a Notice to Proceed.

(2) Date of receipt by the Authorized Officer of the last submittal of additional data pursuant to this Stipulation.

1.7.4.6. If the Authorized Officer requires Permittees to submit additional data on one or more occasions, the review period shall begin from the date of receipt by the Authorized Officer of the last submittal.

1.8. Changes in Conditions

1.8.1. Unforeseen conditions arising during construction, operation, maintenance or termination of the Pipeline System may make it necessary to revise or amend these Stipulations to control or prevent damage to the environment or hazards to public health and safety. In that event, Permittees and the Authorized Officer shall agree as to what revisions or amendments shall be made. If they are unable to agree, the Secretary shall have final authority to determine the matter.

1.9. Antiquities and Historical Sites

1.9.1. Permittees shall engage an archeologist approved by the Authorized Officer to provide surveillance and inspection of the Pipeline System for archeological values.

1.9.2. If, in connection with any operation under this Agreement, or any other Agreement issued in connection with the Pipeline System, Permittees encounter known or previously unknown paleontological, archeological, or historical sites, Permittees shall immediately notify the Authorized Officer and said archeologist. Permittees' archeologist shall investigate and provide an on-the-ground opinion regarding the protection measures to be undertaken by Permittees. The Authorized Officer may suspend that portion of Permittees' operations necessary to preserve evidence pending investigation of the site.

1.9.3. Six copies of all survey and excavation reports shall be filed with the Authorized Officer.

1.10. Completion of Use

1.10.1. Upon completion of the use of all, or a very substantial part, of the Right-of-Way or other portion of the Pipeline System, Permittees shall promptly remove all improvements and equipment, except as otherwise approved in writing by the Authorized Officer, and shall restore the land to a condition that is satisfactory to the Authorized Officer or at the option of Permittees pay the cost of such removal and restoration. The satisfaction of the Authorized Officer shall be stated in writing. Where approved in writing by the Authorized Officer, buried pipe may be left in place, provided all oil and residue are removed from the pipe and the ends are suitably capped.

1.10.2. All areas that do not constitute all, or a very substantial part of the Right-of-Way or other portion of the Pipeline System, utilized pursuant to authorizations issued in connection with the

Pipeline System, shall be Put-to-Bed by Permittees upon completion of their use unless otherwise directed by the Authorized Officer. Put-to-Bed is used herein to mean that Access Roads, material sites and other areas shall be left in such stabilized condition that erosion will be minimized through the use of adequately designed and constructed waterbars, revegetation and chemical surface control; that culverts and bridges shall be removed by Permittees in a manner satisfactory to the Authorized Officer, and that such roads, sites and areas shall be closed to use. Permittees' rehabilitation plans shall be approved in writing by the Authorized Officer prior to termination of use of any such road, or any part thereof, in accordance with Stipulation 2.12.

1.11. **Public Improvements**

1.11.1. Permittees shall protect existing telephone, telegraph and transmission lines, roads, trails, fences, ditches and like improvements during construction, operation, maintenance and termination of the Pipeline System. Permittees shall not obstruct any road or trail with logs, slash, or debris. Damage caused by Permittees to public utilities and improvements shall be promptly repaired by Permittees to a condition which is satisfactory to the Authorized Officer.

1.12. **Regulation of Public Access**

1.12.1. During construction or termination activities, Permittees may regulate or prohibit public access to or upon any Access Road being used for such activity. At all other times, Permittees shall permit free and unrestricted public access to and upon Access Roads, except that with the written consent of the Authorized Officer, Permittees may regulate or prohibit public access and vehicular traffic on Access Roads as required to facilitate operations or to protect the public, wildlife and livestock from hazards associated with operation and maintenance of the Pipeline System. Permittees shall provide appropriate warnings, flagmen, barricades, and other safety measures when Permittees are using Access Roads, or regulating or prohibiting public access to or upon Access Roads.

1.12.2. During construction of the Pipeline System, Permittees shall provide alternative routes for existing roads and trails as determined by the Authorized Officer whether or not these roads or trails are recorded.

1.12.3. Permittees shall make provisions for suitable permanent crossings for the public where the Right-of-Way or Access Roads cross existing roads, foot-trails, winter trails, or other rights-of-way.

1.12.4. After completion of construction of the Pipeline System, and with the concurrence of Permittee, the Authorized Officer may designate areas of the Right-of-Way to which the public shall have free and unrestricted access.

1.13. **Electronically Operated Devices**

1.13.1. Permittee shall screen, filter, or otherwise suppress any electronically operated devices that are installed as part of the Pipeline System which are capable of producing electromagnetic interference radiations so that such devices will not adversely affect the functioning of existing communications systems or navigational aids. In the event that structures such as towers or buildings are to be erected as a part of the Pipeline System, their positioning shall be such that they will not obstruct radiation patterns of line-of-sight communications systems, navigational aids, or similar systems.

1.14. **Camping, Hunting, Fishing and Trapping**

1.14.1. Permittees shall post the Right-of-Way against camping, hunting, fishing, trapping and shooting within the Right-of-Way. Permittees shall prohibit their employees, agents, contractors, subcontractors, and their employees, from engaging in such activities.

1.14.2. Permittees shall inform their employees, agents, contractors, subcontractors, and their employees, of applicable laws and regulations relating to hunting, fishing, and trapping.

1.15. **Small Craft Passage**

1.15.1. The creation of any permanent obstruction to the passage of small craft in streams is prohibited.

1.16. **Protection of Survey Monuments**

1.16.1. Permittees shall mark and protect all geodetic survey monuments encountered during the construction, operation, maintenance and termination of the Pipeline System. These monuments are not to be disturbed; however, if such a disturbance occurs, the Authorized Officer shall be immediately notified thereof in writing.

1.16.2. If any land survey monuments, corners, or accessories (excluding geodetic survey monuments) are destroyed, obliterated or damaged, Permittees shall employ a qualified land surveyor to reestablish or restore same in accordance with the "Manual of Instruction for the Survey of Public Lands" and shall record such survey in the appropriate records. Additional requirements for the protection of monuments, corners, and bearing trees may be prescribed by the Authorized Officer.

1.17. **Fire Prevention and Suppression**

1.17.1. Permittees shall promptly notify the Authorized Officer and take all measures necessary or appropriate for the prevention and suppression of fires in accordance with 43 CFR 2801.1–5(d). Permittees shall comply with the instructions and directions of the Authorized Officer concerning the use, prevention and suppression of fires. Use of open fires in connection with construction of the Pipeline System is prohibited unless authorized in writing by the Authorized Officer.

1.18. **Surveillance and Maintenance**

1.18.1. During the construction, operation, maintenance and termination of the Pipeline System, Permittees shall conduct a surveillance and maintenance program applicable to the subarctic and arctic environment. This program shall be designed to: (1) provide for public health and safety; (2) prevent damage to natural resources; (3) prevent erosion; and (4) maintain Pipeline System integrity.

1.18.2. Permittees shall have a communication system that ensures the transmission of information required for the safe operation of the Pipeline System.

1.18.3. Permittees shall maintain complete and up-to-date records on construction, operation, maintenance and termination activities performed in connection with the Pipeline System. Such records shall include surveillance data, leak and break records, necessary operational data, modification records and such other data as the Authorized Officer may require.

1.18.4. Permittees shall provide and maintain Access Roads and airstrips, the number and location of which shall be approved by the Authorized Officer, to ensure that Permittees' maintenance crews and Federal and State representatives shall have continuing access to the Pipeline System.

1.19. **Housing and Quarters**

1.19.1. Permittees shall furnish, on a reimbursable basis, such representatives of the United States as may be designated by the Authorized Officer with adequate meals, living quarters and office space, reasonable use of Permittees' communications systems, and reasonable surface and air transportation during the construction, operation, maintenance and termination of the Pipeline System. Whenever possible, Permittees shall be notified in writing by the Authorized Officer in advance regarding the number of persons for whom such services and facilities will be required.

1.20. **Health and Safety**

1.20.1. Permittees shall take all measures necessary to protect the health and safety of all persons affected by their activities performed in connection with the construction, operation, maintenance or termination of the Pipeline System, and shall immediately abate any health or safety hazards. Permittees shall immediately notify the Authorized Officer of all serious accidents which occur in connection with such activities.

1.21. **Conduct of Operations**

1.21.1. Permittees shall perform all Pipeline System operations in a safe and workmanlike manner so as to ensure the safety and integrity of the Pipeline System, and shall at all times employ and maintain personnel and equipment sufficient for that purpose. Permittees shall immediately notify the Authorized Officer of any condition, problem, malfunction, or other occurrence which in any way threatens the integrity of the Pipeline System.

1.22. **Applicability of Stipulations**

1.22.1. Nothing in these Stipulations shall be construed as applying to activities of Permittees that have no relation to the Pipeline System.

1.22.2. Nothing in these Stipulations shall be construed to affect any right or cause of action that otherwise would be available to Permittees against any person other than the United States.

2. ENVIRONMENTAL

2.1. **Environmental Briefing**

2.1.1. Prior to, and during, construction of the Pipeline System, Permittees shall provide for environmental and other pertinent briefings for construction and other personnel by such Federal employees as may be designated by the Authorized Officer. Permittees shall arrange the time, place and attendance for such briefings upon request by the Authorized Officer. Permittees shall bear all costs of such briefings other than salary, per diem, subsistence, and travel costs of Federal employees. In addition, Permittees shall separately arrange with the State of Alaska for such similar briefings as the State may desire.

2.2. Pollution Control

2.2.1. General

2.2.1.1. Permittees shall conduct all activities associated with the Pipeline System in a manner that will avoid or minimize degradation of air, land and water quality. In the construction, operation, maintenance and termination of the Pipeline System, Permittees shall perform their activities in accordance with applicable air and water quality standards, related facility siting standards, and related plans of implementation, including but not limited to standards adopted pursuant to the Clean Air Act, as amended, 42 U.S.C. § 1857 *et seq.*, and the Federal Water Pollution Control Act, as amended, 33 U.S.C. § 1321 *et seq.*

2.2.2. Water and Land Pollution

2.2.2.1. Permittees shall comply with applicable "Water Quality Standards" of the State of Alaska as approved by the Environmental Protection Agency.

2.2.2.2. Mobile ground equipment shall not be operated in lakes, streams or rivers unless such operation is approved in writing by the Authorized Officer.

2.2.3. Thermal Pollution

2.2.3.1. Permittees shall comply with the standards set for thermal pollution in the State of Alaska "Water Quality Standards," as approved by the Environmental Protection Agency.

2.2.4. Air Pollution and Ice Fog

2.2.4.1. Permittees shall utilize and operate all facilities and devices used in connection with the Pipeline System so as to avoid or minimize air pollution and ice fog. Facilities and devices which cannot be prevented from producing ice fog shall be located so as not to interfere with airfields, communities or roads.

2.2.4.2. Emissions from equipment, installations and burning materials shall meet applicable Federal and State air quality standards.

2.2.5. Pesticides, Herbicides and other Chemicals

2.2.5.1. Permittees shall use only non-persistent and immobile types of pesticides, herbicides and other chemicals. Each chemical to be used and its application constraint shall be approved in writing by the Authorized Officer prior to use.

2.2.6. Sanitation and Waste Disposal

2.2.6.1. "Waste" means all discarded matter, including but not limited to human waste, trash, garbage, refuse, oil drums, petroleum products, ashes and equipment.

2.2.6.2. All waste generated in construction, operation, maintenance and termination of the Pipeline System shall be removed or otherwise disposed of in a manner acceptable to the Authorized Officer. All applicable standards and guidelines of the Alaska State Department of Environmental Conservation, the United States Public Health Service, the Environmental Protection Agency, and other Federal and State agencies shall be adhered to by Permittees. All incinerators shall meet the requirements of applicable Federal and State laws and regulations and shall be used with maximum precautions to prevent forest and tundra fires. After incineration, material not consumed in the incinerator shall be disposed of in a manner approved in writing by the Authorized Officer. Portable or permanent waste disposal systems to be used shall be approved in writing by the Authorized Officer.

2.3. Buffer Strips

2.3.1. Public Interest Areas

2.3.1.1. No construction activity in connection with the Pipeline System shall be conducted within one-half (½) mile of any officially designated Federal, State or municipal park, wildlife refuge, research natural area, recreation area, recreation site, or any registered National Historic Site or National Landmark, unless such activity is approved in writing by the Authorized Officer.

2.3.2. Vegetative Screen

2.3.2.1. Permittees shall not cut or remove any vegetative cover within a minimum five hundred (500) foot strip between State highways and material sites unless such cutting or removal is approved in writing by the Authorized Officer.

2.3.2.2. Where the Right-of-way crosses State highways, a screen of vegetation native to the specific setting shall be established over disturbed areas unless otherwise approved in writing by the Authorized Officer.

2.3.3. Streams

2.3.3.1. The Pipeline System shall be located so as to provide three hundred (300) foot minimum buffer strips of undisturbed land along streams unless otherwise approved in writing by the Authorized Officer.

2.4. Erosion Control

2.4.1. General

2.4.1.1. Permittees shall perform all Pipeline System construction, operation, maintenance and termination activities so as to avoid or minimize disturbance to vegetation.

2.4.1.2. The design of the Pipeline System shall provide for the construction of control facilities that will avoid or minimize erosion.

2.4.1.3. The erosion control facilities shall be constructed to avoid induced and accelerated erosion and to lessen the possibility of forming new drainage channels resulting from Pipeline System activities. The facilities shall be designed and operations conducted in such a way as to avoid or minimize disturbance to the thermal regime.

2.4.2. Stabilization

2.4.2.1. Surface materials taken from disturbed areas shall be stockpiled and utilized during restoration unless otherwise approved in writing by the Authorized Officer. Stabilization practices, as determined by the needs for specific sites, shall include but shall not be limited to seeding, planting, mulching, and the placement of mat binders, soil binders, rock or gravel blankets, or structures.

2.4.2.2. All disturbed areas shall be left in a stabilized condition satisfactory to the Authorized Officer. Such satisfaction shall be stated in writing by the Authorized Officer.

2.4.3. Crossing of Streams, Rivers or Flood Plains

2.4.3.1. Permittees shall prevent or minimize erosion at stream and river crossings and those parts of the Pipeline System within flood plains, as defined in Stipulation 3.6.

2.4.3.2. Temporary access over stream banks shall be made through use of fill ramps rather than by cutting through stream banks, unless otherwise approved in writing by the Authorized Officer. Permittees shall remove such ramps upon termination of seasonal or final use. Ramp materials shall be disposed of in a manner approved in writing by the Authorized Officer.

2.4.4. Seeding and Planting.

2.4.4.1. Seeding and planting of disturbed areas shall be conducted as soon as practicable and, if necessary, shall be repeated until vegetation is successful, unless otherwise approved in writing by the Authorized Officer. All other restoration shall be completed as soon as possible.

2.4.5. Excavated Material

2.4.5.1. Excavated material in excess of that required to backfill around any structure, including the pipe, shall be disposed of in a manner approved in writing by the Authorized Officer.

2.5. Fish and Wildlife Protection

2.5.1. Passage of Fish

2.5.1.1. Permittees shall provide for uninterrupted movement and safe passage of fish. Any artificial structure or any stream channel change that would cause a blockage to fish shall be provided with a fish passage structure or facility that meets all Federal and State requirements. The proposed design shall be submitted to the Authorized Officer in accordance with Stipulation 1.7.

2.5.1.2. Pump intakes shall be screened to prevent harm to fish.

2.5.1.3. Abandoned water diversion structures shall be plugged and stabilized to prevent trapping or stranding of fish.

2.5.1.4. If material sites are approved adjacent to or in certain lakes, rivers, or streams, the Authorized Officer may require Permittees to construct levees, berms or other suitable means to protect fish and fish passage and to prevent siltation of streams or lakes.

2.5.2. Fish Spawning Beds

2.5.2.1. "Fish Spawning Beds" means the areas where anadromous and resident fish deposit their eggs.

2.5.2.2. Permittees shall avoid channel changes in Fish Spawning Beds designated by the Authorized Officer; however, where channel changes cannot be avoided in such beds, new channels shall be constructed according to written standards supplied by the Authorized Officer.

2.5.2.3. Fish Spawning Beds shall be protected from sediment where soil material is expected to be suspended in water as a result of construction activities. Settling basins shall be constructed to intercept silt before it reaches streams or lakes.

2.5.2.4. Permittees shall comply with any special requirements made by the Authorized Officer for a stream system in order to protect Fish Spawning Beds. Permittees shall repair all damage to Fish Spawning Beds caused by construction, operation, maintenance or termination of the Pipeline System.

2.5.3. Zones of Restricted Activities

2.5.3.1. Permittees' activities in connection with the Pipeline System in key fish and wildlife areas may be restricted by the Authorized Officer during periods of fish and wildlife breeding, nesting, spawning, lambing or calving activity and during major migrations of fish and wildlife. The Authorized Officer shall give Permittees written notice of such restrictive action. From time to time, the Authorized Officer shall furnish Permittees a list of areas where such actions may be required, together with anticipated dates of restriction.

2.5.4. Big Game Movements

2.5.4.1. Permittees shall construct and maintain the Pipeline, both buried and above ground sections, so as to assure free passage and movement of big game animals.

2.6. Materials Sites

2.6.1. Purchase of Materials

2.6.1.1. If Permittees require materials from the public lands, Permittees shall make application to purchase such materials in accordance with 43 CFR, Part 3610. Permittees shall submit a mining plan in accordance with 43 CFR, Part 23. No materials may be removed by Permittees without the written approval of the Authorized Officer.

2.6.1.2. Insofar as possible, use of existing materials sites will be authorized in preference to new sites.

2.6.1.3. Gravel and other construction materials shall not be taken from stream beds, river beds, lake shores or other outlets of lakes, unless the taking is approved in writing by the Authorized Officer.

2.6.2. Layout of Materials Sites

2.6.2.1. Materials site boundaries shall be shaped in such a manner as to blend with surrounding natural land patterns. Regardless of the layout of materials sites, primary emphasis shall be placed on prevention of soil erosion and damage to vegetation.

2.7. Clearing

2.7.1. Boundaries

2.7.1.1. Permittees shall identify approved clearing boundaries on the ground for each Construction Segment prior to beginning clearing operations. All timber and other vegetative material outside clearing boundaries and all blazed, painted or posted trees which are on or mark clearing boundaries are reserved from cutting and removal with the exception of danger trees or snags designated as such by the Authorized Officer.

2.7.2. Timber

2.7.2.1. Prior to initiating clearing operations, Permittees shall notify the Authorized Officer of the amount of merchantable timber, if any, which will be cut, removed or destroyed in the construction and maintenance of the Pipeline System, and shall pay the United States in advance of such construction or maintenance activity, such sum of money as the Authorized Officer determines to be the full stumpage value of the timber to be cut, removed or destroyed.

2.7.2.2. All trees, snags, and other woody material cut in connection with clearing operations shall be cut so that the resulting stumps shall not be higher than six (6) inches measured from the ground on the uphill side.

2.7.2.3. All trees, snags and other woody material cut in connection with clearing operations shall be felled into the area within the clearing boundaries and away from water courses.

2.7.2.4. Hand clearing shall be used in areas where the Authorized Officer determines that use of heavy equipment would be detrimental to existing conditions.

2.7.2.5. All debris resulting from clearing operations and construction that may block stream flow, delay fish passage, contribute to flood damage, or result in stream bed scour or erosion shall be removed.

2.7.2.6. Logs shall not be skidded or yarded across any stream without the written approval of the Authorized Officer.

2.7.2.7. No log landing shall be located within three-hundred (300) feet of any water course.

2.7.2.8. All slash shall be disposed of in construction pads or Access Roads unless otherwise directed in writing by the Authorized Officer.

2.8. Disturbance of Natural Water

2.8.1. All activities of Permittees in connection with the Pipeline System that may create new lakes, drain existing lakes, significantly divert natural drainages, permanently alter stream hydraulics, or disturb significant areas of stream beds are prohibited unless such activities along with necessary mitigation measures are approved in writing by the Authorized Officer.

2.9. Off Right-of-Way Traffic

2.9.1. Permittees shall not operate mobile ground equipment off the Right-of-Way, Access Roads, State highways, or authorized areas, unless approved in writing by the Authorized Officer or when necessary to prevent harm to any Person.

2.10. Aesthetics

2.10.1. Permittees shall consider aesthetic values in planning, construction and operation of the Pipeline System. Where the Right-of-Way crosses a State highway in forested terrain, the straight length of the Pipeline Right-of-Way visible from the highway shall not exceed six hundred (600) feet in length, unless otherwise approved in writing by the Authorized Officer. The Authorized Officer may impose such other requirements as he deems necessary to protect aesthetic values.

2.11. Use of Explosives

2.11.1. Permittees shall submit a plan for use of explosives, including but not limited to blasting techniques, to the Authorized Officer in accordance with Stipulation 1.7.

2.11.2. No blasting shall be done under water or within one quarter (¼) mile of streams or lakes without a permit from the Alaska Department of Fish and Game, when such a permit is required by State law or regulation.

2.12. Restoration

2.12.1. Areas disturbed by Permittees shall be restored by Permittees to the satisfaction of the Authorized Officer as stated in writing.

2.12.2. All cut and fill slopes shall be left in a stable condition.

2.12.3. Materials from Access Roads, haul ramps, berms, dikes, and other earthen structures shall be disposed of as directed in writing by the Authorized Officer.

2.12.4. Vegetation, overburden and other materials removed during clearing operations shall be disposed of by Permittees in a manner approved in writing by the Authorized Officer.

2.12.5. Upon completion of restoration, Permittees shall immediately remove all equipment and supplies from the site.

2.13. Reporting of Oil Discharges

2.13.1. A discharge of Oil by Permittees into or upon the navigable waters of the United States, adjoining shorelines, or into or upon the waters of the contiguous zone in violation of the Federal Water Pollution Control Act, as amended, 33 U.S.C. § 1321 *et seq.* and the regulations issued thereunder, or in violation of applicable laws of the State of Alaska and regulations issued thereunder, is prohibited. Permittees shall give immediate notice of any such discharge to: (1) the Authorized Officer; and (2) such other Federal and State officials as are required by law to be given such notice.

2.13.2. Permittees shall give immediate notice of any spill or leakage of Oil or other pollutant from the Pipeline, the Valdez terminal facility, or any storage facility to: (1) the Authorized Officer; and (2) such other Federal and State officials as are required by law to be given such notice. Any oral notice shall be confirmed in writing as soon as possible.

2.14. Contingency Plans

2.14.1. It is the policy of the Department of the Interior that there should be no discharge of Oil or other pollutant into or upon lands or waters. Permittees must therefore recognize their prime responsibility for the protection of the public and environment from the effects of spillage.

2.14.2. Permittees shall submit their contingency plans to the Authorized Officer at least one-hundred and eighty (180) days prior to scheduled start-up. The plans shall conform to this Stipulation and the National Oil Hazardous Substances Pollution Contingency Plan, 36 F.R. 16215, August 20, 1971, and shall: (1) include provisions for Oil Spill Control[1]; (2) specify that the action agencies responsible for contingency plans in Alaska shall be among the first to be notified in the event of any Pipeline System failure resulting in an Oil spill; (3) provide for immediate corrective action including Oil Spill Control and restoration of the affected resource; (4) provide that the Authorized Officer shall approve any materials or devices used for Oil Spill Control and shall approve any disposal sites or techniques selected to handle oily matter; and (5) include separate and specific techniques and schedules for cleanup of Oil spills on land, lakes, rivers and streams, sea, and estuaries.

2.14.3. Prior to Pipeline start-up, such plans shall be approved in writing by the Authorized Officer, and Permittees shall demonstrate their capability and readiness to execute the plans. Permittees shall update as appropriate the plans and methods of implementation thereof, which shall be submitted annually to the Authorized Officer for his written approval.

2.14.4. If during any phase of the construction, operation, maintenance or termination of the Pipeline, any Oil or other pollutant should be discharged from the Pipeline System, the control and total removal, disposal and cleaning up of such Oil or other pollutant, wherever found, shall be the responsibility of Permittees, regardless of fault. Upon failure of Permittees to control, dispose of, or clean up such discharge, the Authorized Officer may take such measures as he deems necessary to control and clean up the discharge

[1] As used in this Stipulation 2.14.2, Oil Spill Control is defined as: (1) detection of the spill; (2) location of the spill; (3) confinement of the spill; and (4) cleanup of the spill.

at the full expense of Permittees. Such action by the Authorized Officer shall not relieve Permittees of any responsibility as provided herein.

3. TECHNICAL

3.1. General

3.1.1. The following standards shall be complied with in design, construction, operation and termination of the Pipeline System.

3.2. Pipeline System Standards

3.2.1. General Standards

3.2.1.1. All design, material and construction, operation, maintenance and termination practices employed in the Pipeline System shall be in accordance with safe and proven engineering practice and shall meet or exceed the following standards:

(1) U.S.A. Standard Code for Pressure Piping, ANSI B 31.4, "Liquid Petroleum Transportation Piping System."
(2) Department of Transportation Regulations, 49 CFR, Part 195, "Transportation of Liquids by Pipeline."
(3) ASME Gas Piping Standard Committee, 15 Dec. 1970: "Guide for Gas Transmission and Distribution Piping System."
(4) Department of Transportation Regulations, 49 CFR, Part 192, "Transportation of Natural and Other Gas by Pipelines: Minimum Federal Safety Standards."

3.2.1.2. Requirements in addition to those set forth in the above minimum standards may be imposed by the Authorized Officer as necessary to reflect the impact of subarctic and arctic environments. If any standard contains a provision which is inconsistent with a provision in another standard, the more stringent shall apply.

3.2.2. Special Standards

3.2.2.1. The design shall also provide for remotely controlled shutoff valves at each pump station; remotely controlled mainline block valves (intended to control spills); and additional valves located with the best judgment regarding wildlife habitat, fish habitat, and potentially hazardous areas.

3.2.2.2. All practicable means shall be utilized to minimize injury to the ground organic layer.

3.2.2.3. Radiographic inspection of all main line girth welds and pressure testing of the Pipeline shall be conducted by Permittees prior to placing the system in operation.

3.2.2.4. Permittees shall provide for continuous inspection of Pipeline System construction to ensure compliance with the approved design specifications and these Stipulations.

3.2.2.5. Welder qualification tests shall be by destructive means, except that operators of automatic welding equipment for girth welding of tank seams shall be tested by radiography in accordance with ASME Boiler and Pressure Vessel Code, Section 9, Subsection Q-21 (b).

3.2.2.6. Lightning protection shall conform to the requirements of ANSI C5.1—1969, "Lightning Protection Code—1968."

3.2.3. Standards for Access Roads

3.2.3.1. Design, materials and construction practices employed for Access Roads shall be in accordance with safe and proven engineering practice and in accordance with the principles of construction for secondary roads for the subarctic and arctic environments.

3.2.3.2. Permittees shall submit a layout of each proposed Access Road for approval by the Authorized Officer in accordance with Stipulation 1.7.

3.2.3.3. Access Roads shall be constructed to widths suitable for safe operation of equipment at the travel speeds proposed by Permittees.

3.2.3.4. The maximum allowable grade shall be 12 percent unless otherwise approved in writing by the Authorized Officer.

3.3. Construction Mode Requirements

3.3.1. The selection of the Construction Mode (elevated or buried) shall be governed by the following criteria: (1) There shall be an unobstructed air space of at least two feet between the pipe and ground surface; or (2) There shall be no greater heat transfer from the pipe to the ground than results from the use of an unobstructed air space of at least two (2) feet between the pipe and ground surface; or (3) Below the level of the pipe axis the ground shall consist of competent bedrock, soil naturally devoid of permafrost, or if frozen, of Thaw-Stable Sand and Gravel.[2] Above the level of the pipe axis other materials may be present but it must be shown that they will remain stable under all credible conditions; or (4) Results of a detailed field exploration program and analysis indicate that pipe rupture and major terrain disruption will not occur at any place from soil instability. Effects and their interaction, which are to be analyzed on a mile by mile basis to justify the proposed Construction Mode, shall include but not be limited to, thaw plug stability, differential settlement, seismic loading and weakening, and possible movement resulting from slope instability.[3]

As a prerequisite for the use of this criterion, an acceptable comprehensive monitoring system of the Pipeline shall be developed which will include but not be limited to making deformation measurements sufficiently sensitive and prompt to detect the approach to operational tolerance limits (which shall be clearly specified) of the Pipeline; design specifications, operational requirements, and feasibility analysis of such monitoring system shall be submitted in accordance with Stipulation 1.7. Such system shall be operational prior to transmission of Oil through the Pipeline.

3.4. Earthquakes and Fault Displacements

3.4.1. Earthquakes

3.4.1.1. The Pipeline System shall be designed, where technically feasible, by appropriate application of modern, state-of-the-art seismic design procedures to prevent any Oil leakage from the effects (including seismic shaking, ground deformation and earthquake-induced mass movements) of earthquakes distributed along the route as follows:

Zone:	Richter magnitude
Valdez to Willow Lake	8.5
Willow Lake to Paxson	7.0
Paxson to Donnelly Dome	8.0
Donnelly Dome to 67 deg. N.	7.5
67 deg. N. to Prudhoe Bay	5.5

3.4.1.2. Where such design is not technically feasible, the potential damage from an Oil spill shall be minimized by special design provisions that shall include, but shall not be limited to: (1) a network of ground-motion detectors that continuously monitor, record and instantaneously signal the occurrence of ground motion in the vicinity of the Pipeline reaching the Operational Design Level[4] (the critical levels of ground motions shall be approved in writing by the Authorized Officer); (2) rapid programmed shutdown and prompt close inspection of system integrity in the event of ground motion reaching the Operational Design Level; and (3) a special contingency plan for Oil Spill Control for each such seismically hazardous area which shall be filed in accordance with Stipulation 2.14. This plan shall specifically consider expected field conditions in the particular area in the aftermath of a destructive earthquake.

3.4.2. Fault Displacements

3.4.2.1. Prior to applying for a Notice to Proceed for any Construction Segment, Permittees shall satisfy the Authorized Officer that all recognizable or reasonably inferred faults or fault zones along the alignment within that segment have been identified and delineated, and that the risk of Oil leakage resulting from fault movement and ground deformation has been adequately assessed and provided for in the design of the Pipeline for that segment. Evaluation of said risk shall be based on geologic, geomorphic, geodetic, seismic, and other appropriate scientific evidence of past or present fault behavior and shall be compatible with the design earthquakes tabulated above and with observed relationships between earthquake magnitude and extent and amount of deformation and fault slip within the fault zone.

3.4.2.2. Minimum design criteria for a segment of the Pipeline traversing a fault zone that is reasonably interpreted as active, shall be: (1) that the Pipeline resist failure resulting in leakage from two feet of horizontal and/or vertical displacement in the foundation material anywhere within the fault zone; and (2) that no storage tank or pump station be located within the fault zone.

3.4.2.3. Where the Pipeline crosses a fault or lies within a fault zone that is reasonably interpreted as active, Permittees shall monitor crustal deformation in the vicinity of the Pipeline. Such monitoring shall include annual geodetic observation of permanent reference marks established on stable ground. Said reference marks shall be positioned so as to form closed figures and to provide for detection of relative horizontal and vertical displacements as small as 0.10 ft. across principal individual faults within the fault zone and to provide for monitoring of crustal strain with an absolute error of two parts per million within the fault zone. Further, where annual slip on a fault exceeds 0.10 ft. for two successive years,

[2] Thaw-Stable Sand and Gravel is defined as material meeting the following requirements: (a) Material lies within the classes GW, GP, SW, and SP, (Unified Soil Classification) but with up to 6% by weight passing the #200 U.S. standard sieve; if an inorganic granular soil contains more than 6% fines than the #200 sieve, its thaw-stability must be justified. (b) There is no excess (segregated or massive) ice. (c) Thawing of the material *in situ* will not result in excess pore-pressure.

[3] Because of soil variability and/or unique hydrologic conditions in active flood plains, some of the requirements of Stipulation 3.3.1 may not be met in those locations. In such cases proposed designs including special design and/or construction procedures where required by these conditions must be submitted with justification to the Authorized Officer for approval in accordance with Stipulation 1.7.

[4] Highest level that would not produce general pipe deformation sufficient to limit operations.

Permittees shall install recording or telemetering slip-meters. Data obtained from the monitoring shall be provided to the Authorized Officer at specified regular intervals throughout the operational life of the Pipeline. Said data shall be used by the Permittees to aid in the initiation of corrective measures to protect the Pipeline from failure caused by tectonic deformation that would result in leakage.

3.5. Slope Stability

3.5.1. Areas subject to mudflows, landslides, avalanches, rock falls and other types of mass movements shall be avoided where practicable in locating the Pipeline. Where such avoidance is not practicable, the Pipeline design, based upon detailed field investigations and analysis, shall provide measures to prevent the occurrence of, or protect the Pipeline against, the effects of mass movements.

3.6. Stream and Flood Plain Crossings and Erosion

3.6.1. General

3.6.1.1. For each region through which the Pipeline passes, the Pipeline shall be designed to withstand or accommodate the effects (including runoff, stream and flood plain erosion, meander cutoffs, lateral migration, ice-jams, and icings) of those meteorologic, hydrologic (including surface and subsurface) and hydraulic conditions considered reasonably possible for the region. The following standards shall apply to such Pipeline design:

3.6.1.1. For stream crossings and portions of the Pipeline within the flood plain.

3.6.1.1.1.1. The Pipeline shall cross streams underground unless a different means of crossing is approved in writing by the Authorized Officer.

3.6.1.1.1.2. The design flood shall be based on the concept of the "Standard Project Flood" as defined in Corps of Engineers Bulletin 52-8, Part 1.

3.6.1.1.1.3. The depth of channel scour shall be established by appropriate field investigations and theoretical calculations using those combinations of water velocity and depth that yield the maximum value. At the point of maximum scour, the cover over the pipe shall be at least twenty (20) percent of the computed scour, but not less than four (4) feet.

3.6.1.1.1.4. For overhead crossings comparable analysis shall be made to ensure that support structures are adequately protected from the effects of scour, channel migration, undercutting, ice forces and degradation of permafrost.

3.6.1.1.1.5. In flood plains, appropriate construction procedures shall be used wherever there is potential channelization along the pipe.

3.6.1.1.1.6. The pipe trench excavation shall stop an adequate distance from the water crossing to leave a protective plug (unexcavated material) at each bank. These plugs shall be left in place until the stream bed excavation is complete and the pipe laying operation is begun. The plugs shall not be completely removed until absolutely necessary. The trench shall be backfilled with stable material as soon as the pipe is laid.

3.6.1.2. Culverts and Bridges.

3.6.1.2.1. Culverts and bridges necessary for maintenance of the Pipeline shall be designed to accommodate a fifty (50)-year flood in accordance with criteria established by the American Association of State Highway Officials and the Federal Highway Administration and endorsed by the State of Alaska Department of Highways.

3.6.2. Erosion

3.6.2.1. Where necessary because of outfall erosion, stilling basins shall be constructed at the outflow end of culverts. To prevent erosion the pool sides shall be stabilized by appropriate methods; e.g., by the use of riprap.

3.6.2.2. Slopes of cuts through stream banks shall be designed and constructed to minimize erosion and prevent slides.

3.6.2.3. Erosion control procedures shall accommodate and be based on the runoff produced by the maximum rainfall rate and snow melt rate combination reasonably characteristic of the region. The procedures shall also accommodate effects that result from thawing produced by flowing or ponded water on permafrost terrain.

3.7. Sea Waves

3.7.1. Oil transfer facilities at the Valdez terminal shall be protected by cut-off devices designed and located to prevent major Oil leakage from breaking of pipes by destructive sea waves comparable to those generated in Port Valdez by the March 27, 1964 earthquake. Design for such protective features shall be submitted in accordance with Stipulation 1.7.

3.8. Glacier Surges

3.8.1. Surveillance systems sufficient to give adequate warning of impending surges on any glacier that could damage the Pipeline shall be instituted prior to transmission of Oil through the pipe. Procedures for initiation and operation of such surveillance systems and protective procedures in the event of such surges shall be submited in accordance with Stipulation 1.7.

3.9. Construction and Operation

3.9.1. All construction, operation, maintenance, and termination activities in connection with the Pipeline System shall be conducted so as to avoid or minimize thermal and other environmental changes and to provide maximum protection to fish and wildlife and their habitat, and people. All working platforms, pads, fills and other surface modifications shall be planned and executed in such a way that any resulting degradation of permafrost will not jeopardize the Pipeline foundations.

3.9.2. Acceptable plans, procedures and quality controls that ensure compliance with Stipulation 3.9.1 shall be submitted in accordance with Stipulation 1.7.

3.10. Pipeline Corrosion

3.10.1. Permittees shall provide detailed plans for corrosion resistant design and methods for early detection of corrosion. These shall include: (1) pipe material and welding techniques to be used and information on their particular suitability for the environment involved; (2) details on the external pipe protection to be provided (coating, wrapping, etc.), including information on variation of the coating process to cope with variations in environmental factors along the Pipeline route; (3) plans for cathodic protection including details of impressed ground sources and controls to ensure continuous maintenance of adequate protection over the entire surface of the pipe; (4) details of plans for monitoring cathodic protection current including spacing of current monitors; (5) provision for periodic intensive surveys of trouble spots, regular preventive maintenance surveys and special provisions for abnormal potential patterns resulting from the crossing of the Pipeline by other pipelines or cables; and (6) information on precautions to be taken to prevent internal corrosion of the Pipeline. Permittees shall also provide for periodic internal pitting surveys by electro-magnetic or other means.

3.11. Containment of Oil Spills

3.11.1. Permittees shall provide Oil spill containment dikes or other structures around storage tanks at pump stations and at the Valdez terminal. The volume of the containment structures shall be at least: (1) one-hundred ten (110) percent of the total storage volume of the storage tanks in the relevant area, plus (2) a volume sufficient for maximum trapped precipitation and runoff which might be impounded at the time of the spill. Such structures shall be constructed to withstand failure from earthquakes in accordance with Stipulation 3.4 and shall be impervious so as to provide seepage-free storage until disposal of their contents can be effected safely without contamination of the surrounding area.

3.11.2. Permittees shall provide containment dikes or other structures to minimize effects of Oil spills at critical locations along the Pipeline in accordance with Stipulation 2.14.

EXHIBIT A

Stipulations for the Alaskan Leg

of the

Alaska Natural Gas Transportation System

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PREAMBLE

Principles

In the implementation of the Grant of Right-of-Way for the Alaska Natural Gas Transportation System of which these Stipulations are a part, the following principles shall apply:

(1) In the construction, operation, maintenance (including but not limited to a continuing and reasonable program of preventive maintenance), and termination of the PIPELINE SYSTEM, the COMPANY shall employ all practicable means and measures to preserve and protect the environment, as provided in the Stipulations.

(2) The COMPANY and the United States shall balance environmental amenities and values with economic practicalities and technical capabilities, so as to be consistent with applicable national policies. In so doing, they shall take into account, among other considerations, the following:

(a) The benefit or detriment to persons, property, and the environment that may be anticipated to result from a proposed course of conduct;

(b) The particular environmental and technical benefits, costs or detriments reasonably expected to flow from a proposed course of conduct.

(3) The COMPANY shall plan, manage, supervise, and implement the construction, operation, maintenance and termination of the PIPELINE SYSTEM in accordance with sound engineering practices.

Scope

The following Stipulations set forth the standards of environmental and construction performance, and the procedures for the submission and approval of construction plans and environmental safeguards, that are required by Section III, I, of the Terms and Conditions set forth in the Decision and Report to Congress on the Alaska Natural Gas Transportation System which was transmitted to the Congress by the President on September 22, 1977, pursuant to the Alaska Natural Gas Transportation Act of 1976, 15 U.S.C. § 719, et. seq.

These Stipulations are not intended in any way to derogate from, or be construed as being inconsistent with, applicable provisions of law.

Nothing in these Stipulations shall be construed as applying to activities of the COMPANY that have no relation to the PIPELINE SYSTEM.

STIPULATIONS
ALASKA

1. GENERAL

1.1 DEFINITIONS

1.1.1. The following definitions apply to terms used in these Stipulations. They shall also apply to terms used in documents to which these Stipulations are attached unless specifically provided otherwise in such documents.*

1.1.2. "AGENCY" means a Federal AGENCY (other than the Office of the FEDERAL INSPECTOR) which, subject to the provisions of Reorganization Plan No. 1 of 1979, has jurisdiction to issue or enforce certificates, rights-of-way, leases, permits, or other authorizations with respect to the Alaska Natural Gas Transportation System.

1.1.3. "AUTHORIZED OFFICER" means the employee of the AGENCY to whom the head of the AGENCY has delegated the authority to administer the authorization of which this Exhibit is a part. "AUTHORIZED OFFICER," where used in these Stipulations with specific references to other Federal AGENCIES or departments with enforcement functions transferred to the FEDERAL INSPECTOR by Reorganization Plan No. 1 of 1979, means an employee so designated by such AGENCY or department pursuant to Reorganization Plan No. 1 of 1979.

1.1.4. The "COMPANY" means Alaskan Northwest Natural Gas Transportation Company, its successors and assigns.

1.1.5. "CONSTRUCTION MODE" means the type of construction to be employed generally with regard to the PIPELINE.

1.1.6. "CONSTRUCTION SEGMENT" means a portion of the PIPELINE SYSTEM, as agreed upon by the COMPANY and the FEDERAL INSPECTOR, that constitutes a complete physical entity or stage, in and of itself, which can be constructed independently of any other portion or stage of the PIPELINE SYSTEM in a designated area or between two given geographical points.

1.1.7. "DESIGN CRITERIA" means project criteria (i.e., construction, including design, and operational concepts) necessary to delineate the project to be constructed. As a minimum, it includes the following: criteria to be used for the FINAL DESIGN and project concepts, evaluation of data used to establish the DESIGN CRITERIA, drawings showing functional and technical requirements, reports of all test data compiled during the data collection and DESIGN CRITERIA evaluation, standard drawings (if applicable) or drawings to support structural design concepts of each typical facility or structure, proposed CONSTRUCTION MODES, outline of project specifications, sample computations to support the design, and concepts and bases for project siting.

*The words defined herein are in upper case throughout the body of the Stipulations.

1.1.8. "FEDERAL INSPECTOR" means the officer appointed by the President with the advice and consent of the Senate pursuant to Section 7(a)(5) of the Alaska Natural Gas Transportation Act, 15 U.S.C. § 719e, and Reorganization Plan No. 1 of 1979.

1.1.9. "FEDERAL LANDS" means all lands owned by the United States except lands in the National Park System, lands held in trust for an Indian or Indian tribe, and lands on the Outer Continental Shelf.

1.1.10. "FINAL DESIGN" means completed design documents suitable for bid solicitation, including contract plans and specifications; proposed CONSTRUCTION MODES; operational requirements necessary to justify designs; design analysis, including calculations for each particular design feature; all functional and engineering criteria; summaries of engineering tests conducted and their results; and other considerations pertinent to design.

1.1.11. "GAS" means a gaseous mixture, principally of methane and other paraffinic hydrocarbons, suitably conditioned to an acceptable specification for transportation by the PIPELINE.

1.1.12. "HAZARDOUS SUBSTANCES" means OIL, toxic, or hazardous substances as defined by the Environmental Protection Agency, the Department of Transportation, or as specified in writing by the FEDERAL INSPECTOR in consultation with the Environmental Protection Agency's and the Department of Transportation's AUTHORIZED OFFICERS during the review of the COMPANY'S OIL AND HAZARDOUS SUBSTANCES control cleanup and disposal plan.

1.1.13. "NOTICE TO PROCEED" means a written permission to initiate PIPELINE SYSTEM construction that is issued in accordance with Stipulation 1.7.

1.1.14. "OIL" means oil of any kind or any form, including but not limited to fuel oil, sludge, oil refuse, and oil mixed with WASTE.

1.1.15. "PIPELINE" means all parts of those physical facilities, through which the GAS moves, authorized on FEDERAL LANDS by U. S. Department of the Interior Right-of-Way Grant No. F24538.

1.1.16. "PIPELINE SYSTEM" means all facilities on FEDERAL LANDS which are constructed or used by the COMPANY pursuant to the Alaska Natural Gas Transportation Act in connection with the construction, operation, maintenance or termination of the PIPELINE. The term includes the PIPELINE and RELATED FACILITIES, temporary facilities, temporary use areas and material sites used by the COMPANY for the construction, operation, maintenance, or termination of the PIPELINE. It does not include facilities, such as urban administrative offices, which are only indirectly involved in the transportation of GAS; nor does it include facilities used by others in the production, gathering or conditioning of GAS.

1.1.17. "RELATED FACILITIES" means those structures, devices, improvements and sites on FEDERAL LANDS, other than the pipe, the substantially continuous use of which is necessary for the operation and maintenance of the PIPELINE. RELATED FACILITIES includes, if applicable: supporting structures; air fields access roads; compressor stations; valves and other control devices; bridges, culverts and low-water crossings; monitoring and communication devices; retaining walls, berms, dikes, ditches, cuts and fills, including hydraulic and erosion control structures; structures and areas for storing supplies and equipment; cathodic protection devices; and other facilities of a similar nature together with related yards, fences and buildings as the FEDERAL INSPECTOR, after consultation with the COMPANY, shall determine to be RELATED FACILITIES.

1.1.17.1. "RELATED FACILITIES" does not mean those structures, devices, improvements, sites, facilities or areas, the use of which is temporary in nature such as those used only for construction purposes. Among such are: temporary camps, temporary landing strips, temporary bridges, temporary access roads, temporary communication sites, temporary storage sites, and temporary disposal sites.

1.1.18 "REVEGETATION" means the establishment of plant cover on disturbed lands through techniques including; but not limited to, seedbed preparation, seeding, planting, fertilizing, mulching, and watering.

1.1.19. "ROADS" means roads on FEDERAL LANDS, other than State or public highways, that are constructed or used by the COMPANY in connection with the construction, operation, maintenance or termination of the PIPELINE SYSTEM.

1.1.20. "TEMPORARY USE PERMIT" means a revocable, nonpossessory privilege to use specified Federal lands in connection with the preconstruction, construction, operation, maintenance and termination of the PIPELINE SYSTEM.

1.1.21. "TRANS-ALASKA PIPELINE SYSTEM" means that pipeline system referred to in and authorized by the Trans-Alaska Pipeline Authorization Act, Title II, P.L. 93-153, 87 Stat. 584.

1.1.22 "WASTE" means all discarded matter other than construction spoil. It includes, but is not limited to, human waste, trash, garbage, refuse, OIL drums, petroleum products, ashes and equipment.

1.1.23. "WETLANDS" means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. WETLANDS generally include swamps, marshes, bogs, and similar areas.

1.2 APPLICABILITY

1.2.1. The following conditions shall apply to the design, construction, operation, maintenance, and termination of the PIPELINE SYSTEM. Unless clearly inapplicable, the requirements and prohibitions imposed upon the COMPANY by these Stipulations are also imposed upon the COMPANY'S agents, employees, contractors, and subcontractors, and the employees of each of them.

(1) The COMPANY shall ensure compliance with these Stipulations by its agents, employees, and contractors (including subcontractors at any level), and the employees of each of them.

(2) Failure or refusal of the COMPANY'S agents, employees, contractors, subcontractors, or their employees to comply with these Stipulations shall be deemed to be the failure or refusal of the COMPANY.

(3) Where appropriate the COMPANY shall require its agents, employees, contractors and subcontractors to include these Stipulations in all contracts and subcontracts which are entered into by any of them, together with a provision that the other contracting party, together with its agents, employees, contractors and subcontractors, and the employees of each of them, shall likewise be bound to comply with these Stipulations.

1.2.2. Nothing in these Stipulations shall be construed as applying to activities of the COMPANY that have no relation to the PIPELINE SYSTEM.

1.2.3. Nothing in these Stipulations shall be construed to affect any right or cause of action that otherwise would be available to the COMPANY against any person or entity. The United States and the COMPANY do not intend to create any rights under these Stipulations that may be enforced by third parties for their own benefit or for the benefit of others.

1.3. RESPONSIBILITIES

1.3.1. The COMPANY shall comply with these Stipulations and lawful orders of the FEDERAL INSPECTOR implementing these Stipulations.

1.3.2. The authority and obligations of the FEDERAL INSPECTOR, as provided in these Stipulations, shall be exercised and met by the FEDERAL INSPECTOR during the period when the Office of the FEDERAL INSPECTOR is in existence pursuant to the provisions of Reorganization Plan No. 1 of 1979.

1.3.3. Upon termination of the Office of the FEDERAL INSPECTOR, the authority and obligations of the FEDERAL INSPECTOR shall be vested in and fulfilled by the AUTHORIZED OFFICERS of the Federal AGENCIES normally having jurisdiction over such matters.

1.3.4. The COMPANY shall designate a representative who shall be empowered on behalf of the COMPANY to communicate with, and to receive and comply with, all communications and orders of the FEDERAL INSPECTOR. The COMPANY shall also designate field representatives who shall be authorized to and at all times be available to communicate and cooperate with field representatives of the FEDERAL INSPECTOR. The COMPANY shall keep the FEDERAL INSPECTOR informed of any change of the COMPANY'S representatives during the construction, operation, maintenance, and termination of the PIPELINE SYSTEM.

1.3.5. The FEDERAL INSPECTOR may require the COMPANY at any time to furnish any or all data related to design, construction, operation, maintenance, and termination activities undertaken in connection with the PIPELINE SYSTEM that may be reasonably relevant to the FEDERAL INSPECTOR's responsibilities in connection with the construction, operation, maintenance, and termination of the PIPELINE SYSTEM; provided, however, that access to such documents is not prohibited or limited by law or regulation, and provided further that any such

data furnished shall be subject to the provisions of the Freedom of Information Act, 5 U.S.C. § 552. The FEDERAL INSPECTOR shall shall make all requests in writing.

1.3.6. Consonant with the provisions of Section 9(d) of the Alaska Natural Gas Transportation Act, 15 U.S.C. § 719(g), the FEDERAL INSPECTOR may, by written order, require the COMPANY to make such modification of the PIPELINE SYSTEM as he deems necessary to protect or maintain stability of foundation and other earth materials; protect or maintain integrity of the PIPELINE SYSTEM; control or prevent significant damage to the environment (including but not limited to fish and wildlife populations and their habitats); remove hazards to public health and safety; or protect the TRANS-ALASKA PIPELINE SYSTEM from any adverse effects of the COMPANY's activities, including the activities of its agents, employees, contractors (including subcontractors) and the employees of each of them.

1.3.7. The absence of any comment by the FEDERAL INSPECTOR or his designated representative on any plan, design, specification, or other document which may be filed by the COMPANY with the FEDERAL INSPECTOR shall not be deemed to represent in any way whatever any assent to, approval of, or concurrence in such plan, design, specification or other document, or any action proposed therein. Any written approval or instruction by the FEDERAL INSPECTOR or the AUTHORIZED OFFICER may be relied upon by the COMPANY unless and until rescinded in writing. The FEDERAL INSPECTOR, will act in writing upon each submission to him in accordance with the agreed-upon schedules developed pursuant to Stipulations 1.6.1. and 1.7.4. Any disapproving action by the FEDERAL INSPECTOR, including any requests for additional information, shall state what additional action is necessary to gain approval.

1.3.8. The FEDERAL INSPECTOR and the Alaska State Pipeline Coordinator shall have a continuing right of access to any part of the PIPELINE SYSTEM at any time for inspection or monitoring and for any other purpose or reason that is consistent with their responsibilities. This right may be exercised by the FEDERAL INSPECTOR and the Alaska State Pipeline Coordinator and their agents and representatives designated in writing including contractors and subcontractors of the FEDERAL INSPECTOR or the State Pipeline Coordinator who are performing work related to the PIPELINE SYSTEM and who are designated in writing. The FEDERAL INSPECTOR and the COMPANY shall agree within 6 months from the date of issuance of the Grant of which these Stipulations are a part, upon procedures to implement this Stipulation, including reasonable advance notification where practicable.

1.3.9. No order or notice given to the COMPANY on behalf of the FEDERAL INSPECTOR shall be effective as to the COMPANY unless prior written notice of the delegation of authority to issue such order or notice has been given to the COMPANY by the FEDERAL INSPECTOR.

1.3.10. In the implementation of Stipulation 1.2.1., the COMPANY will furnish all supervisory-level employees with copies of these Stipulations and will explain the limitations imposed by these Stipulations.

1.3.11. During the design, construction, operation, maintenance and termination of the PIPELINE SYSTEM, the COMPANY shall furnish representatives of the United States, including contractors and subcontractors, involved in field surveillance of the PIPELINE SYSTEM, adequate meals, living quarters and office space, reasonable use of the COMPANY's communications systems, and reasonable surface and air transportation. For purposes of this Stipulation only, the eligibility for logistic support of individuals involved in field surveillance will be determined by the FEDERAL INSPECTOR. Whenever possible, the FEDERAL INSPECTOR shall give the COMPANY advance written notice of the need for such services and facilities, including the number and names of persons to be accommodated. Reimbursement for such services and facilities will be in accordance with a prearranged unit-price schedule.

1.3.12. The COMPANY shall not interfere with operations of the TRANS-ALASKA PIPELINE SYSTEM, including use of FEDERAL LANDS covered by the TRANS-ALASKA PIPELINE SYSTEM right-of-way, by employees, contractors, subcontractors and agents of the TRANS-ALASKA PIPELINE SYSTEM, except as may be approved in writing by the FEDERAL INSPECTOR.

1.4. COMMUNICATIONS

1.4.1. The COMPANY shall provide a communications capability that ensures the transmission of information required for the safe construction, operation, maintenance and termination of the PIPELINE SYSTEM.

1.4.2. During the period of preconstruction, construction and initial operation of the PIPELINE SYSTEM, all formal written communications between the COMPANY and an AGENCY involving construction, operation, maintenance, or termination of the PIPELINE SYSTEM shall be transmitted through the FEDERAL INSPECTOR or as he may direct. However, documents required by statute or AGENCY regulation to be filed with the AGENCY shall be filed as so required, provided that a copy (or copies) thereof is concurrently filed with the FEDERAL INSPECTOR.

1.4.3. Any written notice or communication, including any telegram, relating to any subject, addressed to the FEDERAL INSPECTOR from the COMPANY, shall be deemed to have been delivered to and received by the FEDERAL INSPECTOR when the notice or communication has been delivered either by messenger during normal business hours, or by registered or certified United States mail, postage prepaid, return receipt requested, to the Office of the FEDERAL INSPECTOR.

1.4.4. Any written order, notice, or other written communication, including any telegram, relating to any subject, that is addressed to the COMPANY from the FEDERAL INSPECTOR shall be deemed to have been delivered to and received by the COMPANY when the order, notice or other communication has been delivered either by messenger during normal business hours, or by registered or certified United States mail, postage prepaid, return receipt requested to the office of the representative designated by the COMPANY pursuant to Stipulation 1.3.4.

1.4.5. All orders or approvals of the FEDERAL INSPECTOR shall be in writing, but in emergencies may be issued orally, with subsequent confirmation in writing as soon as possible thereafter, but not later than 24 hours.

1.5. SUMMARY NETWORK ANALYSIS DIAGRAMS

1.5.1. As a part of the DESIGN CRITERIA, the COMPANY shall submit a summary network analysis diagram for the project to the FEDERAL INSPECTOR for review and approval. As mutually agreed to by the COMPANY and the FEDERAL INSPECTOR, the summary network analysis diagram shall include all environmental, engineering and construction-related activities and contingencies which reasonably may be anticipated in connection with the project. The summary network analysis diagram shall include or address:

(1) Data collection activities;
(2) Submittal and approval activities;
(3) Construction and post-construction activities;
(4) Schedule control techniques;
(5) Submittal of NOTICE TO PROCEED applications;
(6) Other pertinent data.

The summary network analysis diagram shall be prepared employing techniques normal to the industry in sufficient detail and scope to permit the FEDERAL INSPECTOR to determine if the management approach shown or inferred by the network analysis will facilitate the cost-effective, environmentally sound and timely construction of the project.

1.5.2. The summary network analysis diagram shall be updated to indicate current and planned activities at intervals mutually agreeable to the COMPANY and the FEDERAL INSPECTOR.

1.6. DESIGN CRITERIA, PLANS AND PROGRAMS

1.6.1. The COMPANY shall submit DESIGN CRITERIA to the FEDERAL INSPECTOR. It shall also submit comprehensive plans and/or programs (including schedules where appropriate) which shall include but not be limited to the following:

(1) Air quality
(2) Blasting
(3) Camps
(4) Clearing
(5) Corrosion control
(6) Cultural resource preservation
(7) Environmental briefings
(8) Erosion and sedimentation control
(9) Fire control
(10) Liquid waste management
(11) Material exploration and extraction
(12) OIL and HAZARDOUS SUBSTANCES control, cleanup and disposal
(13) Overburden and excess material disposal
(14) Pesticides, herbicides, chemicals
(15) PIPELINE contingency
(16) Quality assurance/quality control
(17) Restoration
(18) River training structures
(19) Solid waste management
(20) Stream, river and floodplain crossings
(21) Surveillance and maintenance

(22) Visual resources
(23) WETLAND construction
(24) Seismic
(25) Human-carnivore interaction

These plans and programs may be combined as appropriate. The COMPANY and the FEDERAL INSPECTOR shall agree to the scope, content and schedule for submission of the requested plans and programs. Any aspects of these plans and programs or the DESIGN CRITERIA that are likely to have a significant impact upon other facilities (such as the TRANS-ALASKA PIPELINE SYSTEM) will be coordinated by the COMPANY with the owners of such other facilities during their development. The COMPANY, in particular, will coordinate with the State of Alaska regarding the PIPELINE SYSTEM alignment between Delta Junction and the Canadian border with respect to the proposed realignments of the Alaska Highway between those two locations, giving due consideration to such proposed highway realignments as shown in documents provided to the COMPANY by the State, such as any Federally approved environmental impact statement for the proposed highway realignment project, the latest of any existing State reconnaissance reports, and segmented highway project design documents. Coordination means providing the facility owner an opportunity to review and comment upon relevant parts of the plans and programs. The COMPANY will reasonably take these comments into consideration. Coordination does not necessarily mean concurrence. Evidence of such coordination must be provided in support of any application for a NOTICE TO PROCEED. In determining the acceptability of the DESIGN CRITERIA and the plans, the FEDERAL INSPECTOR will consider suggestions or objections submitted by owners of affected facilities.

1.6.2. The DESIGN CRITERIA, including the plans and programs specified in Stipulation 1.6.1, shall be approved in writing by the FEDERAL INSPECTOR and shall be complied with by the COMPANY.

1.6.3. Additional or supplementary plans may be required in the event that the plans submitted in accordance with Stipulation 1.6.1 do not provide the detailed and/or site-specific data required to support the FINAL DESIGN required in Stipulation 1.7, or to guide the conduct of the construction, operation, maintenance and termination of the PIPELINE SYSTEM.

1.7. NOTICE TO PROCEED

1.7.1. The COMPANY shall not initiate any field activity on FEDERAL LANDS pursuant to the authorization of which these Stipulations are a part without prior specific written permission. Such permission shall be given either by a NOTICE TO PROCEED, TEMPORARY USE PERMIT or other appropriate written authorization, issued by the FEDERAL INSPECTOR or AUTHORIZED OFFICER, as appropriate. Any NOTICE TO PROCEED, TEMPORARY USE PERMIT or other authorization shall permit field activities only as therein expressly stated and only for the particular field activities therein described. A NOTICE TO PROCEED, TEMPORARY USE PERMIT or other appropriate authorization may contain such site-specific terms and conditions as the FEDERAL INSPECTOR or AUTHORIZED OFFICER deems necessary to implement these Stipulations, and the COMPANY will comply with such terms and conditions.

1.7.2. Before applying for a NOTICE TO PROCEED, the COMPANY shall, in such manner as shall be acceptable to the FEDERAL INSPECTOR, locate and clearly mark on the ground the proposed centerline of the line of pipe, the location of all relevant RELATED FACILITIES and, where applicable, clearing limits and the location of temporary use areas in the proposed work area. When the COMPANY is engaged in activities proximate to the TRANS-ALASKA PIPELINE SYSTEM or, in any event, when such activities could pose a threat to the integrity of the TRANS-ALASKA PIPELINE SYSTEM, the COMPANY shall arrange with the owners of the TRANS-ALASKA PIPELINE SYSTEM, in accordance with industry practice, for them to survey and clearly mark on the ground relevant parts of the TRANS-ALASKA PIPELINE SYSTEM, including related facilities.

1.7.3. Each application for a NOTICE TO PROCEED shall be supported by:

(1) A FINAL DESIGN for the CONSTRUCTION SEGMENT OR SEGMENTS to be covered by the NOTICE TO PROCEED with detailed and/or sitespecific plans as indicated in Stipulation 1.6.3 and computations supporting the design;

(2) All applicable reports and results of environmental studies;

(3) A detailed network analysis diagram for the CONSTRUCTION SEGMENT or SEGMENTS including the COMPANY'S work schedules, applicable permits required by State and Federal agencies, design and review periods, data collection activities, and construction sequencing. All requirements stated in Stipulation 1.5.1, with reference to the summary network analysis diagram, shall apply equally to the detailed network analysis diagram;

(4) A map or maps, prepared in such manner as shall be acceptable to the FEDERAL INSPECTOR, depicting the proposed location of:

  (a) The boundaries of all associated temporary use areas;

  (b) All improvements, buried or aboveground, that are to be constructed;

  (c) The relative location of any part of the TRANS-ALASKA PIPELINE SYSTEM that is proximate to the proposed improvements;

(5) Justification statements for all proposed design features or activities which may not be in conformance with these Stipulations;

(6) An analysis which addresses the effects, if any, of PIPELINE SYSTEM design and proposed activities on the TRANS-ALASKA PIPELINE SYSTEM and other existing facilities and, where necessary, which describes systems designed to ensure protection of the TRANS-ALASKA PIPELINE SYSTEM and other existing facilities from damage arising from the construction, operation, maintenance and termination of the PIPELINE SYSTEM.

1.7.4. Prior to submission of any applications for NOTICES TO PROCEED, the COMPANY and the FEDERAL INSPECTOR shall agree to a schedule for the submission, review and approval of such applications and on the scope of information to be contained therein. The schedule shall allow the FEDERAL INSPECTOR 60 days for review of each complete application for a NOTICE TO PROCEED unless the FEDERAL INSPECTOR gives written notice that more time is needed. The schedule may be revised by mutual agreement, if necessary.

1.7.5. The FEDERAL INSPECTOR shall review each application for a NOTICE TO PROCEED and all data submitted in connection therewith in accordance with schedules as agreed upon pursuant to Stipulation 1.7.4.

1.7.6. The FEDERAL INSPECTOR shall issue a NOTICE TO PROCEED only when, in his judgment, applicable FINAL DESIGNS and other submissions required by Stipulations 1.6.1, 1.6.3, and 1.7.3 conform to these Stipulations.

1.7.7. By written order, following appropriate consultation with the COMPANY, and when other enforcement actions are inadequate or have not been successful, the FEDERAL INSPECTOR may revoke or suspend in whole or in part any NOTICE TO PROCEED which has been issued when, in his judgment, unforeseen conditions later arising require alterations in the NOTICE TO PROCEED in order to: (1) protect or maintain stability of foundation and earth materials; (2) protect or maintain integrity of the PIPELINE SYSTEM; (3) control or prevent significant damage to the environment, including but not limited to fish and wildlife populations and their habitats; or (4) remove hazards to public health and safety.

The FEDERAL INSPECTOR shall expeditiously follow his revocation or suspension order with a more detailed written statement of the reason for the action.

1.8. QUALITY ASSURANCE AND CONTROL

1.8.1. The quality assurance and quality control programs shall be comprehensive and designed to assure that the applicable requirements of 49 CFR Part 192 and environmental and technical Stipulations will be incorporated in the FINAL DESIGN and complied with throughout all phases of construction, operation, maintenance and termination of the PIPELINE SYSTEM. The COMPANY shall provide for continuous inspection of PIPELINE construction to ensure compliance with the approved design specifications and these Stipulations. The term "continuous inspection" as used in this Stipulation means that at least one inspector is observing each PIPELINE construction operation where PIPELINE integrity is involved (e.g., the pipe gang, backend welders, weld nondestructive testing, coating and wrapping, bedding, lowering-in, padding and backfill) at all times while that construction is being performed or where PIPELINE construction operations are proximate to the TRANS-ALASKA PIPELINE SYSTEM.

1.8.2. At a minimum, the following shall be included in the quality assurance program:

(1) Procedures for the detection and prompt abatement of any actual or potential procedure, activity, event or condition, of a serious nature, that:

(a) Is susceptible to abatement by the COMPANY;

(b) Could reasonably be expected to arise out of, or affect adversely, design, construction, operation, maintenance, or termination of all or any part of the PIPELINE SYSTEM; and

(c) That at any time may cause or threaten to cause:

(1) A hazard to the safety of workers or to public health or safety, including but not limited to personal injury or loss of life of any person;

(2) Significant damage to the environment, including but not limited to areas of vegetation or timber, fish or other wildlife populations or their habitats, or any other natural resource; or

(3) Significant damage to existing private improvements on or in the general vicinity of the right-of-way area;

(2) Procedures for the relocation, repair or replacement of improved or tangible property and the rehabilitation of natural resources (including but not limited to REVEGETATION, restocking fish or other wildlife populations, and reestablishing their habitats) seriously damaged or destroyed if the immediate cause of the damage or destruction results from construction, operation, maintenance, or termination of all or any part of the PIPELINE SYSTEM;

(3) Methods and procedures for achieving component and subsystems quality through proper design and specification;

(4) Methods for applying quality assurance and quality control criteria in the selection of the COMPANY'S contractors and subcontractors, and contract purchases of materials and services;

(5) A plan for collecting, recording, storing, retrieving and reviewing data to assure that quality has been attained, including procedures for initiating and maintaining adequate records of inspections, identification of deviations and completion of corrective actions;

(6) Specific methods of detecting deviations from designs, plans, regulations, specifications, stipulations and permits (including establishing effective procedures for timely evaluation and correction of field non-conformance problems) as the basis for initiating corrective action to preclude or rectify the hazards, harm or damage referenced in Sections 1.8.2(1) and 1.8.2(2) of these Stipulations;

(7) Inspection, testing and acceptance of components, sub-systems and subassemblies; and

(8) A plan for conducting surveys and field inspections of all facilities, processes and procedures of the COMPANY, its contractors, subcontractors, vendors and suppliers critical to the achievement of quality.

1.8.3. The COMPANY (including its agents, employees, contractors and subcontractors and the employees of each of them) shall comply with the quality assurance and control program as approved and shall submit reports to the FEDERAL INSPECTOR to demonstrate such compliance. Such reports shall be submitted quarterly unless otherwise requested by the FEDERAL INSPECTOR.

1.9. CONDUCT OF OPERATIONS

1.9.1. The COMPANY shall perform PIPELINE SYSTEM operations in a safe and workmanlike manner so as to ensure protection of the environment and the safety and integrity of the PIPELINE and shall at all times employ qualified personnel and maintain equipment sufficient for that purpose. The COMPANY shall immediately notify the FEDERAL INSPECTOR of any condition, problem, malfunction, or other occurrence which in any way threatens the safety or integrity of the PIPELINE, or significant harm to the environment. In addition, the COMPANY shall take all reasonable precautions to protect the TRANS-ALASKA PIPELINE SYSTEM from damage caused by the COMPANY during construction, operation, maintenance and termination of the PIPELINE SYSTEM. The COMPANY shall notify the FEDERAL INSPECTOR and the owners of the TRANS-ALASKA PIPELINE SYSTEM of any such condition, problem, malfunction or other occurrence which in any way threatens the integrity of the TRANS-ALASKA PIPELINE SYSTEM.

1.10. SURVEILLANCE AND MAINTENANCE

1.10.1. During the construction, operation, maintenance and termination phases of the PIPELINE SYSTEM, the COMPANY shall conduct a surveillance and maintenance program applicable to the subarctic and arctic environment. At minimum, this program shall, with respect to the COMPANY'S activities, be designed to:

(1) Protect public health and safety;

(2) Control damage to natural resources;

(3) Control erosion;

(4) Maintain PIPELINE integrity;

(5) Control damage to public and private property;

(6) Prevent damage to the TRANS-ALASKA PIPELINE SYSTEM from the COMPANY'S activities including the activities of its agents, employees, contractors (including subcontractors) and the employees of each of them, in connection with the PIPELINE.

1.10.2. The COMPANY shall maintain complete and up-to-date records on construction, operation, maintenance, and termination activities performed in connection with the PIPELINE SYSTEM. Such records shall include surveillance data, leak and failure records, necessary operational data, modification records, and such other data as may be required by 49 CFR, Parts 191 and 192, and other applicable Federal laws and regulations.

1.11. HEALTH AND SAFETY

1.11.1 The COMPANY shall take measures necessary to protect the health and safety of all persons directly affected by activities performed by the COMPANY in the general vicinity of the right-of-way or permit area in connection with construction, operation, maintenance or termination of the PIPELINE SYSTEM, and shall immediately abate any health or safety hazards. The COMPANY shall notify the FEDERAL INSPECTOR of accidents which occur in connection with such activities in frequency and detail identical to Occupational Safety and Health Administration reporting requirements.

1.12. PUBLIC AND PRIVATE IMPROVEMENTS

1.12.1. The COMPANY shall provide reasonable protection to existing public or private improvements which may be adversely affected by its activities or those of its agents, employees, contractors (including subcontractors) and the employees of each of them during construction, operation, maintenance and termination of the PIPELINE SYSTEM. This protection shall specifically be provided to the TRANS-ALASKA PIPELINE SYSTEM on FEDERAL LANDS. If it is determined that the COMPANY has caused damage to such public and private improvements, and if the owner so requires, then the COMPANY shall promptly repair, or reimburse the owner for reasonable costs in repairing the property to a condition which is satisfactory to the owner, but need not exceed its condition prior to damage.

1.13. SURVEY MONUMENTS

1.13.1. The COMPANY shall mark and protect all survey monuments encountered during construction, operation, maintenance, and termination of the PIPELINE SYSTEM. These monuments are not to be disturbed; however, if disturbance of a monument or any of its accessories becomes necessary, the COMPANY will notify the FEDERAL INSPECTOR in writing before such disturbance occurs, and the FEDERAL INSPECTOR will provide instructions. A written report to the FEDERAL INSPECTOR will also be made immediately by the COMPANY in the event that any monuments or accessories are inadvertently damaged.

1.13.2. If any public land survey monuments, corners, or accessories (excluding geodetic survey monuments) of the United States or survey monuments of others, are destroyed or damaged during the construction, operation, maintenance, or termination of the PIPELINE SYSTEM, the COMPANY shall employ a qualified land surveyor to reestablish or restore same in accordance with the "Manual of Instructions for the Survey of Public Lands" of the Bureau of Land Management and shall record such survey in the appropriate records. Additional requirements for the protection of monuments, corners, and bearing trees on FEDERAL LANDS may be prescribed by the FEDERAL INSPECTOR.

1.14. FIRE PREVENTION AND SUPPRESSION

1.14.1. The COMPANY shall promptly notify the FEDERAL INSPECTOR of any fires on, or which may threaten any portion of, the PIPELINE SYSTEM and shall take all measures necessary or appropriate for the prevention and suppression of fires in accordance with applicable law. The COMPANY shall comply with the instructions and directions of the FEDERAL INSPECTOR concerning the use, prevention and suppression of fires on FEDERAL LANDS. Use of open fires in connection with construction, operation, maintenance and termination of the PIPELINE SYSTEM is prohibited on FEDERAL LANDS unless authorized in writing by the FEDERAL INSPECTOR.

The COMPANY shall also promptly notify the owners of the TRANS-ALASKA PIPELINE SYSTEM of any fires on, or which may threaten any portion of, the PIPELINE SYSTEM or the TRANS-ALASKA PIPELINE SYSTEM between Prudhoe Bay and Delta Junction.

1.15. ELECTRONICALLY OPERATED DEVICES

1.15.1. The COMPANY shall, as necessary, screen, filter, or otherwise suppress any electronically operated devices installed as part of the PIPELINE SYSTEM which are capable of producing electromagnetic interference radiations so that such devices will not adversely affect the functioning of existing communications systems, including supervisory control systems used in connection with the operation of the TRANS-ALASKA PIPELINE SYSTEM, or navigational aids. In the event that structures such as towers or buildings are to be erected as parts of the PIPELINE SYSTEM, their positioning shall be such that they will not obstruct radiation patterns of existing line-of-sight communications systems, navigational aids, or similar systems. The COMPANY shall not obstruct radiation patterns of existing line-of-sight communications systems, navigational aids, or similar systems. The COMPANY shall furnish a report and calculations showing the expected signal levels to the FEDERAL INSPECTOR.

1.16. TERMINATION OF AUTHORIZATION

1.16.1 Upon revocation or termination of the authorization of which these Stipulations are a part, the COMPANY shall remove all improvements and equipment from the FEDERAL LANDS, unless otherwise approved in writing by the FEDERAL INSPECTOR, and provided that restoration which appropriately can be performed prior to such removal has been completed to the satisfaction of the FEDERAL INSPECTOR as required by applicable stipulations. Procedures to abandon a buried PIPELINE shall be in accordance with the requirements specified in 49 CFR Sec 192.727.

1.17. STOP ORDERS

1.17.1. With respect to construction activities conducted under a NOTICE TO PROCEED, field representatives expressly designated in writing by the FEDERAL INSPECTOR may issue a stop order at the site of an activity to a field representative of the COMPANY designated pursuant to Stipulation 1.3.4. The COMPANY shall cease that particular activity immediately. Except in emergencies, all stop orders shall be in writing, and when issued orally, they shall be confirmed in writing within 24 hours. The stop order or a written confirmation of the order shall specify:

(1) The specific construction activity or activities which must be stopped;

(2) The reason for issuance of the order, including a description of the serious and immediate problem which requires the cessation of a particular construction activity;

(3) The name of the designated field representative of the FEDERAL INSPECTOR issuing the order;

(4) The name of the designated field representative of the COMPANY to whom the order is issued;

(5) The time and date of the order and the site of construction activity at which it is issued.

1.17.2 The FEDERAL INSPECTOR shall maintain a record of all such stop orders which includes this same information. Resumption of any construction activity suspended under a stop order shall be immediately authorized by the FEDERAL INSPECTOR or a designated field representative in writing once mitigating, corrective, or alternative measures have been implemented by the COMPANY.

1.17.3 Subject to the provisions of Section 9(d) of the Alaska Natural Gas Transportation Act, 15 U.S.C. §719(g), stop orders may be issued only when:

(1) An issue arises with respect to compliance with these Stipulations or the NOTICE TO PROCEED which authorized the construction activity in question;

(2) The FEDERAL INSPECTOR or his field representative determines that such issue presents problems or conflicts of a serious and immediate nature; and

(3) Mitigating or corrective measures cannot be identified or agreed upon by the FEDERAL INSPECTOR or his field representative and a designated representative of the COMPANY and immediately implemented.

1.18. REGULATION OF ACCESS

1.18.1 The COMPANY shall provide, as necessary, and maintain ROADS and airstrips, the number, location and standards of which shall be approved by the FEDERAL INSPECTOR, to provide for continuing maintenance and surveillance of the PIPELINE SYSTEM.

1.18.2. During construction or termination activities, the COMPANY may regulate or prohibit public access to or upon any ROAD being used for such activity. At all other times, the COMPANY shall permit free and unrestricted public access to and upon ROADS, except that with the written consent of the FEDERAL INSPECTOR, the COMPANY may regulate or prohibit public access and vehicular traffic on ROADS as required to facilitate operations or to protect the public, wildlife and livestock from hazards associated with operation and maintenance of the PIPELINE. The COMPANY shall provide appropriate warnings, flagmen, barricades, and other safety measures when the COMPANY is using ROADS or regulating public access to or upon ROADS.

1.18.3. During construction of the PIPELINE, the COMPANY shall provide alternative routes for existing roads and trails at locations and to standards as determined by the FEDERAL INSPECTOR, whether or not these roads or trails are recorded.

1.18.4. The COMPANY shall make provisions for suitable permanent crossings for the public at locations and to standards approved in writing by the FEDERAL INSPECTOR where the right-of-way crosses existing roads, foot-trails, winter trails, or other existing rights-of-way, including those validly established pursuant to 43 U.S.C. 932 prior to October 21, 1976.

1.19. USE OF EXISTING FACILITIES

1.19.1. Subject to existing rights vested in other parties, the COMPANY shall use existing facilities to the maximum extent feasible in all construction, operation, maintenance, and termination activities associated with the PIPELINE SYSTEM.

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2. ENVIRONMENTAL

2.1. ENVIRONMENTAL BRIEFINGS

2.1.1. The COMPANY shall develop and provide environmental briefings for supervisory and field personnel directly related to the project and for Federal field representatives in accordance with the approved environmental briefings plan required by Stipulation 1.6.1.

2.2. POLLUTION CONTROL

2.2.1. GENERAL

2.2.1.1. The COMPANY shall construct, operate, maintain, and terminate the PIPELINE SYSTEM in a manner that will avoid or minimize degradation of air, land and water quality. The COMPANY shall comply with applicable air and water quality standards and Federal laws and regulations relating to pollution control or prevention.

2.2.2. WATER AND LAND POLLUTION

2.2.2.1. The COMPANY shall comply with applicable State of Alaska "Water Quality Standards," as approved by the Environmental Protection Agency, and with requirements of the Environmental Protection Agency's National Pollutant Discharge Elimination System discharge permit program.

2.2.2.2. Mobile ground equipment shall not be operated in lakes, WETLANDS, streams, or rivers unless such operation is approved in writing by the FEDERAL INSPECTOR.

2.2.2.3. The temperature of natural surface or ground waters shall not be changed significantly by the PIPELINE SYSTEM or by any constructionrelated activities unless approved in writing by the FEDERAL INSPECTOR.

2.2.2.4. The COMPANY shall comply with the standards for thermal pollution in the State of Alaska "Water Quality Standards," as approved by the Environmental Protection Agency.

2.2.3. PESTICIDES, HERBICIDES AND OTHER CHEMICALS

2.2.3.1. Where possible, the COMPANY shall use nonpersistent and immobile types of pesticides, herbicides and other chemicals. Only those pesticides and herbicides currently registered by the Environmental Protection Agency pursuant to the Federal Insecticide, Fungicide and Rodenticide Act shall be applied. Applications of pesticides and herbicides shall be in accordance with label directions approved by the Environmental Protection Agency. Each chemical to be used and its application constraints shall be approved in writing by the FEDERAL INSPECTOR prior to use.

2.2.4. SANITATION AND WASTE DISPOSAL

2.2.4.1. All HAZARDOUS SUBSTANCES and WASTE generated in construction, operation, maintenance and termination of the PIPELINE SYSTEM shall be removed or otherwise disposed of in a manner acceptable to the FEDERAL INSPECTOR. All applicable Federal and State requirements will be incorporated in the plans required in Stioulation 1.6.1.

2.2.5. ICE FOG

2.2.5.1. The COMPANY shall utilize and operate all facilities and devices used in connection with the PIPELINE SYSTEM so as to avoid or minimize ice fog. Facilities and devices which cannot be prevented from producing ice fog shall be located so as to minimize interference with airfields, communities or roads.

2.3. BUFFER STRIPS

2.3.1. Where the PIPELINE right-of-way crosses highways, and other roads designated by the FEDERAL INSPECTOR, the PIPELINE shall be clearly marked as required in 49 CFR 192.707, and a screen of vegetation native to the adjacent areas shall be established over disturbed areas unless otherwise approved in writing by the FEDERAL INSPECTOR.

2.3.2. The PIPELINE SYSTEM shall be located so as to provide buffer strips of undisturbed land at least 500 feet wide between the PIPELINE SYSTEM and streams, lakes, and WETLANDS unless otherwise approved in writing by the FEDERAL INSPECTOR.

2.3.3. Undisturbed buffer strips at least 500 feet wide will be maintained between material sites and state highways unless otherwise approved in writing by the FEDERAL INSPECTOR.

2.4. EROSION AND SEDIMENTATION CONTROL

2.4.1. GENERAL

2.4.1.1. The COMPANY shall perform all PIPELINE SYSTEM activities so as to minimize disturbance to all surface areas.

2.4.1.2. The design of the PIPELINE SYSTEM shall provide for the control of erosion and sediment production, transport and deposit.

2.4.1.3. Erosion control measures, including the use of erosion control structures, if necessary, shall be implemented on FEDERAL LANDS in accordance with the plans approved under Stipulation 1.6.1 to limit induced and accelerated erosion, limit sediment production and transport and lessen the possibility of forming new drainage channels. The design of such measures shall be based on the rainfall rate and snowmelt combination characteristic of the region, the effects of thawing produced by flowing or ponded water on permafrost, and the effects of ice. Permanent erosion control structures shall be designed to accommodate a 50-year flood.

2.4.1.4. Surface materials suitable for use in restoration that are taken from disturbed areas shall be stockpiled and utilized during restoration unless otherwise approved in writing by the FEDERAL INSPECTOR. Erosion and sediment control practices to be utilized shall be determined by the needs of specific sites and, as appropriate, shall include but not be limited to REVEGETATION, mulching, and placement of mat binders, soil binders, rock or gravel blankets or structures.

2.4.2. CROSSING OF STREAMS, RIVERS, FLOODPLAINS AND WETLANDS

2.4.2.1. The COMPANY shall minimize erosion and sedimentation at stream, river and WETLANDS crossings and those parts of the PIPELINE SYSTEM within floodplains, as provided in Stipulation 3.4.

2.4.2.2. Temporary access over streambanks prior to and following trenching shall be made through use of fill ramps rather than by cutting through streambanks, unless otherwise approved in writing by the FEDERAL INSPECTOR. The COMPANY shall remove such ramps upon termination of seasonal or final use. Ramp materials shall be disposed of in a manner approved in writing by the FEDERAL INSPECTOR.

2.4.3. EXCAVATED MATERIAL

2.4.3.1. Excavated material in excess of that required to backfill around any structure, including the pipe, shall be disposed of in accordance with the approved overburden and excess material disposal plan required in Stipulation 1.6.1.

2.4.3.2. Excavated materials shall not be stockpiled in rivers, streams or floodplains, or on ice unless approved in writing by the FEDERAL INSPECTOR. In WETLANDS, stockpiling shall be in accordance with the plan required by Stipulation 1.6.1.

2.5. FISH AND WILDLIFE PROTECTION

2.5.1. The COMPANY shall design, construct, operate, maintain and terminate the PIPELINE SYSTEM so as to assure free passage and movement of fish in streams designated by the FEDERAL INSPECTOR. Temporary blockages of fish necessitated by instream activities may be approved. The proposed designs and construction plans shall include the time and place that such temporary blockages may occur.

2.5.2. Pump intakes shall be screened to prevent harm to fish. Screening specifications shall be approved by the FEDERAL INSPECTOR.

2.5.3 When abandoned, water diversion structures shall be removed or plugged and stabilized, unless otherwise approved in writing by the FEDERAL INSPECTOR.

2.5.4. FISH SPAWNING BEDS, FISH REARING AREAS, AND OVERWINTERING AREAS

2.5.4.1. "FISH SPAWNING BEDS" means those areas where anadromous and resident fish deposit their eggs.

2.5.4.2. "FISH REARING AREAS" means those areas inhabited by fish during any life stage.

2.5.4.3. "OVERWINTERING AREAS" means those areas inhabited by fish between freezeup and breakup.

2.5.4.4. The COMPANY shall avoid disturbances to those FISH SPAWNING BEDS, FISH REARING AREAS and OVERWINTERING AREAS designated by the FEDERAL INSPECTOR. However, where disturbances cannot be avoided, proposed modifications and appropriate mitigation measures shall be designed by the COMPANY and approved in writing by the FEDERAL INSPECTOR.

2.5.4.5. The COMPANY shall protect FISH SPAWNING BEDS, FISH REARING AREAS and OVERWINTERING AREAS from sediment where soil material is expected to be suspended in water as a result of construction activities. Settling basins or other sediment control structures shall be constructed and maintained to intercept such sediment before it reaches rivers, streams, lakes or WETLANDS.

2.5.4.6. The COMPANY shall comply with any site-specific terms and conditions imposed by the FEDERAL INSPECTOR to protect FISH SPAWNING BEDS, FISH REARING AREAS and OVERWINTERING AREAS from the effects of the COMPANY's activities. If material sites are approved adjacent to or in lakes, rivers, streams, WETLANDS, or floodplains, the FEDERAL INSPECTOR may require the COMPANY to construct levees or berms or employ other suitable means to protect fish and fish passage and to prevent or minimize sedimentation. The COMPANY shall repair damage to such areas caused by construction, operation, maintenance or termination of the PIPELINE SYSTEM to the satisfaction of the FEDERAL INSPECTOR as stated in writing.

2.5.4.7. The COMPANY shall not take water from FISH SPAWNING BEDS, FISH REARING AREAS and OVERWINTERING AREAS or waters that directly replenish those areas during critical periods that will be defined by the FEDERAL INSPECTOR, unless otherwise approved by the FEDERAL INSPECTOR.

2.5.5. ZONES OF RESTRICTED ACTIVITIES

2.5.5.1. Activities of the COMPANY in connection with construction, operation, maintenance and termination of the PIPELINE SYSTEM in key fish and wildlife areas and in specific areas where threatened or endangered species of animals are found may be restricted by the FEDERAL INSPECTOR during periods of fish and wildlife breeding, nesting, spawning, lambing and calving activity, overwintering, and during major migrations of fish and wildlife. The FEDERAL INSPECTOR shall provide the COMPANY written notice of such restrictive action. At least annually, and as far in advance of such restrictions as is possible, the FEDERAL INSPECTOR shall furnish the COMPANY an updated list of those areas where such actions may be required, together with anticipated dates of restriction.

2.5.6. BIG GAME MOVEMENTS

2.5.6.1. The COMPANY shall design, construct and maintain both the buried and aboveground sections of the PIPELINE so as to assure free passage and movement of big game animals.

2.6. PURCHASE OF MATERIALS AND TIMBER

2.6.1. If the COMPANY requires mineral materials from lands of the United States, it shall make application to purchase such materials in accordance with 43 CFR Part 3610 and shall submit a mining plan in accordance with 43 CFR Part 23. No materials may be removed by the COMPANY without written approval. Application to purchase merchantable timber shall be made in accordance with 43 CFR Part 5400.

2.6.2. LAYOUT OF MATERIAL SITES

2.6.2.1. Materials site boundaries shall be shaped in such a manner as to blend with surrounding natural land patterns. Regardless of the layout of material sites, primary emphasis shall be placed on prevention of soil erosion, damage to vegetation, and destruction of fish and wildlife habitat.

2.7. CLEARING

2.7.1. BOUNDARIES

2.7.1.1. The COMPANY shall identify clearing boundaries on the ground which shall be approved by the FEDERAL INSPECTOR prior to beginning clearing operations. All timber and other vegetative material outside clearing boundaries and all blazed, painted or posted trees which are on or mark clearing boundaries are reserved from cutting and removal with the exception of danger trees or snags designated by the COMPANY and approved by the FEDERAL INSPECTOR.

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2.7.2. CLEARING PROCEDURES

2.7.2.1. All trees, snags and other wood material cut in connection with clearing operations shall be cut so that the resulting stumps shall not be higher than six (6) inches measured from the ground on the uphill side.

2.7.2.2. All trees, snags and other wood material cut in connection with clearing operations shall be felled into the area within the clearing boundaries and away from watercourses.

2.7.2.3. Hand clearing shall be used in areas where the FEDERAL INSPECTOR determines that use of heavy equipment would be detrimental to existing conditions.

2.7.2.4. All debris resulting from clearing operations and construction that may block streamflow, delay fish passage, contribute to flood damage, or result in streambed scour or erosion shall be removed within 48 hours unless otherwise approved or directed by the FEDERAL INSPECTOR.

2.7.3. DISPOSAL OF CLEARING DEBRIS

2.7.3.1. All slash shall be disposed of in construction pads or ROADS unless otherwise approved in writing by the FEDERAL INSPECTOR. Slash shall be disposed of prior to the end of the first winter after cutting.

2.7.3.2. Disposal of vegetation, nonmerchantable timber, overburden and other materials removed during clearing operations shall be addressed in the plans required in Stipulation 1.6.1 and approved in writing by the FEDERAL INSPECTOR.

2.8. DISTURBANCE OR USE OF NATURAL WATERS

2.8.1. All activities of the COMPANY in connection with the PIPELINE SYSTEM that may create new lakes, drain existing lakes, significantly divert natural drainages and surface runoff, permanently alter stream or groundwater hydrology, or disturb significant areas of streambeds are prohibited unless such activities along with necessary mitigation measures are approved in writing by the FEDERAL INSPECTOR.

2.8.2. The COMPANY shall not develop or utilize any wells or surface water sources on FEDERAL LANDS for the construction, operation, maintenance and termination of the PIPELINE SYSTEM without the prior written approval of the FEDERAL INSPECTOR.

2.9. OFF RIGHT-OF-WAY TRAFFIC

2.9.1. The COMPANY shall not operate mobile ground equipment on FEDERAL LANDS off the right-of-way, any roads, or authorized areas unless approved in writing by the FEDERAL INSPECTOR or when necessary to prevent immediate harm to any person or property.

2.10. VISUAL RESOURCES

2.10.1. The COMPANY shall consider visual resources in planning, construction, operation and termination of the PIPELINE SYSTEM. The COMPANY shall prepare a visual resource plan for the PIPELINE SYSTEM in accordance with Stipulation 1.6.1.

2.11. USE OF EXPLOSIVES

2.11.1. The COMPANY shall submit a plan for storage and use of explosives, including but not limited to blasting techniques, to the FEDERAL INSPECTOR for approval in accordance with Stipulation 1.6.1.

2.11.2. No blasting shall be done under water or within one quarter (1/4) mile of streams or lakes with identified fisheries or wildlife resources without written approval of the FEDERAL INSPECTOR.

2.11.3. Timing and location of blasting shall be approved by the FEDERAL INSPECTOR.

2.12. RESTORATION

2.12.1. Upon completion of use, the COMPANY shall restore all areas of FEDERAL LANDS disturbed by it, in accordance with schedules approved by the FEDERAL INSPECTOR and approved plans required under Stipulation 1.6.1. Restoration performed by the COMPANY shall be approved in writing by the FEDERAL INSPECTOR.

2.12.2. Restoration includes, where appropriate, erosion and sediment control, REVEGETATION, reestablishment of native species, visual amelioration and stabilization. Unless otherwise directed by the FEDERAL INSPECTOR, all disturbed areas of FEDERAL LANDS shall be left in such stabilized condition that erosion will be minimized through such means as adequately designed and constructed waterbars, REVEGETATION and chemical surface control. Culverts and bridges shall be removed, and slopes shall be restored by the COMPANY in a manner satisfactory to the FEDERAL INSPECTOR.

2.12.3. REVEGETATION of disturbed areas of FEDERAL LANDS shall be accomplished as soon as practicable in accordance with plans and schedules required under Stipulation 1.6.1. The results of REVEGETATION must be satisfactory to the FEDERAL INSPECTOR, as stated in writing.

2.12.4. The COMPANY shall dispose of all materials from ROADS, haul ramps, berms, dikes, and other earthen structures it has placed on FEDERAL LANDS, in accordance with approved restoration plans unless otherwise directed by the FEDERAL INSPECTOR.

2.12.5. Pending restoration of a disturbed area of FEDERAL LANDS, the COMPANY shall maintain the area in a stabilized condition satisfactory to the FEDERAL INSPECTOR.

2.12.6. Upon completion of restoration of an area of FEDERAL LANDS, the COMPANY shall remove all equipment and supplies from that area in accordance with approved restoration plans, unless otherwise directed by the FEDERAL INSPECTOR.

2.12.7. The COMPANY shall maintain all restored areas of FEDERAL LANDS in accordance with approved plans required under Stipulation 1.6.1.

2.13. REPORTING, PREVENTION, CONTROL, CLEANUP AND DISPOSAL OF OIL AND HAZARDOUS SUBSTANCES DISCHARGES

2.13.1. The COMPANY shall give notice in accordance with applicable law of any spill, leakage, or discharge of OIL or other HAZARDOUS SUBSTANCES in connection with the construction, operation, maintenance or termination of the PIPELINE SYSTEM to:

(1) The FEDERAL INSPECTOR and

(2) Such other Federal and State officials as are required by law to be given such notice.

Any oral notice shall be confirmed in writing as soon as possible.

2.13.2. The COMPANY shall submit an OIL and HAZARDOUS SUBSTANCE control, cleanup and disposal plan to the FEDERAL INSPECTOR in accordance with Stipulation 1.6.1, and where applicable, in accordance with 40 CFR Part 112. The plan shall conform to this Stipulation and shall outline all areas where OIL and/or HAZARDOUS SUBSTANCES are stored, utilized, transported or distributed. The plan shall address fuel distribution systems, storage and containment, containerized products, leak detection systems, handling procedures, training programs, provisions for collection, storage and ultimate disposal of waste OIL, cleanup methods, and disposal sites. The plan shall be approved in writing by the FEDERAL INSPECTOR, and the COMPANY shall demonstrate its capability and readiness to execute the plan.

2.14. PIPELINE CONTINGENCY PLAN

2.14.1. The COMPANY shall submit a PIPELINE contingency plan to the FEDERAL INSPECTOR in accordance with Stipulation 1.6.1. The plan shall conform to

the requirements of 49 CFR Sections 192.605 and 192.615 and shall outline the steps to be taken in the event of a failure, leak or explosion in the PIPELINE. The plan shall be approved in writing by the FEDERAL INSPECTOR prior to PIPELINE startup, and the COMPANY shall demonstrate its capability and readiness to execute the plan.

2.14.2. The COMPANY shall, as appropriate, update the plan and methods of implementation thereof, which shall be submitted annually to the FEDERAL INSPECTOR.

2.15. CULTURAL RESOURCES

2.15.1. The COMPANY shall undertake the affirmative responsibility to identify, protect and preserve cultural, historic, prehistoric and archeological resources that may be impacted by its activities in the overall construction project in the State of Alaska on both Federal and non-Federal lands consistent with the National Historic Preservation Act of 1966, as amended, 16 U.S.C. 470, et seq., the Archaeological and Historic Preservation Act of 1974, 16 U.S.C. 469, et seq., and the implementing procedures of the Advisory Council on Historic Preservation, 36 CFR Part 800. This responsibility will be executed in a manner consistent with the terms of a Memorandum of Agreement, under Section 106 of the National Historic Preservation Act of 1966, 16 U.S.C. 470f, as amended, between the Advisory Council on Historic Preservation, the State Historic Preservation Officer, and appropriate Federal and State officials, and developed in consultation with the COMPANY. The terms of such Memorandum of Agreement, except as otherwise mandated by law, shall not compel a change in the basic nature and general route of the approved transportation system or otherwise prevent or impair in any significant respect the expeditious construction and initial operation of the transportation system.

2.16. HUNTING, FISHING AND TRAPPING

2.16.1. The COMPANY shall inform its employees, agents, contractors, subcontractors and their employees of applicable laws and regulations relating to hunting, fishing, and trapping.

2.17. SMALL CRAFT PASSAGE

2.17.1. The creation of any permanent obstruction to the passage of small craft in streams is prohibited.

3. TECHNICAL

3.1. PIPELINE SYSTEM STANDARDS

3.1.1. GENERAL STANDARDS

3.1.1.1. All design, including selection of material, and construction, operation, maintenance and termination practices employed with respect to the PIPELINE SYSTEM shall be in accordance with sound engineering practice and, with regard to the PIPELINE, shall meet or exceed the Department of Transportation Regulations, 49 CFR, Parts 191, "Reports of Leaks," and 192, "Transportation of Natural and Other Gas by Pipelines: Minimum Federal Safety Standards."

3.1.1.2. Requirements in addition to those set forth in the above minimum standards may be imposed by the FEDERAL INSPECTOR as necessary to reflect the impact of subarctic and arctic environments. The FEDERAL INSPECTOR will make every effort to identify such additional requirements during the design phase.

3.1.2. SPECIFIC STANDARDS

3.1.2.1. The PIPELINE design shall provide for sectionalizing block valves, protective devices to prevent overpressuring, and other safety devices installed at locations required by 49 CFR Part 192, or as may be designated by the FEDERAL INSPECTOR during the DESIGN CRITERIA reviews to accommodate potentially hazardous areas, other facilities and environmental values.

3.1.2.2. The COMPANY shall inspect 100 percent where practicable but not less than 90 percent of the main line girth welds using radiographic or other nondestructive inspection techniques to assure compliance with defect acceptability standards approved by the FEDERAL INSPECTOR. Where radiography is used, x-ray radiography will be used, unless otherwise approved by the FEDERAL INSPECTOR.

3.1.2.3. The PIPELINE design for construction in environmentally sensitive areas designated by the FEDERAL INSPECTOR, shall provide for minimum maintenance needs to reduce reentry requirements.

3.1.2.4. All practicable means shall be utilized to minimize injury to the ground organic layer.

3.1.2.5. Welder qualification tests shall be by destructive means, in accordance with Section 3 of API 1104, except that operators of automatic welding equipment may be qualified by radiography. Welder qualification tests for station piping facilities may alternately be in accordance with ASME Boiler and Pressure Vessel Code, Section 9.

3.1.2.6. All construction, operation, maintenance and termination activities in connection with the PIPELINE SYSTEM shall be conducted so as to avoid or minimize thermal changes. All working platforms, pads, fills and other surface modifications shall be planned and executed in such a way that any resulting alteration of permafrost will not jeopardize PIPELINE integrity and the surrounding environment.

3.1.2.7. A monitoring program shall be developed by the COMPANY as part of the surveillance and maintenance plan required by Stipulation 1.6.1, which shall identify any PIPELINE movement that may affect PIPELINE integrity, resulting from frost heave, settlement or seismic forces. This program, including baseline data, shall be finalized and operational prior to transmission of GAS through the PIPELINE.

3.1.3. STANDARDS FOR ROADS

3.1.3.1. The COMPANY shall submit a layout of each proposed ROAD for approval by the FEDERAL INSPECTOR in accordance with Stipulation 1.7.

3.1.3.2. ROADS constructed by the COMPANY shall be constructed and maintained to standards suitable for safe operation of equipment at the travel speeds proposed by the COMPANY in accordance with Stipulation 3.1.3.3.

3.1.3.3. Design, materials and construction practices employed for ROADS shall be in accordance with safe and proven engineering practice. ROADS intended for permanent use shall be constructed in accordance with generally accepted principles of construction for secondary roads for the subarctic and arctic environments. Existing roads approved for use by the COMPANY that do not meet these standards need not be upgraded, subject to approval of the FEDERAL INSPECTOR, provided that the basic access requirements imposed by Stipulation 1.18 are satisfied.

3.1.3.4. The maximum allowable grade shall be 12 percent, unless otherwise approved in writing by the FEDERAL INSPECTOR.

3.2. EARTHQUAKES AND FAULT DISPLACEMENTS

3.2.1. EARTHQUAKES

3.2.1.1. The PIPELINE shall be designed by appropriate application of modern, state-of-the-art seismic design procedures to protect the PIPELINE from the effects (including seismic shaking, ground deformation and earthquake-induced mass movements) of earthquakes distributed along the route as follows:

ZONE	Richter Magnitude
Canadian/Alaska Border to Big Delta	6.5
Big Delta to 67 deg. N.	7.5
67 deg. N. to Prudhoe Bay	5.5

3.2.1.2. The COMPANY shall provide a seismic monitoring system, to be approved by the FEDERAL INSPECTOR, and shall ensure there are adequate procedures for the safe shutdown of the PIPELINE under seismic conditions thay may affect PIPELINE integrity. Such procedures, to be considered adequate, shall include but not necessarily be limited to:

(1) Communication capability with all key operating control points on the PIPELINE SYSTEM, the GAS processing plant, and other parties with seismic monitoring capabilities, as appropriate;

(2) A control center and alternate for the PIPELINE SYSTEM;

(3) Operating procedures establishing the actions to be taken in the event of seismic conditions that may affect PIPELINE integrity;

(4) Seismic sensors as necessary to supplement existing monitoring capabilities.

3.2.2. FAULT DISPLACEMENTS

3.2.2.1. Prior to applying for a NOTICE TO PROCEED for any CONSTRUCTION SEGMENT, the COMPANY shall satisfy the FEDERAL INSPECTOR that all recognizable or reasonably inferred faults or fault zones along the alignment within that CONSTRUCTION SEGMENT have been identified and delineated and any risk of major PIPELINE damage resulting from fault movement and ground deformation has been adequately assessed and provided for in the design of the PIPELINE SYSTEM for that CONSTRUCTION SEGMENT. Evaluation of said risk shall be based on geologic, geomorphic, geodetic, seismic, and other appropriate scientific evidence of past or present fault behavior and shall be compatible with the design earthquakes tabulated in Stipulation 3.2.1.1 and with observed relationships between earthquake magnitude and extent and amount of deformation and fault slip within the fault zone.

3.2.2.2. Minimum DESIGN CRITERIA for any portion of the PIPELINE SYSTEM traversing a fault zone that is interpreted by the FEDERAL INSPECTOR as active shall be: (1) that the PIPELINE resist failure resulting in line rupture from maximum anticipated horizontal and/or vertical displacement in the foundation material anywhere within the fault zone during the life of the PIPELINE; and (2) that no storage tank or compressor station be located within the fault zone unless otherwise approved by the FEDERAL INSPECTOR.

3.3. SLOPE STABILITY

3.3.1. Areas subject to mudflows, landslides, avalanches, rock falls and other types of mass movements shall be avoided where practicable in locating the PIPELINE SYSTEM. Where such avoidance is not practicable, the PIPELINE SYSTEM design, based upon detailed field investigations and analyses, shall provide measures to prevent the occurrence of, or protect the PIPELINE SYSTEM from, the effects of mass movement. The PIPELINE SYSTEM shall be designed to protect existing facilities, including the TRANS-ALASKA PIPELINE SYSTEM, from the effects of mass movement caused by the COMPANY's activities or the activities of its agents, employees, contractors (including activities or the activities of its agents, employees, contractors (including subcontractors) and the employees of each of them and shall not adversely affect slope stability protection measures of existing structures.

E'-16

3.4. STREAM AND FLOODPLAIN CROSSINGS

3.4.1. GENERAL

3.4.1.1. The PIPELINE SYSTEM shall be designed so as to minimize the number of stream and WETLAND crossings and to include, but not be limited to, consideration of aufeis development, erosion and sedimentation, restriction of natural meander, or alteration of the physical or chemical nature of the water body, and the effect of any alteration in these factors caused by the COMPANY's activities or the activities of its agents, employees, contractors (including subcontractors) and the employees of each of them upon existing facilities, including the TRANS-ALASKA PIPELINE SYSTEM.

3.4.1.2. The PIPELINE SYSTEM shall be designed to withstand or accommodate the effects (including runoff, stream and floodplain erosion, meander cutoffs, lateral migration, ice jams, and icings) of those meteorologic and hydrologic (including surface and subsurface) conditions considered characteristic for each hydrologic region. For stream crossings and portions of the PIPELINE within the floodplain, the following standards shall apply to such PIPELINE design.

3.4.1.2.1. The design flood shall be based on the concept of the "Standard Project Flood" as defined in Corps of Engineers Bulletin 52-8, Part 1, unless otherwise approved by the FEDERAL INSPECTOR.

3.4.1.2.2. The depth of channel scour shall be established by appropriate field investigations and theoretical calculations using those combinations of water velocity and depth that yield the maximum value. At the point of maximum scour, the cover over the top of the pipe shall be at least twenty (20) percent of the computed scour, but not less than four (4) feet.

3.4.1.2.3. For overhead crossings, analysis shall be made to ensure that support structures are adequately protected from the effects of scour, channel migration, undercutting, ice forces and degradation of permafrost, and other external and internal loads.

3.4.1.2.4. To avoid channelization along the pipe, appropriate design and construction procedures will be included in the plans required in Stipulation 1.6.1 and shall be used wherever there is potential for such channelization.

3.4.1.2.5. Methods of constructing stream crossings, including excavation and backfill of pipe trench near and through streambanks and existing rivertraining structures, shall be approved in writing by the FEDERAL INSPECTOR prior to initiation of construction.

3.4.1.3. Low water crossings (fords across streams or rivers where any mobile ground equipment is moved on the streambed) shall be designed, constructed, maintained, and restored to standards approved in writing by the FEDERAL INSPECTOR.

3.4.2. EROSION

3.4.2.1 To prevent erosion, the culvert inlet and outlet areas shall be stabilized by appropriate methods, e.g., by the use of stilling basins or riprap.

3.4.2.2. Slopes of cuts through stream banks shall be designed and constructed to minimize erosion and prevent slides.

3.4.2.3. Erosion control procedures shall accommodate and be based on the runoff produced by the rainfall rate and snow melt combination characteristic of the region. The procedures shall also accommodate effects that result from thawing produced by flowing or ponded water on permafrost terrain and the effects of ice.

3.4.3. CULVERTS AND BRIDGES

3.4.3.1. Culverts and bridges necessary for operation and maintenance of the PIPELINE shall be designed at a minimum to accommodate a fifty (50) year flood in accordance with criteria established by the American Association of State Highway Officials and the Federal Highway Administration and endorsed by the State of Alaska Department of Transportation.

3.4.3.2. Culverts necessary for construction or operation of the PIPELINE SYSTEM shall be installed a minimum of six (6) inches below the thalweg in fish streams identified by the FEDERAL INSPECTOR.

3.5. PIPELINE CORROSION

3.5.1. The COMPANY shall provide plans, as required by Stipulation 1.6.1, for corrosion resistant design and methods for early detection of corrosion in accordance with 49 CFR Part 192. This shall include consideration of:

(1) Pipeline material to be used and information on its particular suitability for the environment involved;

(2) Details on the external pipe protection to be provided (coating, wrapping, etc.), including information on variations of the coating process to cope with variations in environmental factors along the PIPELINE route;

(3) Plans for cathodic protection including details of impressed current sources and controls to ensure continuous maintenance of adequate protection over the entire surface of the pipe;

(4) Details of plans for monitoring cathodic protection current, including spacing of current monitors;

(5) Provision for periodic intensive surveys of trouble spots, regular preventive maintenance surveys, and special provisions for abnormal potential patterns, especially those resulting from other pipelines or cables;

(6) Information on any precautions that may be required to prevent internal corrosion of the PIPELINE.

3.6. CONSTRUCTION MODE REQUIREMENTS

3.6.1. The selection of the CONSTRUCTION MODE shall be governed by the results of adequate geotechnical field exploration and testing programs. Comprehensive analyses shall be made to assure that PIPELINE integrity will be maintained and that construction or operation of the PIPELINE will not cause or exacerbate major terrain disturbances. Analysis shall consider stresses and strains on the PIPELINE by internal and external loading and shall include, but not be limited to, total and differential heaving, permafrost (especially liquefaction and differential settlement after thawing), frost action, seismic loading, slope stability, active faults, swelling soils, subsidence, erosion, flooding, icings and differential temperature stress. The final design for the CONSTRUCTION MODE shall be submitted to the FEDERAL INSPECTOR for approval prior to pipe installation, in accordance with Stipulation 1.7.

Application No. 071-0YD-2-8..282

Name of Applicant Alaskan Northwest Natural Gas Transportation Company, a partnership, by its agent and operator, Northwest Alaskan Pipeline Co.

Effective Date 04 JAN 1984

Expiration Date *(If applicable)* ______

File No. Sagavanirktok River 120

DEPARTMENT OF THE ARMY
PERMIT

Referring to written request dated December 2, 1982 for a permit to:

(✓) Perform work in or affecting navigable waters of the United States, upon the recommendation of the Chief of Engineers, pursuant to Section 10 of the Rivers and Harbors Act of March 3, 1899 *(33 U.S.C. 403)*;

( ) Discharge dredged or fill material into waters of the United States upon the issuance of a permit from the Secretary of the Army acting through the Chief of Engineers pursuant to Section 404 of the Clean Water Act *(33 U.S.C. 1344)*;

( ) Transport dredged material for the purpose of dumping it into ocean waters upon the issuance of a permit from the Secretary of the Army acting through the Chief of Engineers pursuant to Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 *(86 Stat. 1052; P.L. 92-532)*;

Northwest Alaskan Pipeline Company
1001 Noble Street
Suite 300
Fairbanks, Alaska 99701

is hereby authorized by the Secretary of the Army:

to place uncontaminated clean gravel fill for work pads and access roads associated with the permanent structures of the Alaska Natural Gas Transportation System (ANGTS). This will include work pads for the placement of the ANGTS Line, pads for compressor stations, metering station, erosion protection structures, access roads, culvert crossings, low water crossings, permanent stream crossing and temporary storage of ditch spoils and materials (see page 1A)

in The project activites are located from Prudhoe Bay to the Alaska/Canada border as shown on the Civil Alignments sheets 1-131, dated June 1982 and included with the public notice.

in accordance with the plans and drawings attached hereto which are incorporated in and made a part of this permit *(on drawings, give file number or other definite identification marks.)*

"PROPOSED: ALASKA NATURAL GAS TRANSPORTATION SYSTEM; IN: PRUDHOE BAY, FROM ALASKA/CANADA BORDER; APPLICATION BY: NORTHWEST ALASKAN PIPELINE COMPANY; DATED: DECEMBER 2, 1983; 8 SHEETS"

subject to the following conditions:

I. General Conditions:

a. That all activities identified and authorized herein shall be consistent with the terms and conditions of this permit; and that any activities not specifically identified and authorized herein shall constitute a violation of the terms and conditions of this permit which may result in the modification, suspension or revocation of this permit, in whole or in part, as set forth more specifically in General Conditions j or k hereto, and in the institution of such legal proceedings as the United States Government may consider appropriate, whether or not this permit has been previously modified, suspended or revoked in whole or in part.

b. That all activities authorized herein shall, if they involve, during their construction or operation, any discharge of pollutants into waters of the United States or ocean waters, be at all times consistent with applicable water quality standards, effluent limitations and standards of performance, prohibitions, pretreatment standards and management practices established pursuant to the Clean Water Act (*33 U.S.C. 1344*), the Marine Protection, Research and Sanctuaries Act of 1972 (*P.L. 92-532, 86 Stat. 1052*), or pursuant to applicable State and local law.

c. That when the activity authorized herein involves a discharge during its construction or operation, or any pollutant (*including dredged or fill material*), into waters of the United States, the authorized activity shall, if applicable water quality standards are revised or modified during the term of this permit, be modified, if necessary, to conform with such revised or modified water quality standards within 6 months of the effective date of any revision or modification of water quality standards, or as directed by an implementation plan contained in such revised or modified standards, or within such longer period of time as the District Engineer, in consultation with the Regional Administrator of the Environmental Protection Agency, may determine to be reasonable under the circumstances.

d. That the discharge will not destroy a threatened or endangered species as identified under the Endangered Species Act, or endanger the critical habitat of such species.

e. That the permittee agrees to make every reasonable effort to prosecute the construction or operation of the work authorized herein in a manner so as to minimize any adverse impact on fish, wildlife, and natural environmental values.

f. That the permittee agrees that he will prosecute the construction or work authorized herein in a manner so as to minimize any degradation of water quality.

g. That the permittee shall allow the District Engineer or his authorized representative(s) or designee(s) to make periodic inspections at any time deemed necessary in order to assure that the activity being performed under authority of this permit is in accordance with the terms and conditions prescribed herein.

h. That the permittee shall maintain the structure or work authorized herein in good condition and in reasonable accordance with the plans and drawings attached hereto.

i. That this permit does not convey any property rights, either in real estate or material, or any exclusive privileges; and that it does not authorize any injury to property or invasion of rights or any infringement of Federal, State, or local laws or regulations.

j. That this permit does not obviate the requirement to obtain state or local assent required by law for the activity authorized herein.

k. That this permit may be either modified, suspended or revoked in whole or in part pursuant to the policies and procedures of 33 CFR 325.7.

l. That in issuing this permit, the Government has relied on the information and data which the permittee has provided in connection with his permit application. If, subsequent to the issuance of this permit, such information and data prove to be materially false, materially incomplete or inaccurate, this permit may be modified, suspended or revoked, in whole or in part, and/or the Government may, in addition, institute appropriate legal proceedings.

m. That any modification, suspension, or revocation of this permit shall not be the basis for any claim for damages against the United States.

n. That the permittee shall notify the District Engineer at what time the activity authorized herein will be commenced, as far in advance of the time of commencement as the District Engineer may specify, and of any suspension of work, if for a period of more than one week, resumption of work and its completion.

o. That if the activity authorized herein is not completed on or before ________ day of ________, 19 ________, (*three years from the date of issuance of this permit unless otherwise specified*) this permit, if not previously revoked or specifically extended, shall automatically expire.

p. That this permit does not authorize or approve the construction of particular structures, the authorization or approval of which may require authorization by the Congress or other agencies of the Federal Government.

q. That if and when the permittee desires to abandon the activity authorized herein, unless such abandonment is part of a transfer procedure by which the permittee is transferring his interests herein to a third party pursuant to General Condition t hereof, he must restore the area to a condition satisfactory to the District Engineer.

r. That if the recording of this permit is possible under applicable State or local law, the permittee shall take such action as may be necessary to record this permit with the Register of Deeds or other appropriate official charged with the responsibility for maintaining records of title to and interests in real property.

s. That there shall be no unreasonable interference with navigation by the existence or use of the activity authorized herein.

t. That this permit may not be transferred to a third party without prior written notice to the District Engineer, either by the transferee's written agreement to comply with all terms and conditions of this permit or by the transferree subscribing to this permit in the space provided below and thereby agreeing to comply with all terms and conditions of this permit. In addition, if the permittee transfers the interests authorized herein by conveyance of realty, the deed shall reference this permit and the terms and conditions specified herein and this permit shall be recorded along with the deed with the Register of Deeds or other appropriate official.

u. That if the permittee during prosecution of the work authorized herein, encounters a previously unidentified archeological or other cultural resource within the area subject to Department of the Army jurisdiction that might be eligible for listing in the National Register of Historic Places, he shall immediately notify the district engineer.

II. **Special Conditions:** *(Here list conditions relating specifically to the proposed structure or work authorized by this permit)*:

a. No work under this permit may proceeed without an appropriate authorization to proceed from the Office of the Federal Inspector (OFI). This authorization would be incorporated within the Notice to Proceed (N.T.P.) Any plans submitted in applications for the N.T.P. under the December 1, 1980 Department of the Interior (Grant of Right-of-Way)[2] for the Alaska Natural Gas Transportation System (ANGTS) shall not be inconsistent with, or preclude compliance with, the criteria of this permit. These plans shall be distributed by the OFI to appropriate State and Federal agencies for their comments.

b. All activites conducted under the purview of this permit shall be done in accordance with the conditions outlined in the "OFI's List of Sensitive Wildlife Areas"[3] and "List of Fish Streams for the proposed gas pipeline corridor from Prudhoe Bay to the Canadian border."[4]

c. Protection restrictions for the endangered Peregrine Falcon apply as outlined in the List of Sensitive Wildlife Areas.

d. Unless clearly inapplicable to the activities to be performed under this permit, the stipulations for the Alaskan Leg from the December 1, 1980 Department of the Interior (DOI) Grant of Right-of-Way to the Alaska Northwest Gas Transportation Company are by reference incorporated as part of this permit. Should DOI relax or lift these stipulations they remain conditions of this permit unless otherwise specified.

e. A minimum distance of 500' shall be maintained between the toe of work pads and access roads and any adjacent lake or streambank. New gravel fills shall utilize nonwetland areas as much as possible, unless otherwise approved by the OFI.

f. Construction shall be conducted to minimize surface disturbance and siltation of wetlands and waterbodies.

g. Drainage structures shall be installed and maintained by the permittee, that are adequate to maintain natural surface drainage and fish passage. Appropriate measures shall be taken to avoid ponding of water upslope of gravel fills and dewatering of wetlands downslope. Design criteria for fish passage shall be approved by OFI.

h. All drainage structures shall be stabilized by the permittee, to minimize loss of gravel fill from water erosion.

The following Special Conditions will be applicable when appropriate:

STRUCTURES IN OR AFFECTING NAVIGABLE WATERS OF THE UNITED STATES:

a. That this permit does not authorize the interference with any existing or proposed Federal project and that the permittee shall not be entitled to compensation for damage or injury to the structures or work authorized herein which may be caused by or result from existing or future operations undertaken by the United States in the public interest.

b. That no attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the activity authorized by this permit.

c. That if the display of lights and signals on any structure or work authorized herein is not otherwise provided for by law, such lights and signals as may be prescribed by the United States Coast Guard shall be installed and maintained by and at the expense of the permittee.

d. That the permittee, upon receipt of a notice of revocation of this permit or upon its expiration before completion of the authorized structure or work, shall, without expense to the United States and in such time and manner as the Secretary of the Army or his authorized representative may direct, restore the waterway to its former conditions. If the permittee fails to comply with the direction of the Secretary of the Army or his authorized representative, the Secretary or his designee may restore the waterway to its former condition, by contract or otherwise, and recover the cost thereof from the permittee.

e. Structures for Small Boats: That permittee hereby recognizes the possibility that the structure permitted herein may be subject to damage by wave wash from passing vessels. The issuance of this permit does not relieve the permittee from taking all proper steps to insure the integrity of the structure permitted herein and the safety of boats moored thereto from damage by wave wash and the permittee shall not hold the United States liable for any such damage.

MAINTENANCE DREDGING:

a. That when the work authorized herein includes periodic maintenance dredging, it may be performed under this permit for ______________ years from the date of issuance of this permit (*ten years unless otherwise indicated*);

b. That the permittee will advise the District Engineer in writing at least two weeks before he intends to undertake any maintenance dredging.

DISCHARGES OF DREDGED OR FILL MATERIAL INTO WATERS OF THE UNITED STATES:

a. That the discharge will be carried out in conformity with the goals and objectives of the EPA Guidelines established pursuant to Section 404(b) of the Clean Water Act and published in 40 CFR 230;

b. That the discharge will consist of suitable material free from toxic pollutants in toxic amounts.

c. That the fill created by the discharge will be properly maintained to prevent erosion and other non-point sources of pollution.

DISPOSAL OF DREDGED MATERIAL INTO OCEAN WATERS:

a. That the disposal will be carried out in conformity with the goals, objectives, and requirements of the EPA criteria established pursuant to Section 102 of the Marine Protection, Research and Sanctuaries Act of 1972, published in 40 CFR 220-228.

b. That the permittee shall place a copy of this permit in a conspicuous place in the vessel to be used for the transportation and/or disposal of the dredged material as authorized herein.

This permit shall become effective on the date of the District Engineer's signature.

Permittee hereby accepts and agrees to comply with the terms and conditions of this permit.

Harold W Males — Jan 4th 1984

VICE PRES. PERMITTEE NWA P/L Co — DATE

BY AUTHORITY OF THE SECRETARY OF THE ARMY:

______________________ — ______________________

David B. Barrows — DATE

~~DISTRICT ENGINEER~~ Chief, Regulatory Functions Branch

FOR: U.S. ARMY, CORPS OF ENGINEERS Colonel Neil E. Saling

Transferee hereby agrees to comply with the terms and conditions of this permit.

______________________ — ______________________

TRANSFEREE — DATE

U.S. GOVERNMENT PRINTING OFFICE : 1983 O - 401-534

imported for backfill of the pipe trench only in Category "C" wetlands as defined by Markon (1980)[1] including: wet tundra, tall and low shrub riparian, mix shrub wetland, sedge-grass tundra, tussock tundra, forested wetland and moss bog.

The permit will authorize the construction of pipeline work pads with a maximum top width of 60' and side slopes of approximately 2:1. The work pads will parallel the centerline of the pipeline. The access roads will have a maximum top width of 42' and side slopes of approximately 2:1. Existing gravel pads and roads shall be used to the maximum extent practicable. It is estimated that construction of these pads and roads shall not require more than 15 million cubic yards (cy) of material in waters of the United States.

Work pads and access roads shall be designed to provide structural stability for the intended purpose and to minimize thermal degradation. Appropriate measures shall be taken to minimize longitudinal erosion along work pads and access road fills.

i. Crossing-drainage structures shall be installed and maintained by the permittee, that provide for natural surface drainage. Temporary structures shall be designed, at a minimum, to accomodate a Q_5 discharge. Permanent drainage structures shall be designed for a Q_{50} or greater discharge.

j. The width of gravel fills at small stream crossings shall be minimized and designed in accordance with OFI apporoval criteria.

k. To the maximum extent possible, placement of gravel fill across flowing water and watercourses shall be perpendicular to normal flow direction.

l. Measures shall be taken to avoid removal of the vegetative mat, particularly in thaw-unstable areas.

m. Slash and debris resulting from clearing operations associated with work pads and/or access roads construction shall be disposed of as approved by OFI.

n. Work pads and access roads shall be sloped and maintained to allow runoff. Material bladed from work pads and access roads and surfaces shall not be deposited in streams, lakes, wetlands or left in berms along the driving surfaces.

o. Equipment shall operate only on gravel work pads within the approved working limits unless otherwise approved by the OFI.

p. Site-specific plans addressing the stabilization/restoration of the disturbed wetland areas and streams shall be submitted to the OFI for approval at the time of the work plan submission.

q. As-built drawings of constructed work pads, access roads, and drainage structures through wetlands and streams will be provided to the OFI within one year after commissioning the gas pipeline and initial gas flow.

r. Discharges of dredged or fill material shall not restrict or impede the movement of those aquatic species indigenous to the waterbodies or the passage of normal or expected high flows or cause the relocation of the waters.

s. The fill created by the discharge shall be properly maintained to prevent erosion and other non-point sources of pollution.

t. Appropriate measures shall be taken to minimize the movement/loss of temporarily stored excavated ditch material and imported backfill material resulting from hydraulic or thermal erosion.

u. Construction activities shall be conducted in such a manner that siltation/sedimentation of adjacent wetlands and waterbodies is minimized in compliance with applicable Federal and State statutes, regulations, and permits.

v. Temporarily stored excavated ditch material or imported material shall not be deposited in flowing water, unless otherwise approved by the OFI.

w. Excavated ditch material which does not have the potential to flow when thawed and/or imported backfill material may be stored temporarily on wetlands, within approved working limits, from October 15 through March 31.

x. Excavated ditch material which does not have the potential to flow when thawed and/or imported backfill material may be stored temporarily on wetlands, within approved working limits, from April 1 through October 14 but must be removed expeditiously in accordance with OFI approved plans.

y. Frozen excavated ditch material which has the potential to flow when thawed may be temporarily stored within approved work limits during the colder months, generally October 15 to April 1 south of the Brooks Range and October 15 to April 15 in and north of the Brooks Range. Should melting occur and detrimental movement of silt laden melt water take place during unusual mild weather, the material shall be removed expeditiously in accordance with OFI approved plans.

z. Excavated ditch material which has a moisture content exceeding the liquid limits shall be immediately removed to an approved spoil disposal site or temporarily stored on site in accordance with a plan approved by OFI.

aa. Stockpiling of excavated ditch material or imported backfill in floodplains may be done only upon approval of OFI.

bb. Temporary storage of excavated ditch material and/or imported material for backfill may occur on ice (ie., in frozen river channels) but shall require site-specific approval by the OFI and shall be removed before ice breakup.

References

Footnotes

1) Carl J. Markon, 1980; Terrestial and Aquatic Habitat Mapping Along the Alaska Natural Gas Pipeline System; U.S. Fish nd Wildlife Service Special Study Report, December 1980, 67pp.

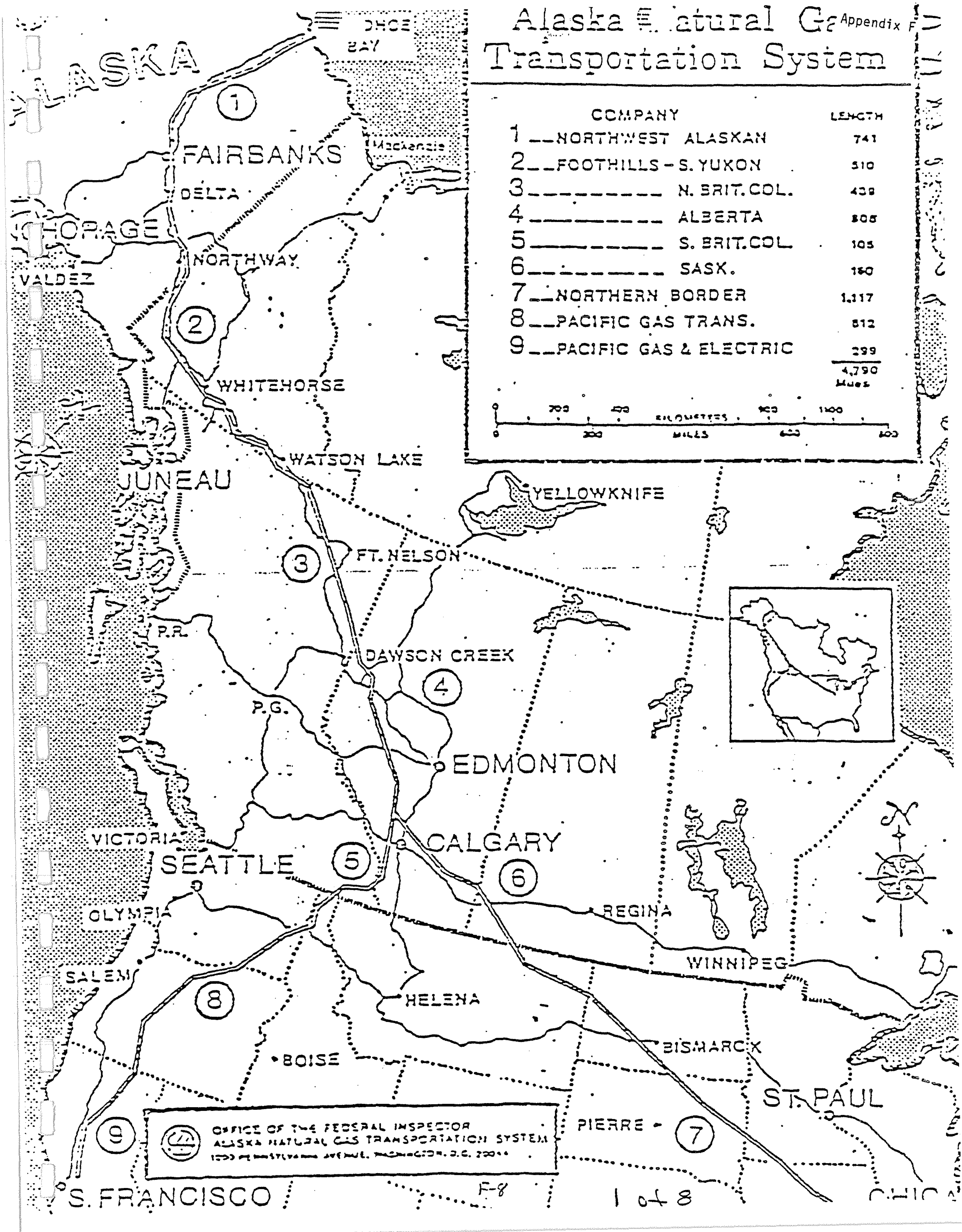
2) U.S. Department of the Interior, Grant of Right-of-Way for the Alaska Northwest Gas Transportation System, Alaska Segment, Serial No. F-24538, 1 December 1980.

3) List of Sensitive Wildlife Areas between Prudhoe Bay and the Canadian Border along the proposed Northwest Alaskan Pipeline Company Gas Pipeline Route; 25 November 1981.

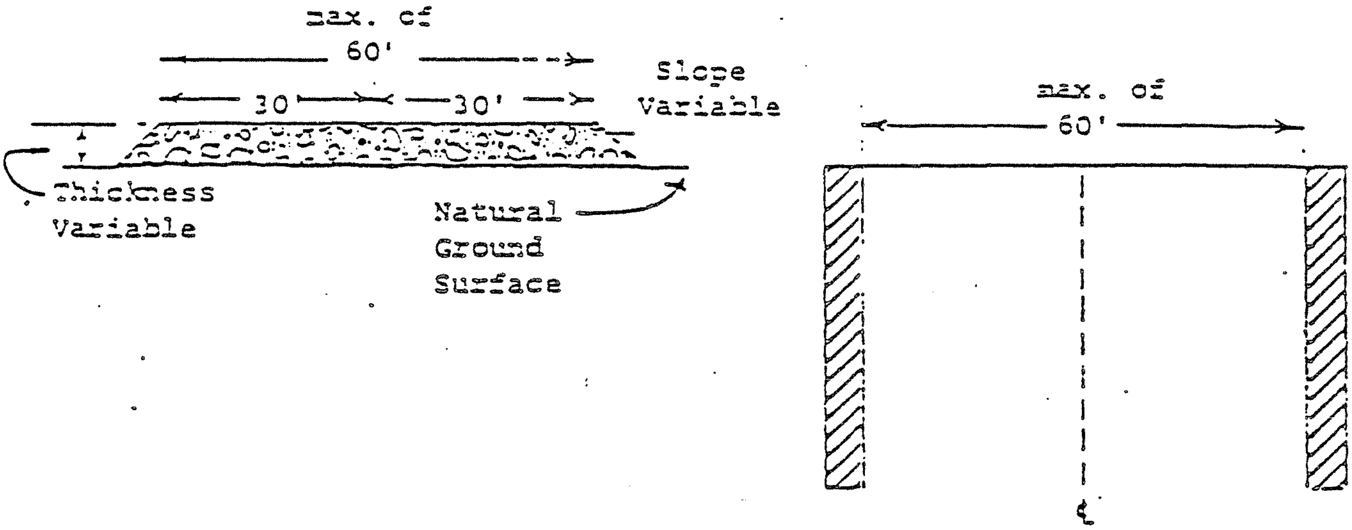
4) List of Fish Streams between Prudhoe Bay and the Canadian border along the proposed Northwest Alaskan Pipeline Company Gas Pipeline Route; 30 November 1981.

Alaska Natural Gas Transportation System

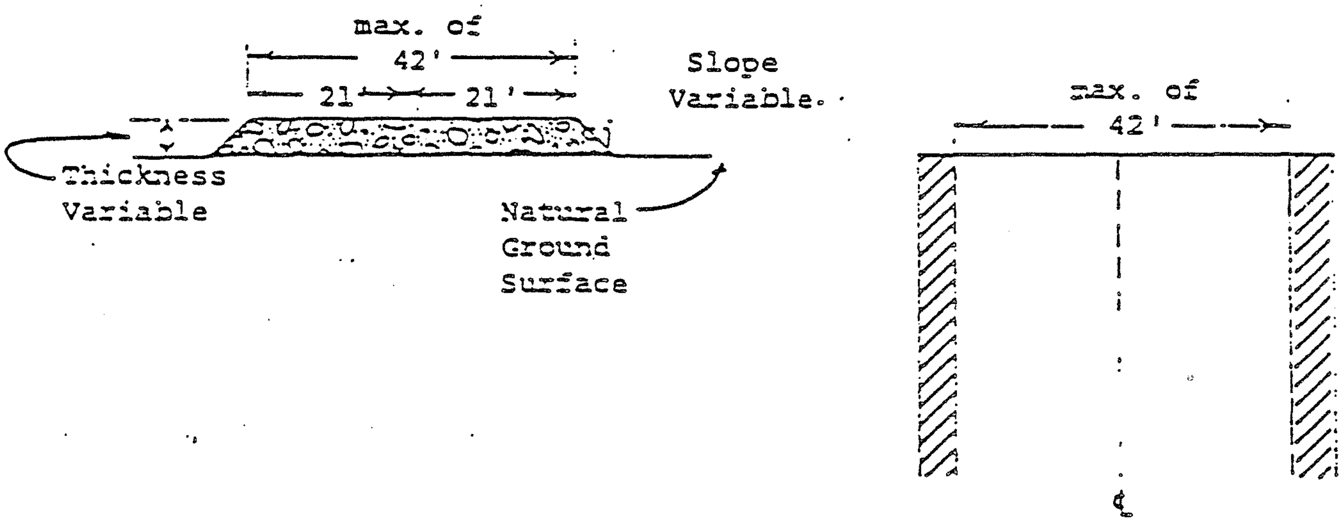
COMPANY		LENGTH
1 — NORTHWEST ALASKAN		741
2 — FOOTHILLS -	S. YUKON	510
3 —	N. BRIT. COL.	438
4 —	ALBERTA	808
5 —	S. BRIT. COL.	105
6 —	SASK.	160
7 — NORTHERN BORDER		1,117
8 — PACIFIC GAS TRANS.		812
9 — PACIFIC GAS & ELECTRIC		299
		4,790 Miles



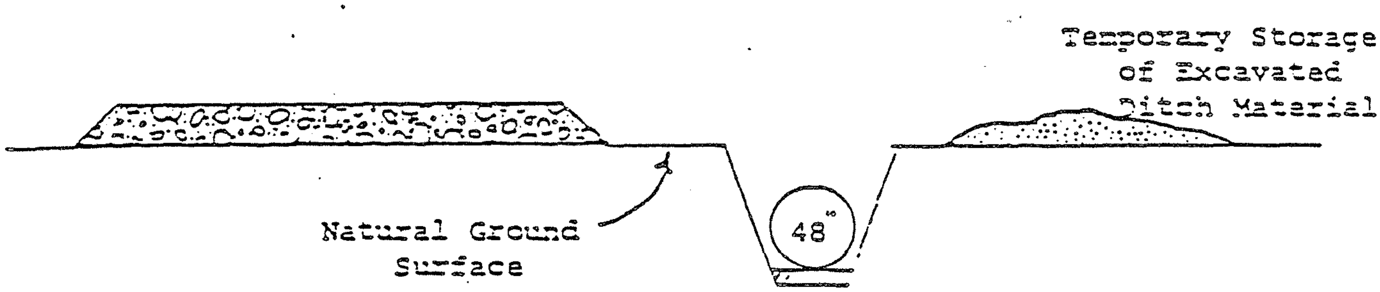
TYPICAL WORKPAD



TYPICAL ACCESS ROAD



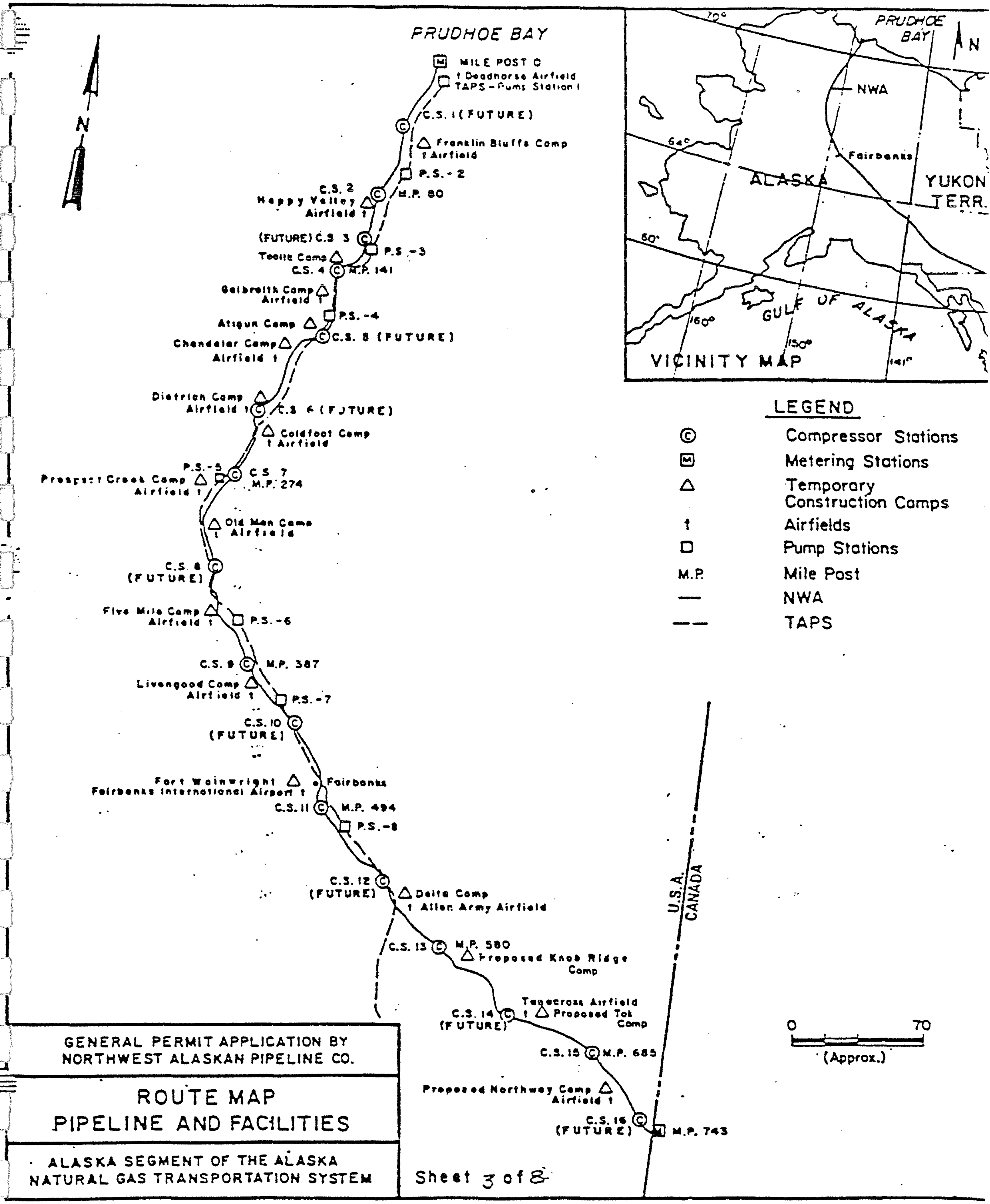
TYPICAL CONSTRUCTION ZONE

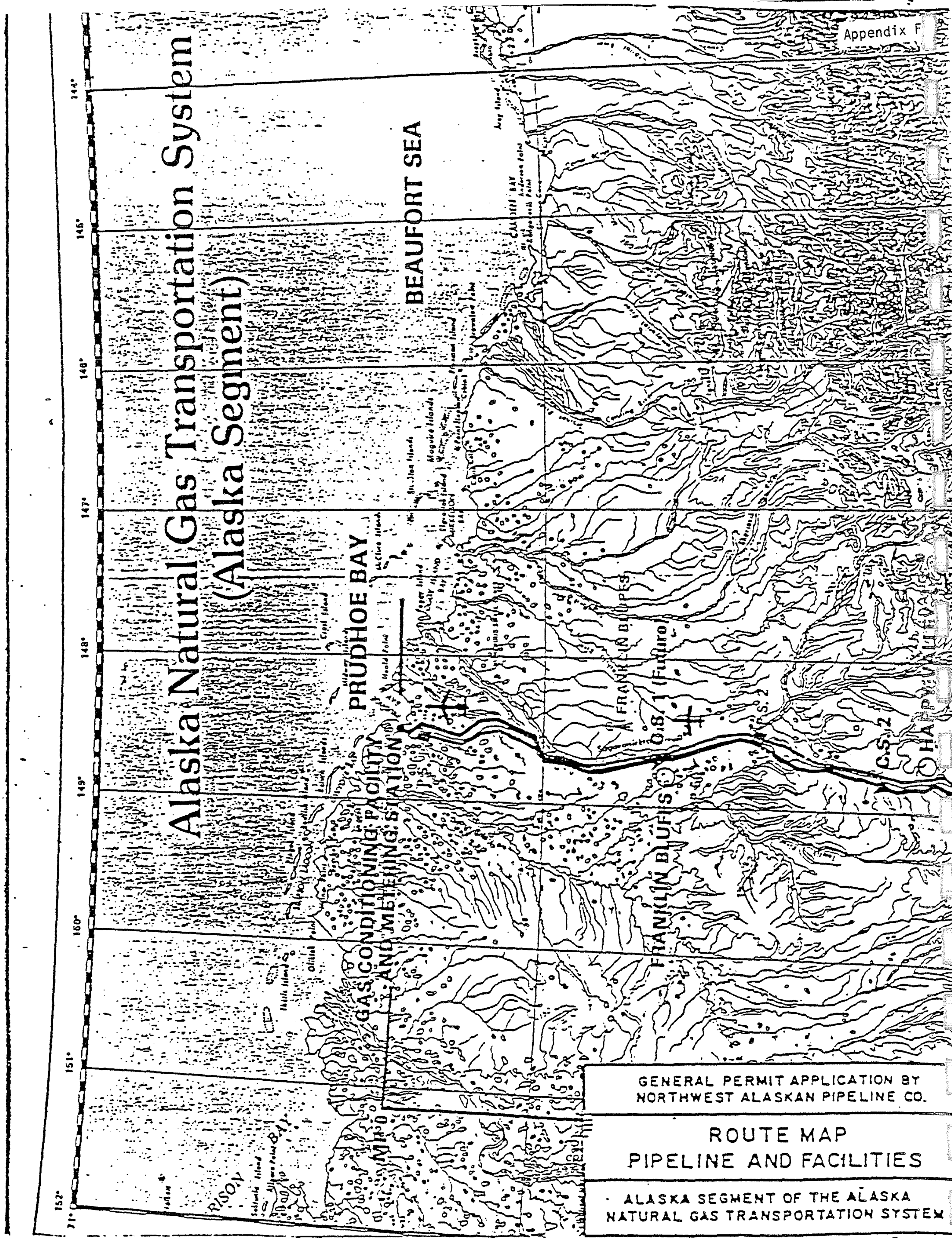


ALASKA NATURAL GAS TRANSPORTATION SYSTEM

2 of 8

Drawings not to scale.


PRUDHOE BAY
N
MILE POST 0
Deadhorse Airfield
TAPS - Pump Station 1
C.S. 1 (FUTURE)
Franklin Bluffs Camp
Airfield
P.S. - 2
C.S. 2
Happy Valley
Airfield
M.P. 80
(FUTURE) C.S 3
P.S. -3
Toolik Camp
C.S. 4
M.P. 141
Galbraith Camp
Airfield
P.S. -4
Atigun Camp
Chandalar Camp
Airfield
C.S. 5 (FUTURE)
Dietrich Camp
Airfield
C.S. 6 (FUTURE)
Coldfoot Camp
Airfield
P.S. -5
Prospect Creek Camp
Airfield
C.S. 7
M.P. 274
Old Man Camp
Airfield
C.S. 8
(FUTURE)
Five Mile Camp
Airfield
P.S. -6
C.S. 9
M.P. 387
Livengood Camp
Airfield
P.S. -7
C.S. 10
(FUTURE)
Fort Wainwright
Fairbanks
Fairbanks International Airport
C.S. 11
M.P. 494
P.S. -8
C.S. 12
(FUTURE)
Delta Camp
Allen Army Airfield
C.S. 13
M.P. 580
Proposed Knob Ridge Comp
Tanacross Airfield
Proposed Tok Comp
C.S. 14
(FUTURE)
C.S. 15
M.P. 685
Proposed Northway Camp
Airfield
C.S. 16
(FUTURE)
M.P. 743
U.S.A.
CANADA
70°
PRUDHOE BAY
NWA
64°
Fairbanks
ALASKA
YUKON TERR.
60°
GULF OF ALASKA
160°
150°
141°
VICINITY MAP
LEGEND
Compressor Stations
Metering Stations
Temporary Construction Camps
Airfields
Pump Stations
M.P. Mile Post
NWA
TAPS
0
70
(Approx.)
GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.
ROUTE MAP
PIPELINE AND FACILITIES
ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM
Sheet 3 of 8

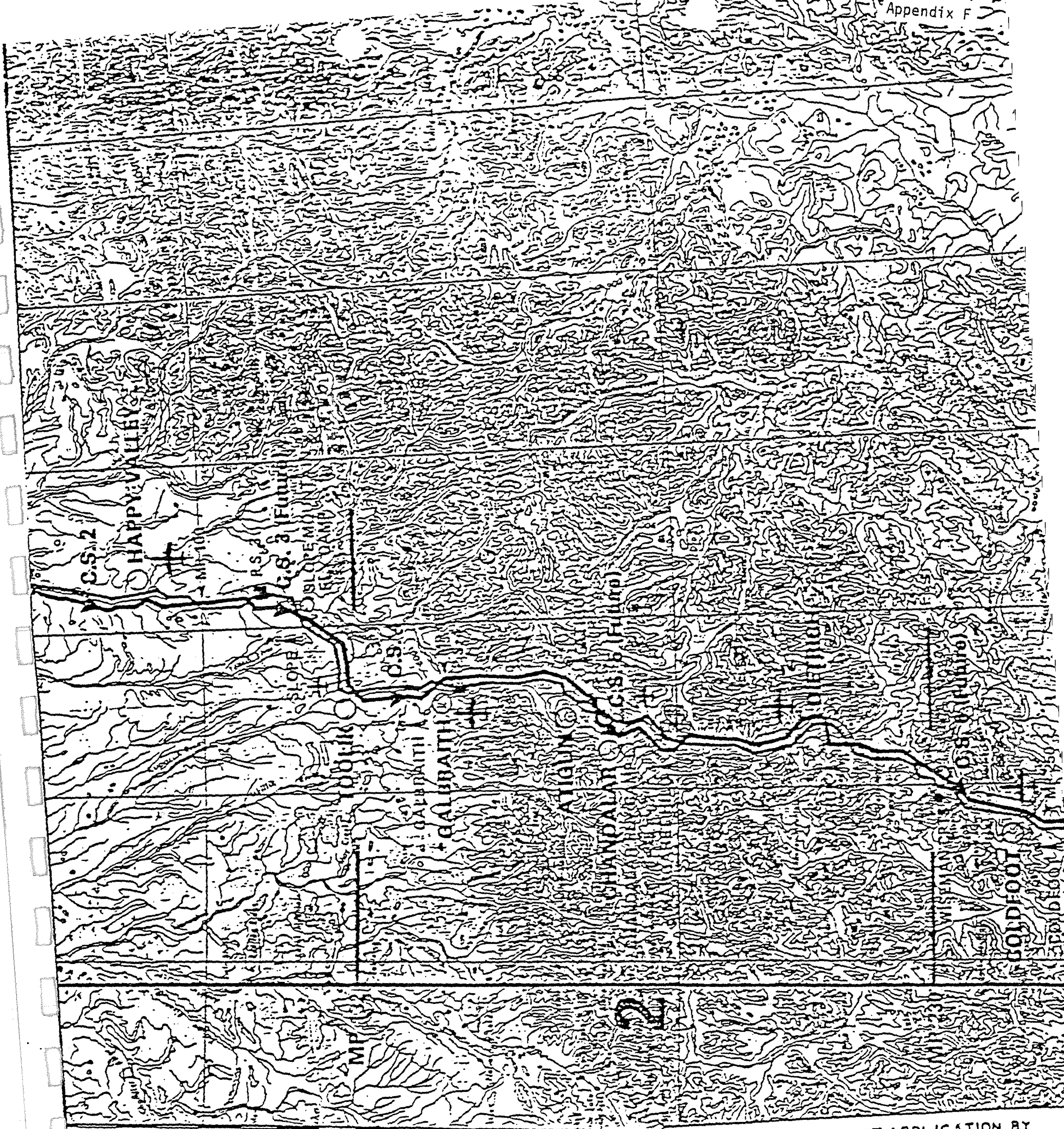


GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.

ROUTE MAP
PIPELINE AND FACILITIES

ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM

SHEET 4 OF 8

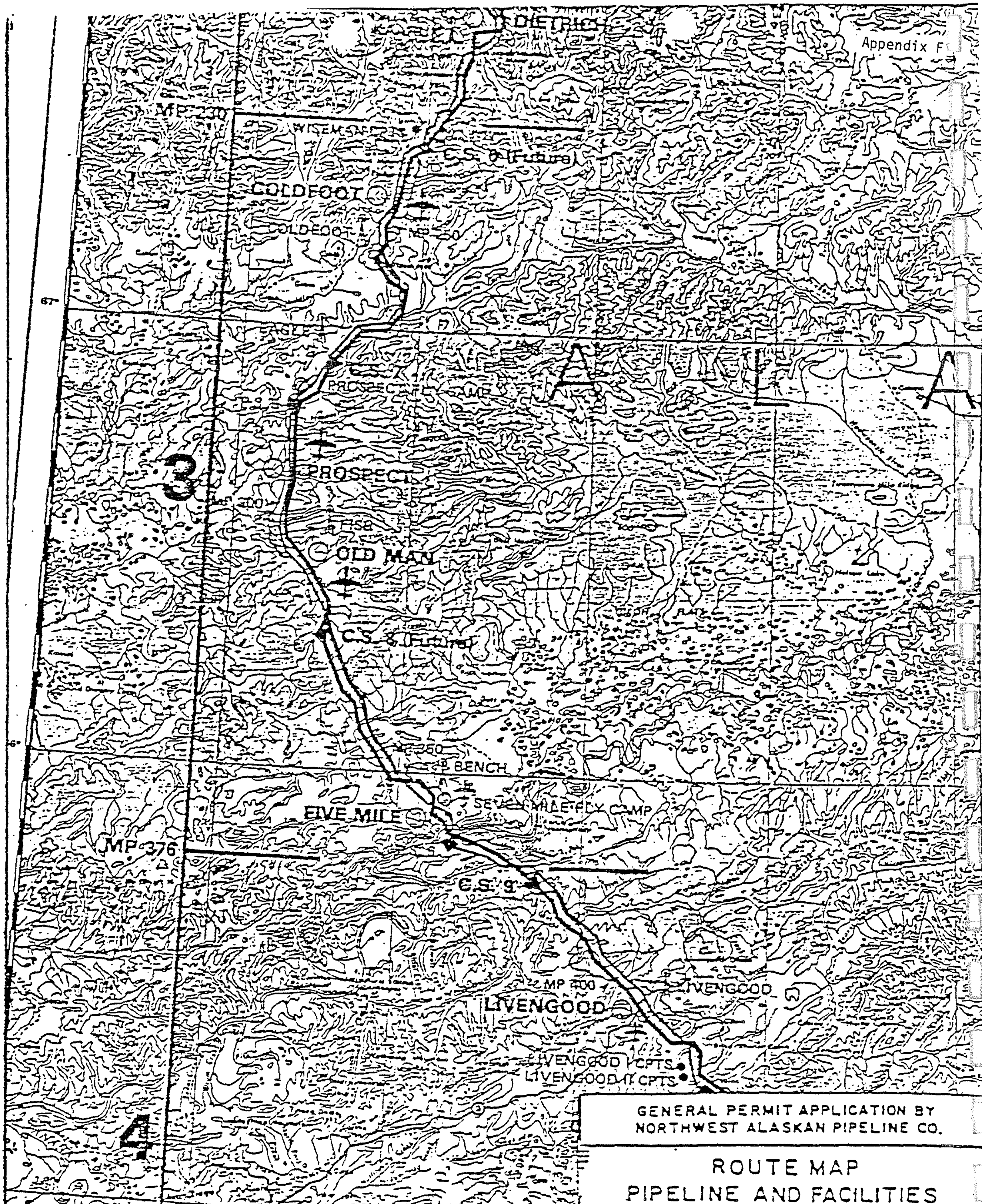


GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.

ROUTE MAP
PIPELINE AND FACILITIES

ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM

SHEET 5 OF 8

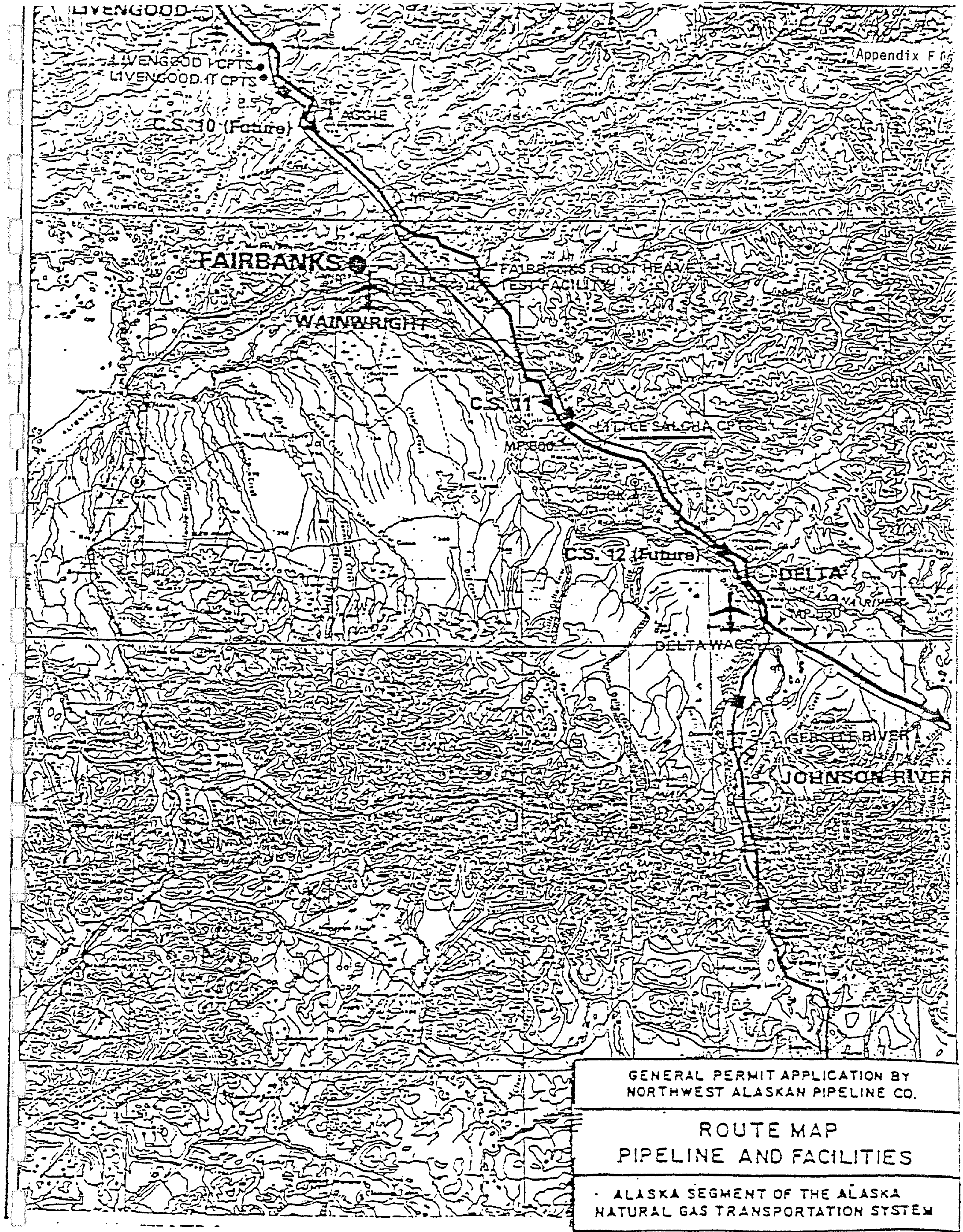


GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.

ROUTE MAP
PIPELINE AND FACILITIES

ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM

SHEET 6 OF 8

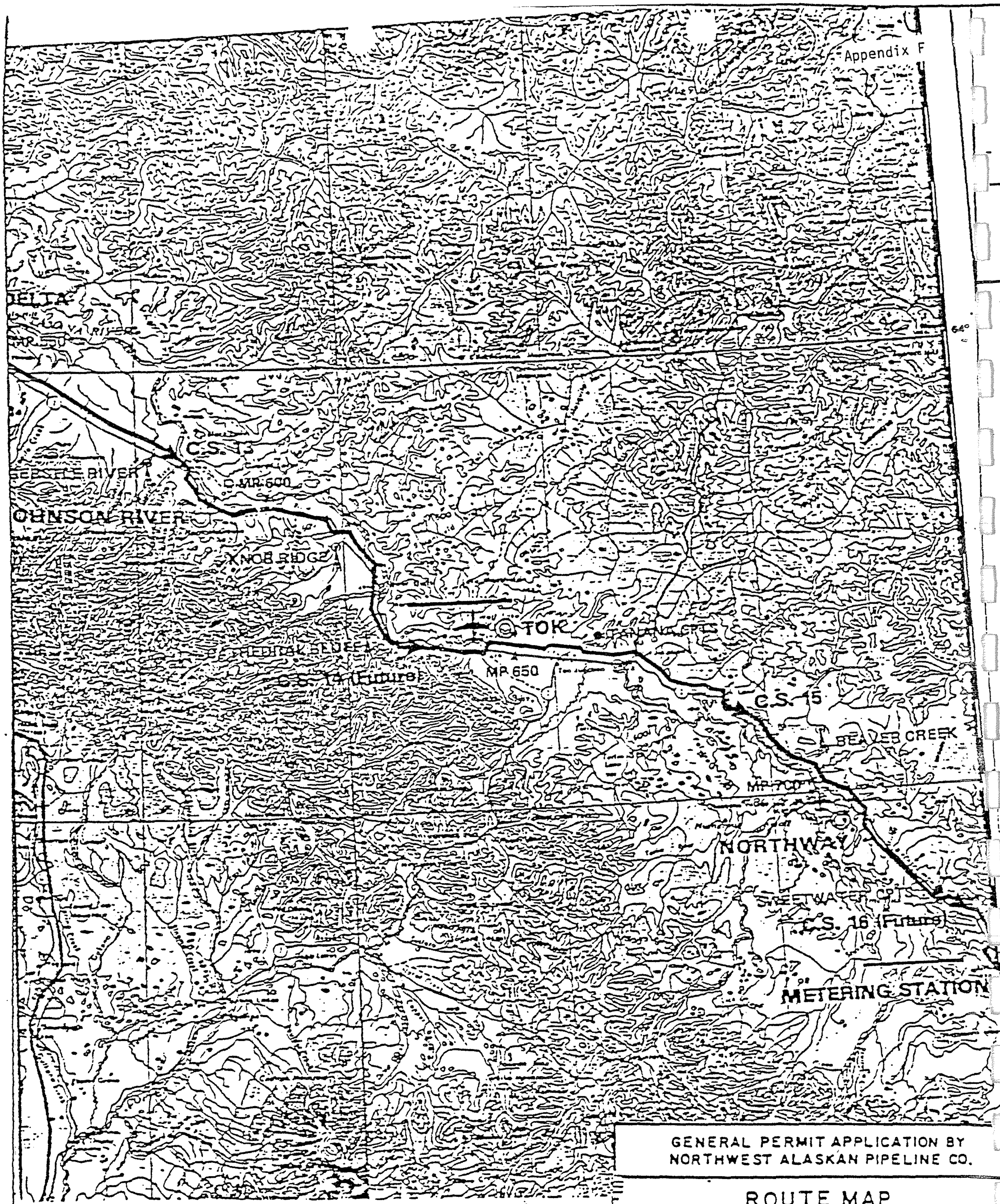


GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.

ROUTE MAP
PIPELINE AND FACILITIES

ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM

SHEET 7 OF 8



GENERAL PERMIT APPLICATION BY
NORTHWEST ALASKAN PIPELINE CO.

ROUTE MAP
PIPELINE AND FACILITIES

ALASKA SEGMENT OF THE ALASKA
NATURAL GAS TRANSPORTATION SYSTEM

SHEET 8 OF 8

STATE OF ALASKA

DEPARTMENT OF ENVIRONMENTAL CONSERVATION

CERTIFICATE OF REASONABLE ASSURANCE

A Certificate of Reasonable Assurance, as required by Section 401 of the Clean Water Act, has been requested by Nothwest Alaskan Pipeline Company, 1001 Noble Street, Suite 300, Fairbanks, Alaska 99701 for placement of uncontaminated clean gravel fill for workpads and access roads associated with the permanent structures of the Alaska Natural Gas Transportation System (ANGTS). This would include workpads for the placement of the ANGTS line, pads for compressor stations, metering station, erosion protection structures, access roads, temporary culvert crossing, low water crossing, and permanent stream crossings. Work also included in this notice is for temporary storage of ditch spills and materials imported for backfill of the pipe trench only in Category "C" wetlands as defined by Markon (1980) including: wet tundra, tall and low shrub riparian, mix shrub wetland, sedge-grass tundra, tussock tundra, forested wetland and moss bog.

The proposed activity is located from Prudhoe Bay to the Alaska/Canada border as shown on the Civil Alignment sheets 1-131 and plans dated June 1982 included with the public notice.

Public Notice of the application for this certification has been made in accordance with 18 AAC 15.180.

Water Quality Certification is required for the proposed activity because the activity will be authorized by a Department of the Army permit identified as Sag River 120, NPACO 071-OYD-2-830282 and a discharge may result from the proposed activity.

Having reviewed the application and comments received in response to the public notice, the Alaska Department of Environmental Conservation ~~certifies~~ certifies that there is reasonable assurance that the proposed activity, as well as any discharge which may result, is in compliance with the requirements of Section 401 of the Clean Water Act which includes the Alaska Water Quality Standards, 18 AAC 70, and the Standards of the Alaska Coastal Management Program, 6 AAC 80.

September 30, 1983
Date:

Douglas L. Lowery
Douglas L. Lowery
Regional Environmental Supervisor

STATE OF ALASKA

BILL SHEFFIELD, GOVERNOR

Appendix F

OFFICE OF THE GOVERNOR

POUCH AW
JUNEAU, ALASKA 99811
PHONE: (907) 465-3568

OFFICE OF MANAGEMENT AND BUDGET

DIVISION OF GOVERNMENTAL COORDINATION

October 26, 1983

Mr. Harold Moles
Northwest Alaskan
Pipeline Company
1001 Noble Street,
Suite 300
Fairbanks, AK 99701

Dear Mr. Moles:

SUBJECT: SAGAVANIRKTOK RIVER 120 (REVISED)
STATE I.D. NO. AK830708-17
COE NO. 071-OYD-2-830282

The Division of Governmental Coordination has completed review of your consistency certification and supporting information for the above proposal pursuant to Section 307(c)(3)(A) of the Federal Coastal Zone Management Act as per 15 CFR 930, Subpart D.

The proposal is to place uncontaminated clean gravel fill for workpads and access roads associated with the permanent structures of the Alaska Natural Gas Transportation System (ANGTS). This would include workpads for the placements of the ANGTS line, pads for compressor stations, metering station, erosion protection structures, access roads, culvert crossings, low water crossings, and permanent stream crossings. Work also included in this notice is for temporary storage of ditch spoils and materials imported for backfill of the pipe trench only in Category "C" wetlands as defined by Markon (1980) including: wet tundra, tall and low shrub riparian, mix shrub wetland, sedge-grass tundra, tussock tundra, forested wetland and moss bog.

The original Corps of Engineers Public Notice has been revised (reference letter, Barrows to Grundy, October 19, 1983). In addition, the word "temporary" has been deleted from the phrase "temporary culvert crossings," in the first paragraph under "WORK."

As currently planned, we concur that the project is consistent with the Standards of the Alaska Coastal Management Program (ACMP).

01 A35LH

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If changes to the original proposal are made during its implementation, you are required to contact this office to determine if a review of the revision is necessary.

By a copy of this letter, we are informing the U.S. Army Corps of Engineers that your project as proposed is consistent with the ACMP. If you have any questions please contact me or at 465-3562.

Thank you for your cooperation with the Alaska Coastal Management Program.

Sincerely,

Jay H. Hogan
Associate Director

lr/979

cc: Don Rice, COE, Anchorage

ESTIMATED QUANTITIES OF HAZARDOUS SUBSTANCES STORED, HANDLED OR CONSUMED FOR THE PROPOSED TAGS PROJECT DURING OPERATIONS

Hazardous substances to be stored, handled, and consumed at the TAGS LNG plant/marine terminal site include the following significant quantities:

Description	Monthly Consumption	Storage	Remarks
Ethylene	55,440 lbs	1,200,000 lbs	6,000 bbl refrigerated storage sphere.
Propane	484,440 lbs	4,532,000 lbs	4 high pressure 16,230 ft^3 bullets.
Nitrogen	684,000 SCF	5,121,050 SCF	55,000 gal liquid nitrogen tank.
Gas Turbine/ Compressor Oil	nil	150 bbl	Stored in 55 gal drums.
Seal Oil	25 bbl	50 bbl	Stored in 55 gal drums.
Glycol	2 bbl	80 bbl	Stored in 55 gal drums.
Chlorine	350 lbs	2,000 lbs	Stored in 2000 lbs cylinders.
Halon (or other inert gas)	0	3,000 lbs	Stored in 300 lbs cylinders. (One system replacement)
Methanol	0	10 bbl	Stored in 55 gallon drums.
Diesel	1,845 bbl	40,000 bbl	Two 20,000 barrel tanks.
Molecular Sieve	0	10,000 lbs	Stored in barrels. (One trap replacement)
Activated Carbon	0	10,000 lbs	Stored in barrels. (One trap replacement)

Other hazardous materials to be stored, handled, and used at TAGS permanent facility locations include various cleansers, oils, lubricants, electrical materials, corrosion inhibitors, acids, paints, pesticides, solvents, glycols, water treatment chemicals and reproduction equipment chemicals.

Hazardous substances to be stored, handled, and consumed at the TAGS compressor station sites include the following in significant quantities:

Hazardous Substance Description	Monthly Consumption	Storage	Remarks
Nitrogen	3,750 SCF	7,500 SCF	250 standard cubic foot (SCF) bottles at 2200 psig, 6 bottles/station
Gas Turbine/ Compressor Oil	0	1,200 gal	Synthetic Oil
Seal Oil	550 gal	5,500 gal	Stored in 55 gallon drums
Halon (or other inertgas)	0	3,000 lbs	Stored in 300 lb. cylinders
Glycol	20	2,200 gal	Stored in 55 gal drums
Freon (or other refrigerant gas)	0	10,000 lbs	Stored in one ton containers. Make-up storage of 2%
Diesel	11,500 gal	200,000 gal	40,000 gal tank at station
Gasoline	3,000 gal	25,000 gal	5,000 gal tank at station

The Fairbanks Maintenance Faciltity will maintain storage of the following refrigerants and chemicals:

Lube Oil	8,600 gal	(two reservoir replacements)
Seal Oil	1,200 gal	
Halon	8,800 lbs	(one total system replacement)
Freon	18,000 lbs	(5% volume/year)

H-1

PART 193—LIQUEFIED NATURAL GAS FACILITIES: FEDERAL SAFETY STANDARDS

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193.2005 Applicability.
193.2007 Definitions.
193.2009 Rules of regulatory construction.
193.2011 Reporting.
193.2013 Incorporation by reference.
193.2015 Petition for finding or approval.
193.2017 Plans and procedures.

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193.2059 Flammable vapor-gas dispersion protection.
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193.2063 Flooding.
193.2065 Soil characteristics.
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193.2069 Other severe weather and natural conditions.
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Appendix H

AUTHORITY: 49 U.S.C. 1671 et. seq.; 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: 45 FR 9203, Feb. 11, 1980, unless otherwise noted.

Subpart A—General

§ 193.2001 Scope of part.

(a) This part prescribes safety standards for LNG facilities used in the transportation of gas by pipeline that is subject to the Natural Gas Pipeline Safety Act of 1968 and Part 192 of this chapter.

(b) This part does not apply to:

(1) LNG facilities used by ultimate consumers of LNG or natural gas.

(2) LNG facilities used in the course of natural gas treatment or hydrocarbon extraction which do not store LNG.

(3) In the case of a marine cargo transfer system and associated facilities, any matter other than siting pertaining to the system or facilities between the marine vessel and the last manifold (or in the absence of a manifold, the last valve) located immediately before a storage tank.

(4) Any LNG facility located in navigable waters (as defined in Section 3(8) of the Federal Power Act (16 U.S.C. 796(8)).

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57418, Aug. 28, 1980]

§ 193.2003 Semisolid facilities.

An LNG facility used in the transportation or storage of LNG in a semisolid state need not comply with any requirement of this part which the Director finds impractical or unnecessary because of the semisolid state of LNG. In making such a finding, the Director may impose appropriate alternative safety conditions.

§ 193.2005 Applicability.

(a) New or amended standards in this part governing the siting, design,

installation, or construction of an LNG facility and related personnel qualifications and training do not apply to:

(1) LNG facilities under construction before the date such standards are published; or

(2) LNG facilities for which an application for approval of the siting, construction, or operation was filed before March 1, 1978, with the Department of Energy (or any predecessor organization of that Department) or the appropriate State or local agency in the case of any facility not subject to the jurisdiction of the Department of Energy under the Natural Gas Act (not including any facility the construction of which began after November 29, 1979, not pursuant to such an approval).

(b) If an LNG facility listed in paragraph (a) of this section is replaced, relocated, or significantly altered after February 11, 1980, the replacement, relocated facility, or significantly altered facility must comply with the applicable requirements of this part governing siting, design, installation, and construction, except that:

(1) The siting requirements apply only to LNG storage tanks that are significantly altered by increasing the original storage capacity or relocated, not pursuant to an application for approval filed as provided by paragraph (a)(2) of this section before March 1, 1978; and

(2) To the extent compliance with the design, installation, and construction requirements would make the replaced, relocated, or altered facility incompatible with other facilities or would otherwise be impracticable, the replaced, relocated, or significantly altered facility may be designed, installed, or constructed in accordance with the original specifications for the facility, or in a manner that the Director finds acceptable.

(c) The siting, design, installation, and construction of an LNG facility under construction before February 11, 1980, or that is listed in paragraph (a)(2) of this section (except a facility under construction before July 1, 1976) must meet the applicable requirements of NFPA 59A (1972 edition) and Part 192 of this chapter or the applicable requirements of this part, except that no Part 192 standard issued after March 1, 1978, applies to an LNG facility listed in paragraph (a)(2) of this section.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57418, Aug. 28, 1980; Amdt. 193-2, 45 FR 70404, Oct. 23, 1980]

§ 193.2007 Definitions.

As used in this part:

"Ambient vaporizer" means a vaporizer which derives heat from naturally occurring heat sources, such as the atmosphere, sea water, surface waters, or geothermal waters.

"Cargo transfer system" means a component, or system of components functioning as a unit, used exclusively for transferring hazardous fluids in bulk between a tank car, tank truck, or marine vessel and a storage tank.

"Component" means any part, or system of parts functioning as a unit, including, but not limited to, piping, processing equipment, containers, control devices, impounding systems, lighting, security devices, fire control equipment, and communication equipment, whose integrity or reliability is necessary to maintain safety in controlling, processing, or containing a hazardous fluid.

"Container" means a component other than piping that contains a hazardous fluid.

"Control system" means a component, or system of components functioning as a unit, including control valves and sensing, warning, relief, shutdown, and other control devices, which is activated either manually or automatically to establish or maintain the performance of another component.

"Controllable emergency" means an emergency where reasonable and prudent action can prevent harm to people or property.

"Design pressure" means the pressure used in the design of components for the purpose of determining the minimum permissible thickness or physical characteristics of its various parts. When applicable, static head shall be included in the design pressure to determine the thickness of any specific part.

"Determine" means make an appropriate investigation using scientific methods, reach a decision based on sound engineering judgment, and be able to demonstrate the basis of the decision.

"Dike" means the perimeter of an impounding space forming a barrier to prevent liquid from flowing in an unintended direction.

"Director" means Director of the Materials Transportation Bureau or any person to whom authority in the matter concerned has been delegated.

"Emergency" means a deviation from normal operation, a structural failure, or severe environmental conditions that probably would cause harm to people or property.

"Exclusion zone" means an area surrounding an LNG facility in which an operator or government agency legally controls all activities in accordance with § 193.2057 and § 193.2059 for as long as the facility is in operation.

"Fail-safe" means a design feature which will maintain or result in a safe condition in the event of malfunction or failure of a power supply, component, or control device.

"g" means the standard acceleration of gravity of 9.806 metre per second^2 (32.17 feet per second^2).

"Gas," except when designated as inert, means natural gas, other flammable gas, or gas which is toxic or corrosive.

"Hazardous fluid" means gas or hazardous liquid.

"Hazardous liquid" means LNG or a liquid that is flammable or toxic.

"Heated vaporizer" means a vaporizer which derives heat from other than naturally occurring heat sources.

"Impounding space" means a volume of space formed by dikes and floors which is designed to confine a spill of hazardous liquid.

"Impounding system" includes an impounding space, including dikes and floors for conducting the flow of spilled hazardous liquids to an impounding space.

"Liquefied natural gas" or "LNG" means natural gas or synthetic gas having methane (CH_4) as its major constituent which has been changed to a liquid or semisolid.

"LNG facility" means a pipeline facility that is used for liquefying or solidifying natural gas or synthetic gas or transferring, storing, or vaporizing liquefied natural gas.

"LNG plant" means an LNG facility or system of LNG facilities functioning as a unit.

"m^3" means a volumetric unit which is one cubic metre, 6.2898 barrels, 35.3147 ft.^{3}, or 264.1720 U.S. gallons, each volume being considered as equal to the other.

"Maximum allowable working pressure" means the maximum gage pressure permissible at the top of the equipment, containers or pressure vessels while operating at design temperature.

"Normal operation" means functioning within ranges of pressure, temperature, flow, or other operating criteria required by this part.

"Operator" means a person who owns or operates an LNG facility.

"Person" means any individual, firm, joint venture, partnership, corporation, association, state, municipality, cooperative association, or joint stock association and includes any trustee, receiver, assignee, or personal representative thereof.

"Pipeline facility" means new and existing piping, rights-of-way, and any equipment, facility, or building used in the transportation of gas or in the treatment of gas during the course of transportation.

"Piping" means pipe, tubing, hoses, fittings, valves, pumps, connections, safety devices or related components for containing the flow of hazardous fluids.

"Storage tank" means a container for storing a hazardous fluid, including an underground cavern.

"Transfer piping" means a system of permanent and temporary piping used for transferring hazardous fluids between any of the following: Liquefaction process facilities, storage tanks, vaporizers, compressors, cargo transfer systems, and facilities other than pipeline facilities.

"Transfer system" includes transfer piping and cargo transfer system.

"Vaporization" means an addition of thermal energy changing a liquid or semisolid to a vapor or gaseous state.

"Vaporizer" means a heat transfer facility designed to introduce thermal energy in a controlled manner for changing a liquid or semisolid to a vapor or gaseous state.

"Waterfront LNG plant" means an LNG plant with docks, wharves, piers, or other structures in, on, or immediately adjacent to the navigable waters of the United States or Puerto Rico and any shore area immediately adjacent to those waters to which vessels may be secured and at which LNG cargo operations may be conducted.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57418, Aug. 28, 1980; Amdt. 193-2, 45 FR 70404, Oct. 23, 1980]

§ 193.2009 Rules of regulatory construction.

(a) As used in this part:

(1) "Includes" means including but not limited to;

(2) "May" means is permitted to or is authorized to;

(3) "May not" means is not permitted to or is not authorized to; and

(4) "Shall" or "must" is used in the mandatory and imperative sense.

(b) In this part:

(1) Words importing the singular include the plural; and

(2) Words importing the plural include the singular.

§ 193.2011 Reporting.

Leaks and spills of LNG must be reported in accordance with the requirements of Part 191 of this chapter.

§ 193.2013 Incorporation by reference.

(a) There are incorporated by reference in this part all materials referred to in this part that are not set forth in full. The incorporated materials are deemed published under 5 U.S.C. 552(a) and 1 CFR Part 51 and are part of this regulation as though set forth in full. All incorporated materials are listed in Appendix A to this Part 193 with the applicable editions in parentheses following the title of the referenced material. Only the latest listed edition applies, except that an earlier listed edition may be followed with respect to components which are designed, manufactured, or installed in accordance with the earlier edition before the latest edition is adopted, unless otherwise provided in this part. The incorporated materials are subject to change, but any change will be announced by publication in the FEDERAL REGISTER before it becomes effective.

(b) All incorporated materials are available for inspection in the Materials Transportation Bureau, U.S. Department of Transportation, 400 Seventh Street, SW., Washington, D.C. 20590, and at the Office of the Federal Register Library, 1100 L Street, NW., Washington, D.C. In addition, copies of the incorporated materials are available from the respective organizations listed in Appendix A to this Part 193.

(c) Incorporated by reference provisions approved by the Director of the Federal Register.

(49 U.S.C. 1674 (a); 49 CFR 1.53 and Appendix A to Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-2, 45 FR 70410, Oct. 23, 1980]

§ 193.2015 Petitions for finding or approval.

Where a rule in this part authorizes the Director to make a finding or approval, any operator may petition the Director to make such finding or approval. Petitions must be sent to the Director, Materials Transportation Bureau, 400 7th Street, SW., Washington, D.C. 20590, and be received at least 90 days before the operator requests that the finding or approval be made. Each petition must refer to the rule authorizing the action sought and contain information or arguments that justify the action. Unless otherwise specified, no public proceeding is held on a petition before it is granted or denied. Within 90 days after a petition is received, the Director notifies the petitioner of the disposition of the petition or, if the request requires more extensive consideration or additional information or comments are requested and delay is expected, of the date by which action will be taken.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[Amdt. 193-1, 45 FR 57418, Aug. 28, 1980]

§ 193.2017 Plans and procedures.

(a) Each operator shall maintain at each LNG plant the plans and procedures required for that plant by this part. The plans and procedures must be available upon request for review and inspection by the Director or any State Agency that has submitted a current certification or agreement with respect to the plant under section 5 of the Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. 1674). In addition, each change to the plans or procedures must be available at the LNG plant for review and inspection within 20 days after the change is made.

(b) The Director or the State Agency, after notice and opportunity for hearing, may require the operator to amend its plans and procedures as necessary to provide a reasonable level of safety.

(49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1)

[Amdt. 193-2, 45 FR 70404, Oct. 23, 1980]

Subpart B—Siting Requirements

§ 193.2051 Scope.

This subpart prescribes siting requirements for the following LNG facilities: Containers and their impounding systems, transfer systems and their impounding systems, emergency shutdown control systems, fire control systems, and associated foundations, support systems, and normal or auxiliary power facilities necessary to maintain safety.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[Amdt. 193-1, 45 FR 57418, Aug. 28, 1980]

§ 193.2055 General.

An LNG facility must be located at a site of suitable size, topography, and configuration so that the facility can be designed to minimize the hazards to persons and offsite property resulting from leaks and spills of LNG and other hazardous fluids at the site. In selecting a site, each operator shall determine all site-related characteristics which could jeopardize the integrity and security of the facility. A site must provide ease of access so that personnel, equipment, and materials from offsite locations can reach the site for fire fighting or controlling spill associated hazards or for evacuation of personnel.

§ 193.2057 Thermal radiation protection.

(a) *Thermal exclusion zone.* Each LNG container and LNG transfer system must have a thermal exclusion zone in accordance with the following:

(1) Within the thermal exclusion zone, the impounding system may not be located closer to targets listed in paragraph (d) of this section than the exclusion distance "d" determined according to this section, unless the target is a pipeline facility of the operator.

(2) If grading and drainage are used under § 193.2149(b), operators must comply with the requirements of this section by assuming the space needed for drainage and collection of spilled liquid is an impounding system.

(b) *Measurement.* The exclusion distance "d" is measured along the line (PT), as shown in the following impoundment diagram, where the following apply:

(1) T is a point on the target that is closest to (P).

(2) D is a point closest to (T) on the top inside edge of the innermost dike.

(3) θ is one of the following angles with the vertical, to account for flame tilt and potential preignition vapor formation:

(i) An assumed angle of $(\theta) = 45°$; or

(ii) An angle determined in accordance with a mathematical model that meets the criteria of paragraph (c)(2) of this section, using the maximum wind speed that is exceeded less than 5 percent of the time based on recorded data for the area.

(4) L is one of the following lengths to account for flame height:

(i) An assumed length of $(L) = 6(A/\pi)^{0.5}$, where (A) is the horizontal area across the impounding space measured at the lowest point along the top inside edge of the dike; or

(ii) A length determined in accordance with a mathematical model that meets the criteria of paragraph (c)(2) of this section, using appropriate pa-

rameters consistent with the time period that a target could be subjected to exposure before harm would result.

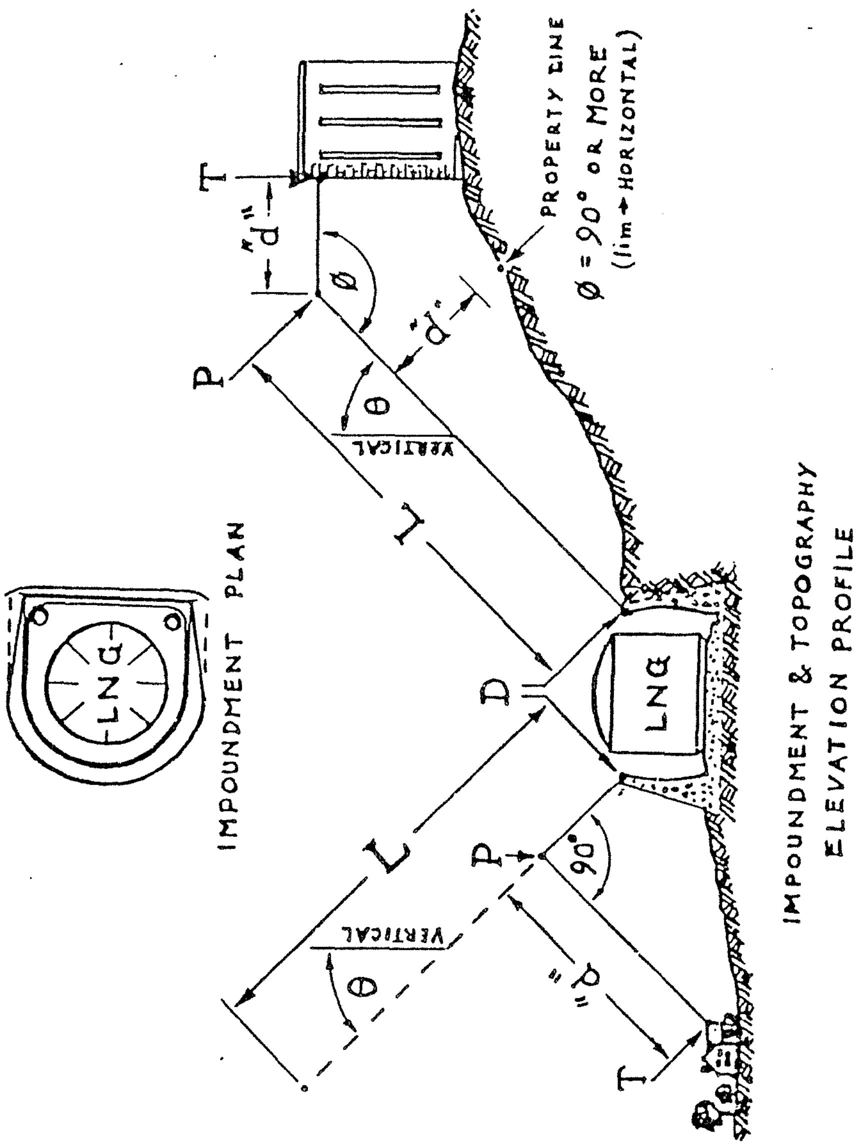
(5) PD is a line of length (L) or less, lying at angle θ in the vertical plane that intersects points (D) and (T).

(6) PT is a line lying in the vertical plane of line (PD), that:

(i) Is perpendicular to line (PD) when (PD) is less than (L); or

(ii) Has an angular elevation not above the horizontal at (P) when (PD) equals (L);

(7) P is the point where (PT) and (PD) intersect.



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(c) *Exclusion distance length.* The length of an exclusion distance for each impounding space may not be less than the distance "d" determined in accordance with one of the following:

(1) $d=(f)(A)^{0.5}$, where

A=the largest horizontal area across the impounding space measured at the lowest point along the top inside edge of the dike.
f=values for targets prescribed in paragraph (d) of this section.

(2) Determine "d" from a mathematical model for thermal radiation and other appropriate fire characteristics which assures that the incident thermal flux levels in paragraph (d) of this section are not exceeded. The model must:

(i) Use atmospheric conditions which, if applicable, result in longer exclusion distances than other atmospheric conditions occurring at least 95 percent of the time based on recorded data for the site area;

(ii) Have been evaluated and verified by testing at a scale, considering scaling effects, appropriate for the range of application;

(iii) Have been submitted to the Director for approval, with supportive data as necessary to demonstrate validity; and

(iv) Have received approval by the Director.

(d) *Limiting values for incident radiant flux on offsite targets.* The maximum incident radiant flux at an offsite target from burning of a total spill in an impounding space must be limited to the distances in paragraph (c) of this section using the following values of "(f)" or "Incident Flux":

Offsite target	(f)	Incident flux Btu/ft.² hour
(1) Outdoor areas occupied by 20 or more persons during normal use, such as beaches, playgrounds, outdoor theaters, other recreation areas or other places of public assembly	(3)	1,600
(2) Buildings that are used for residences, or occupied by 20 or more persons during normal use	(1.6)	4,000
(3) Buildings made of cellulosic materials or are not fire resistant or do not provide durable shielding from thermal radiation that: (i) Have exceptional value, or contain objects of exceptional value based on historic uniqueness described in Federal, State, or local registers; (ii) Contain explosive, flammable, or toxic materials in hazardous quantities; or (iii) Could result in additional hazard if exposed to high levels of thermal radiation	(1.6)	4,000
(4) Structures that are fire resistant and provide durable shielding from thermal radiation that have the characteristics described in paragraphs (3)(i) through (3)(iii) above	(1.1)	6,700
(5) Public streets, highways, and mainlines of railroads—	(1.1)	6,700
(6) Other structures, or if closer to (P), the right-of-way line of the facility	(0.8)	10,000

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57418, Aug. 28, 1980]

§ 193.2059 Flammable vapor-gas dispersion protection.

(a) *Dispersion exclusion zone.* Except as provided by paragraph (e) of this section, each LNG container and LNG transfer system must have a dispersion exclusion zone with a boundary described by the minimum dispersion distance computed in accordance with this section. The following are prohibited in a dispersion exclusion zone unless it is an LNG facility of the operator:

(1) Outdoor areas occupied by 20 or more persons during normal use, such as beaches, playgrounds, outdoor theaters, other recreation areas, or other places of public assembly.

(2) Buildings that are:

(i) Used for residences;

(ii) Occupied by 20 or more persons during normal use;

(iii) Contain explosive, flammable, or toxic materials in hazardous quantities;

(iv) Have exceptional value or contain objects of exceptional value based on historic uniqueness described in Federal, State, or local registers; or

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(v) Could result in additional hazard if exposed to a vapor-gas cloud.

(b) *Measuring dispersion distance.* The dispersion distance is measured radially from the inside edge of an impounding system along the ground contour to the exclusion zone boundary.

(c) *Computing dispersion distance.* A minimum dispersion distance must be computed for the impounding system. If grading and drainage are used under § 193.2149(b), operators must comply with the requirements of this section by assuming the space needed for drainage and collection of spilled liquid is an impounding system. Dispersion distance must be determined in accordance with the following dispersion parameters, using applicable parts of the mathematical model in Appendix B of the report, "Evaluation of LNG Vapor Control Methods," 1974, or a model for vapor dispersion which meets the requirements of paragraphs (ii) through (iv) in § 193.2057(c)(2):

(1) Average gas concentration in air = 2.5 percent.

(2) Dispersion conditions are a combination of those which result in longer predicted downwind dispersion distances than other weather conditions at the site at least 90 percent of the time, based on U.S. Government weather data, or as an alternative where the model used gives longer distances at lower wind speeds, Category F atmosphere, wind speed = 4.5 miles per hour, relative humidity equals 50.0 percent, and atmospheric temperatures = 0.0 C.

(3) Dispersion coordinates y, z, and H, where applicable, = 0.

(d) *Vaporization design rate.* In computing dispersion distance under paragraph (c) of this section, the following applies:

(1) Vaporization results from the spill caused by an assumed rupture of a single transfer pipe (or multiple pipes that lack provisions to prevent parallel flow) which has the greatest overall flow capacity, discharging at maximum potential capacity, in accordance with the following conditions:

(i) The rate of vaporization is not less than the sum of flash vaporization and vaporization from boiling by heat transfer from contact surfaces during the time necessary for spill detection, instrument response, and automatic shutdown by the emergency shutdown system but, not less than 10 minutes, plus, in the case of impounding systems for LNG storage tanks with side or bottom penetrations, the time necessary for the liquid level in the tank to reach the level of the penetration or equilibrate with the liquid impounded assuming failure of the internal shutoff valve.

(ii) In determining variations in vaporization rate due to surface contact, the time necessary to wet 100 percent of the impounding floor area shall be determined by equation C-9 in the report "Evaluation of LNG Vapor Control Methods," 1974, or an alternate model which meets the requirements of paragraphs (ii) through (iv) in § 193.2057(c)(2).

(iii) After spill flow is terminated, the rate of vaporization is vaporization of the remaining spillage, if any, from boiling by heat transfer from contact surfaces that are reducing in area and temperature as a function of time.

(iv) Vapor detention space is all space provided for liquid impoundment and vapor detention outside the component served, less the volume occupied by the spilled liquid at the time the vapor escapes the vapor detention space.

(2) The boiling rate of LNG on which dispersion distance is based is determined using the weighted average value of the thermal properties of the contact surfaces in the impounding space determined from eight representative experimental tests on the materials involved. If surfaces are insulated, the insulation must be designed, installed, and maintained so that it will retain its performance characteristics under spill conditions.

(e) *Planned vapor control.* An LNG facility need not have a dispersion exclusion zone if the Director finds that compliance with paragraph (a) of this section would be impractical and the operator prepares and follows a plan for controlling LNG vapor that is found acceptable by the Director. The plan must include circumstances under which LNG vapor is controlled

to preclude the dispersion of a flammable mixture from the LNG facility under all predictable environmental conditions that could adversely affect control. The reliability of the method of control must be demonstrated by testing or experience with LNG spills.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57418, Aug. 28, 1980]

§ 193.2061 Seismic investigation and design forces.

(a) Except for shop fabricated storage tanks of 70,000 gallons or less capacity mounted within 2 feet of the ground, if an LNG facility is located at a site in Zone 0 or 1 of the "Seismic Risk Map of the United States," UBC, each operator shall determine, based on a study of faults, hydrologic regime, and soil conditions, whether a potential exists at the site for surface faulting or soil liquefaction.

(b) Subject to paragraph (f) of this section, LNG facilities must be designed and built to withstand, without loss of structural or functional integrity, the following seismic design forces, as applicable:

(1) For LNG facilities (other than shop fabricated storage tanks of 70,000 gallons or less capacity mounted within 2 feet of the ground) located at a site in Puerto Rico in Zone 2, 3, or 4 of the "Seismic Risk Map of the United States," or at a site determined under paragraph (a) of this section to have a potential for surface faulting or soil liquefaction, the forces that could reasonably be expected to occur at the foundation of the facility due to the most critical ground motion, motion amplification, permanent differential ground displacement, soil liquefaction, and symmetric and assymmetric reaction forces resulting from hydrodynamic pressure and motion of contained liquid in interaction with the facility structure.

(2) For all other LNG facilities, the total lateral force set forth in UBC, Volume 1, corresponding to the zone of the "Seismic Risk Map of the United States" in which the facility is located, and a vertical force equal to the total lateral force.

(c) Each operator of an LNG facility to which paragraph (b)(1) of this section applies shall determine the seismic design forces on the basis of a detailed geotechnical investigation and in accordance with paragraphs (d) and (e) of this section. The investigation must include each of the following items that could reasonably be expected to affect the site and be sufficient in scope to identify all hazards that could reasonably be expected to affect the facility design:

(1) Identification and evaluation of faults, Quaternary activity of those faults, tectonic structures, static and dynamic properties of materials underlying the site, and, as applicable, tectonic provinces within 100 miles of the site;

(2) Identification and evaluation of all historically reported earthquakes which could affect the determination under this section of the most critical ground motion or differential displacement at the site when correlated with particular faults, tectonic structures, and tectonic provinces, as applicable; and

(3) Identification and evaluation of the hydrologic regime and the potential of liquefaction-induced soil failures.

(d) The most critical ground motion must be determined in accordance with paragraph (e) of this section either:

(1) Probabilistically, when the available earthquake data are sufficient to show that the yearly probability of exceedance of most critical ground motion is 10^{-4} or less; or

(2) Deterministically, when the available earthquake data are insufficient to provide probabilistic estimates, with the objective of determining a most critical ground motion with a yearly probability of exceedance of 10^{-4} or less.

(e) The determination of most critical ground motion, considering local and regional seismological conditions, must be made by using the following:

(1) A regionally appropriate attenuation relationship, assuming that earthquakes occur at a location on a fault, tectonic structure, or tectonic province, as applicable, which would cause the most critical seismic move-

ment at the site, except that where epicenters of historically reported earthquakes cannot be reasonably related to known faults or tectonic structures, but are recognized as being within a specific tectonic province which is within 100 miles of the site, assume that those earthquakes occur within their respective provinces at a source closest to the site.

(2) A horizontal design response spectrum determined from the mean plus one standard deviation of a free-field horizontal elastic response spectra whose spectral amplitudes are consistent with values expected for the most critical ground motion.

(3) A vertical design response spectrum that is either two-thirds of the amplitude of the horizontal design response spectrum at all frequencies or equal to the horizontal design response spectrum where the site is located within 10 miles of the earthquake source.

(f) An LNG storage tank or its impounding system may not be located at a site where an investigation under paragraph (c) of this section shows that any of the following conditions exists unless the Director grants an approval for the site:

(1) The estimated design horizontal acceleration exceeds 0.8g at the tank or dike foundation.

(2) The specific local geologic and seismic data base is sufficient to predict future differential surface displacement beneath the tank and dike area, but displacement not exceeding 30 inches cannot be assured with a high level of confidence.

(3) The specific local geologic and seismic data base is not sufficient to predict future differential surface displacement beneath the tank and dike area, and the estimated cumulative displacement of a Quaternary fault within one mile of the tank foundation exceeds 60 inches.

(4) The potential for soil liquefaction cannot be accommodated by design and construction in accordance with paragraph (b)(1) of this section.

(g) An application for approval of a site under paragraph (f) of this section must provide at least the following:

(1) A detailed analysis and evaluation of the geologic and seismic characteristics of the site based on the geotechnical investigation performed under paragraph (c) of this section, with emphasis on prediction of near-field seismic response.

(2) The design plans and structural analysis for the tank, its impounding system, and related foundations, with a report demonstrating that the design requirements of this section are satisfied, including any test results or other documentation as appropriate.

(3) A description of safety-related features of the site or designs, in addition to those required by this part, if applicable, that would mitigate the potential effects of a catastrophic spill (e.g., remoteness or topographic features of the site, additional exclusion distances, or multiple barriers for containing or impounding LNG).

(h) Each container which does not have a structurally liquid-tight cover must have sufficient freeboard with an appropriate configuration to prevent the escape of liquid due to sloshing, wave action, and vertical liquid displacement caused by seismic action.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2063 Flooding.

(a) Each operator shall determine the effects of flooding on an LNG facility site based on the worst occurrence in a 100-year period. The determination must take into account:

(1) Volume and velocity of the floodwater;

(2) Tsunamis (local, regional, and distant);

(3) Potential failure of dams;

(4) Predictable land developments which would affect runoff accumulation of water; and

(5) Tidal action.

(b) The effect of flooding determined under paragraph (a) of this section must be accommodated by location or design and construction, as applicable, to reasonably assure:

(1) The structural or functional integrity of LNG facilities; and

(2) Access from outside the LNG facility and movement of personnel and equipment about the LNG facility site for the control of fire and other emergencies.

§ 193.2065 Soil characteristics.

(a) Soil investigations including borings and other appropriate tests must be made at the site of each LNG facility to determine bearing capacity, settlement characteristics, potential for erosion, and other soil characteristics applicable to the integrity of the facility.

(b) The naturally occurring or designed soil characteristics at each LNG facility site must provide load bearing capacities, using appropriate safety factors, which can support the following loads without excessive lateral or vertical movement that causes a loss of the functional or structural integrity of the facility involved:

(1) Static loading caused by the facility and its contents and any hydrostatic testing of the facility; and

(2) Dynamic loading caused by movement of contents of the facility during normal operation, including flow, sloshing, and rollover.

§ 193.2067 Wind forces.

(a) LNG facilities must be designed to withstand without loss of structural or functional integrity:

(1) The direct effect of wind forces;

(2) The pressure differential between the interior and exterior of a confining, or partially confining, structure; and

(3) In the case of impounding systems for LNG storage tanks, impact forces and potential penetrations by wind borne missiles.

(b) The wind forces at the location of the specific facility must be based on one of the following:

(1) For shop fabricated containers of LNG or other hazardous fluids with a capacity of not more than 70,000 gallons, applicable wind load data in ANSI A 58.1, 1972 edition.

(2) For all other LNG facilities:

(i) An assumed sustained wind velocity of not less than 200 miles per hour, unless the Director finds a lower velocity is justified by adequate supportive data; or

(ii) The most critical combination of wind velocity and duration, with respect to the effect on the structure, having a probability of exceedance in a 50-year period of 0.5 percent or less, if adequate wind data are available and the probabilistic methodology is reliable.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2069 Other severe weather and natural conditions.

(a) In addition to the requirements of §§ 193.2061, 193.2063, 193.2065, and 193.2067, each operator shall determine from historical records and engineering studies the worst effect of other weather and natural conditions which may predictably occur at an LNG facility site.

(b) The facility must be located and designed so that such severe conditions cannot reasonably be expected to result in an emergency involving the factors listed in § 193.2063(b).

§ 193.2071 Adjacent activities.

(a) Each operator shall determine that present and reasonably foreseeable activities adjacent to an LNG facility site that could adversely affect the operation of the LNG facility or the safety of persons or offsite property, if damage to the facility occurs.

(b) An LNG facility must not be located where present or projected offsite activities would be reasonably expected to:

(1) Adversely affect the operation of any of its safety control systems;

(2) Cause failure of the facility; or

(3) Cause the facility not to meet the requirements of this part.

§ 193.2073 Separation of facilities.

Each LNG facility site must be large enough to provide for minimum separations between facilities and between facilities and the site boundary to:

(a) Permit movement of personnel, maintenance equipment, and emergency equipment around the facility; and

(b) Comply with distances specified in sections 2-2.4 through 2-2.7 of NFPA 59A.

Subpart C—Design

§ 193.2101 Scope.

This subpart prescribes requirements for the selection and qualification of materials for components, and for the design and installation or construction of components and buildings, including separate requirements for impounding systems, LNG storage tanks, and transfer systems.

MATERIALS

§ 193.2103 General.

Materials for all components must be—

(a) Able to maintain their structural integrity under all design loadings, including applicable environmental design forces under Subpart B of this part;

(b) Physically, chemically, and thermally compatible within design limits with any fluid or other materials with which they are in contact; and

(c) Qualified in accordance with the applicable requirements of this subpart.

§ 193.2105 Extreme temperatures; normal operations.

Each operator shall—

(a) Determine the range of temperatures to which components will be subjected during normal operations, including required testing, initial start-up, cooldown operations, and shutdown conditions; and

(b) Use component materials that meet the design standards of this part for strength, ductility, and other properties throughout the entire range of temperatures to which the component will be subjected in normal operations.

§ 193.2107 Extreme temperatures, emergency conditions.

(a) Each operator shall determine the effects on components not normally exposed to extreme cold (including a component's foundation or support system) of contact by LNG or cold refrigerant that could result from error, a spill, or other emergency determined as required by this part.

(b) Each operator shall determine the effects on components (including their foundations or support systems) of the extreme heat which could result from an LNG or other hazardous fluid fire.

(c) Where the exposure determined under paragraph (a) or (b) of this section could result in a failure that would worsen the emergency, the component or its foundation or support system, as appropriate, must be:

(1) Made of material or constructed to be suitable for the extreme temperature to which it could be subjected; or

(2) Protected by insulation or other means that will delay failure due to extreme temperature in order to allow adequate time to take emergency responses.

(d) If a material that has low resistance to flame temperatures is used in any component containing a hazardous fluid, the material must be protected so that any heat resulting from a controllable emergency does not cause the release of fluid that would result in an uncontrollable emergency.

§ 193.2109 Insulation.

During normal operations, insulation materials must:

(a) Maintain insulating values;

(b) Withstand thermal and mechanical design loads; and

(c) Be covered with a material that is noncombustible in the installed state, is not subject to detrimental ultraviolet decay, and that can withstand the forces of wind according to ANSI A58.1 and anticipated loading which could occur in a controllable emergency.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2111 Cold boxes.

All cold boxes must be made of noncombustible material and the insulation must be made of materials which are noncombustible in the installed condition.

§ 193.2113 Piping.

(a) Piping made of cast iron, malleable iron, or ductile iron may not be used to carry any cryogenic or hazardous fluids.

(b) Piping materials intended for normal use at temperatures below −28.9° C (−20° F) or for use under § 193.2107(c)(1) must be qualified by testing in accordance with ANSI B 31.3 to comply with § 193.2103(b).

§ 193.2115 Concrete subject to cryogenic temperatures.

Concrete intended for normal use at cryogenic temperatures or for use under § 193.2107(c)(1) may not be used unless:

(a) Materials, measurements, mixing, placing, prestressing, and post-stressing of concrete meets generally accepted engineering practices;

(b) Metallic reinforcing, prestressing wire, structural and nonstructural members used in concrete are acceptable in the installed condition for the temperature and stress levels encountered at design loading conditions; and

(c) Tests for the compressive strength, the coefficient of contraction, an acceptable thermal gradient, and, if applicable, acceptable surface loading to prevent detrimental spalling are performed on the concrete at the lowest temperature for which the concrete is designed or similar test data on these properties are available.

§ 193.2117 Combustible materials.

Combustible materials are not permitted for the construction of buildings, plant equipment, and the foundations and supports of buildings and plant equipment in areas where ignition of the material would worsen an emergency. However, limited combustible materials may be used when the use of noncombustible materials is impractical.

§ 193.2119 Records

Each operator shall keep a record of all materials for components, buildings, foundations, and support systems, as necessary to verify that material properties meet the requirements of this part. These records must be maintained for the life of the item concerned.

EFFECTIVE DATE NOTE: At 45 FR 9184-9185, Feb. 11, 1980, the effectiveness of § 193.2119 was deferred, pending further notice.

DESIGN OF COMPONENTS AND BUILDINGS

§ 193.2121 General.

Components, including their foundations and support systems, must be designed, fabricated, and installed to withstand, without loss of functional or structural integrity, predictable loadings not including environmental design forces under Subpart B of this part unless applicable under that subpart.

§ 193.2123 Valves.

(a) Each valve, including control valves and relief valves, must be designed, manufactured, and tested to comply with ANSI B31.3 or ANSI B31.5 or ANSI B31.8 or API Standard 6D, if design conditions fall within their scope.

(b) Extended bonnet valves must be used for service temperatures below −45.6° C (−50° F).

(c) Valves used for cryogenic liquid service must be designed to operate in the position in which they are installed.

(d) Powered local and remote operation must be provided for valves intended for use during a controllable emergency that would be difficult or excessively time-consuming to operate manually during such an emergency.

(e) Valves must be designed and installed so that an excessive load on the piping system does not render the valve inoperable.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2125 Automatic shutoff valves.

Each automatic shutoff valve or combination of valves must:

(a) Have a fail-safe design;

(b) Operate to stop fluid flow which would endanger the operational integrity of plant equipment; and

(c) Close at a rate to avoid fluid hammer which would endanger the operating integrity of a component.

§ 193.2127 Piping.

(a) Piping must be designed, manufactured, and tested to comply with ANSI B 31.3.

(b) All cryogenic and hazardous fluid piping must have connections to facilitate blowdown and purge as required by this part.

(c) Each cryogenic or hazardous fluid piping system that is aboveground must be identified by color coding, painting, or labeling.

(d) Seamless pipe or pipe with a longitudinal joint efficiency of 1.0 determined in accordance with ANSI B31.3, or pipe with a design pressure less than two-thirds of the mill-proof test pressure or subsequent shop or field hydrostatic test pressure must be used for process and transfer piping handling cryogenic or other hazardous fluids with a service temperature below −22° F (−30° C).

(e) For longitudinal or spiral weld piping handling LNG or cryogenic fluids, the heat affected zone must comply with section 323.2.2 of ANSI B31.3.

(f) Threaded piping used in hazardous fluid service must be at least Schedule 80.

§ 193.2129 Piping attachments and supports.

Piping attachments and supports for LNG or refrigerant piping must be designed to prevent excessive heat transfer which can result in either unintentional restraint of piping caused by ice formations or the embrittlement of supporting steel.

§ 193.2131 Building design.

(a) Each building or structural enclosure in which potentially hazardous quantities of flammable materials are handled must be designed and constructed to minimize fire hazards.

(b) Buildings or structural enclosures in which hazardous or cryogenic fluids are handled shall be of lightweight, noncombustible construction with nonload-bearings walls.

(c) If rooms containing such fluids are located within or attached to buildings in which such fluids are not handled, i.e., control rooms, shops, etc., the common walls shall be limited to not more than two in number, shall be designed to withstand a static pressure of at least 4800 Pa (100 psf), have no doors or other communicating openings, and shall have a fire resistance rating of at least 1 hour.

§ 193.2133 Buildings; ventilation.

(a) Each building in which potentially hazardous quantities of flammable fluids are handled must be ventilated to minimize the possibility, during normal operation, of hazardous accumulation of a flammable gas and air mixture, hazardous products of combustion, and other hazardous vapors in enclosed process areas by one of the following means:

(1) A continuously operating mechanical ventilation system;

(2) A combination gravity ventilation system and normally off mechanical ventilation system which is activated by suitable flammable gas detectors at a concentration not exceeding 25 percent of the lower flammable limit of the gas;

(3) A dual rate mechanical ventilation system with the high rate activated by suitable flammable gas detectors at a concentration not exceeding 25 percent of the lower flammable limit of the gas; or

(4) A gravity ventilation system composed of a combination of wall openings, roof ventilators, and, if there are basements or depressed floor levels, a supplemental mechanical ventilation system.

(b) The ventilation rate must be at least 1 cubic foot per minute of air per square foot of floor area. If vapors heavier than air can be present, the ventilation must be proportioned according to the area of each level.

§ 193.2135 Expansion or contraction.

Each operator shall consider the amount of contraction and expansion of each component during operating and environmental thermal cycling and shall:

(a) Provide components that operate without detrimental stress or restriction of movement, within each component and between components, caused by contraction and expansion; and

(b) Prevent ice buildup from detrimentally restricting the movement of components caused by contraction and expansion.

§ 193.2137 Frost heave.

(a) Each operator shall:

(1) Determine which components and their foundations could be endangered by frost heave from ambient temperatures or operating temperatures of the component; and

(2) Provide protection against frost heave which might impair their structural integrity.

(b) For each component and foundation determined under paragraph (a) of this section, instrumentation must be installed to warn of potential structural impairment due to frost heave, unless the operator includes in the maintenance procedures required by this part, a method and schedule of inspection that will detect changes in the elevation.

§ 193.2139 Ice and snow.

(a) Components must be designed to support the weight of ice and snow which could normally collect or form on them.

(b) Each operator shall provide protection for components from falling ice or snow which may accumulate on structures.

(c) Valves and moving components must not become inoperative due to ice formation on the component.

§ 193.2141 Electrical systems.

(a) Each operator shall select and install electrical equipment and wiring for components in accordance with NFPA-70 and, where applicable section 7-62 of NFPA-59A.

(b) Electrical grounding and bonding must be in accordance with section 7-7.1.1 of NFPA-59A.

(c) Protective measures for stray or impressed currents must be provided in accordance with section 7-7.3 of NFPA-59A.

§ 193.2143 Lightning.

Each operator shall install proper grounds as necessary to minimize the hazard to plant personnel and components, including all electrical circuits, as a result of lightning.

§ 193.2145 Boilers and pressure vessels.

Boilers must be designed and fabricated in accordance with section I or section IV of the ASME Boiler and Pressure Vessel Code. Other pressure vessels subject to that Code must be designed and fabricated in accordance with Division 1 or Division 2 of section VIII.

§ 193.2147 Combustion engines and turbines.

Combustion engines and gas turbines must be installed in accordance with NFPA-37.

IMPOUNDMENT DESIGN AND CAPACITY

§ 193.2149 Impoundment required.

(a) An impounding system must be provided for storage tanks to contain a potential spill of LNG or other hazardous liquid.

(b) Grading or drainage or an impounding system must be provided to ensure that accidental spills or leaks from the following components and areas do not endanger components or adjoining property or enter navigable waterways:

(1) Liquefaction and other process equipment;

(2) Vaporizers;

(3) Transfer systems;

(4) Parking areas for tank cars or tank trucks; and

(5) Areas for loading, unloading, or storing portable containers and dewar vessels.

(c) Impounding systems for LNG must be designed and constructed in accordance with this subpart. Impounding systems intended for containment of hazardous liquids other than LNG must meet the requirements of NFPA-30.

§ 193.2151 General design characteristics.

(a) An impounding system must have a configuration or design which, to the maximum extent possible, will prevent liquid from escaping impoundment by leakage, splash from collapse of a structure or part thereof, momentum and low surface friction, foaming, failure of pressurized piping, and accidental pumping.

(b) The basic form of an impounding system may be excavation, a natural geological formation, manufactured diking, such as berms or walls, or any combination thereof.

§ 193.2153 Classes of impounding systems.

(a) For the purpose of this part, impounding systems are classified as follows:

Class 1. A system which surrounds the component served with the inner surface of the dike constructed against or within 24 inches of the component served.

Class 2. A system which surrounds the component or area served with the dike located a distance away from the component or at the periphery of the area.

Class 3. A system which conducts a spill by dikes and floors to a remote impounding space which does not surround the component or area served.

(b) In the case of an impounding system consisting of a combination of classes, requirements of this part regarding a single class apply according to the percentage of impoundment provided by each class.

§ 193.2155 Structural requirements.

(a) Subject to paragraph (b) of this section, the structural parts of an impounding system must be designed and constructed to prevent impairment of the system's performance reliability and structural integrity as a result of the following:

(1) The imposed loading from—

(i) Full hydrostatic head of impounded LNG;

(ii) Hydrodynamic action, including the effect of any material injected into the system for spill control;

(iii) The impingement of the trajectory of an LNG jet discharged at any predictable angle; and

(iv) Anticipated hydraulic forces from a credible opening in the component or item served, assuming that the discharge pressure equals design pressure.

(2) The erosive action from a spill, including jetting of spilling LNG, and any other anticipated erosive action including surface water runoff, ice formation, dislodgement of ice formation, and snow removal.

(3) The effect of the temperature, any thermal gradient, and any other anticipated degradation resulting from sudden or localized contact with LNG.

(4) Exposure to fire from impounded LNG or from sources other than impounded LNG.

(5) If applicable, the potential impact and loading on the dike due to—

(i) Collapse of the component or item served or adjacent components; and

(ii) If the LNG facility adjoins the right-of-way of any highway or railroad, collision by or explosion of a train, tank car, or tank truck that could reasonably be expected to cause the most severe loading.

(b) For spills from LNG storage tanks with Class 2 or 3 impounding systems, imposed loading and surging flow characteristics must be based on a credible release of the tank contents.

(c) If an LNG storage tank is located within a horizontal distance of 6,100 m. (20,000 ft.) from the nearest point of the nearest runway serving large aircraft as defined in 14 CFR Part 1.1, a Class 1 impounding system must be used which is designed to withstand collision by, or explosion of, the heaviest aircraft which can take off or land at the airport.

§ 193.2157 Coatings and coverings.

Insulation, sealants, or other coatings and coverings which are part of an impounding system—

(a) Must be noncombustible in an installed condition when exposed to an LNG fire resulting from a spill that covers the floor of the impounding space;

(b) Must withstand exposure to fire from sources determined as required by this part, other than impounded LNG, for a period of time until fire protective or fire extinguishing action is taken; and

(c) When used for the purpose of maintaining the functional integrity of an impounding system, must be capable of withstanding sudden exposure to LNG without loss of such integrity.

§ 193.2159 Floors.

Floors of Class 2 and Class 3 impounding systems must, to the extent feasible—

(a) Slope away from the component or item impounded and to a sump basin installed under § 193.2171;

(b) Slope away from the nearest adjacent component;

(c) Drain surface waters from the floor at rates based on a storm of 10-year frequency and 1-hour duration and other natural water sources; and

(d) Be designed to minimize the wetted floor area.

§ 193.2161 Dikes, general.

(a) Penetrations in dikes to accommodate piping or any other purpose are prohibited.

(b) An outer wall of a component served by an impounding system may not be used as a dike except for a concrete wall designed to comply with the requirements of § 193.2155(c) or equivalent design impact loading.

§ 193.2163 Vapor barriers.

If vapor barriers are installed in meeting the requirements of § 193.2059, they must be designed and constructed to detain LNG vapor.

§ 193.2165 Dike dimensions.

In addition to dike dimensions needed to comply with other requirements of this subpart, to minimize the possibility that a trajectory of accidentally discharged liquid would pass over the top of a dike, the horizontal distance from the inner wall of the component or vessel served to the closest inside edge of the top of the dike must at least equal the vertical distance from the maximum liquid level in the component or vessel to the inside edge of the top of the dike.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2167 Covered systems.

(a) A covered impounding system is prohibited unless it is—

(1) Sealed from the atmosphere and filled with an inert gas; or

(2) Permanently interconnected with the vapor space of the component served.

(b) Flammable nonmetallic membranous covering is prohibited in a covered system.

(c) For systems to which paragraph (a)(1) of this section applies, instrumentation and controls must be provided to—

(1) Maintain pressures at a safe level; and

(2) Monitor gas concentrations in accordance with § 193.2169.

(d) Dikes must have adequate structural strength to assure that they can withstand impact from a collapsed cover and all anticipated conditions which could cause a failure of the impounding space cover.

§ 193.2169 Gas leak detection.

Appropriate areas within an impounding system where collection or passage of LNG or LNG vapor could be expected must be equipped with sensing and warning devices to monitor continuously for the presence of LNG or LNG vapor and to warn before LNG gas concentration levels exceed 25 percent of the lower flammable limit.

§ 193.2171 Sump basins.

Except for Class 1 impounding systems, a sump basin must be located in each impounding system for collection of water.

§ 193.2173 Water removal.

(a) Except for Class 1 systems, impounding systems must have sump pumps and piping running over the dike to remove water collecting in the sump basin.

(b) The water removal system must have adequate capacity to remove water at rates which equal the maximum predictable collection rate from a storm of 10-year frequency and 1-hour duration, and other natural causes.

(c) Sump pumps for water removal must—

(1) Be operated as necessary to keep the impounding space as dry as practical; and

(2) If sump pumps are designed for automatic operation, have redundant automatic shutdown controls to prevent operation when LNG is present.

§ 193.2175 Shared impoundment.

When an impounding system serves more than one LNG storage tank, a means must be provided to prevent low temperature or fire resulting from leakage from any one of the storage tanks served causing any other storage tank to leak. The means must not result in a vapor dispersion distance which exceeds the exclusion zone required by § 193.2059.

(49 U.S.C. 1674a; 49 CFR 1.53 and Appendix A of Part 1)

[Amdt. 193-1, 45 FR 57419, Aug. 28, 1980]

§ 193.2179 Impoundment capacity; general.

In addition to capacities otherwise required by this subpart, an impounding system must have sufficient volumetric capacity to provide for—

(a) Displacement by the component, tank car, tank truck, container, or dewar vessel served; and

(b) Where applicable, displacement which could occur when a higher density substance than the liquid to be impounded enters the system, considering all relevant means of assuring capacity.

§ 193.2181 Impoundment capacity, LNG storage tanks.

(a) Except as provided in paragraph (b) of this section, each impounding system serving an LNG storage tank must have a minimum volumetric liquid impoundment capacity as follows:

Number of tanks in system	Class or type of system	System capacity in percent of LNG tank's maximum liquid capacity
1	Class 1	110 percent.
	Classes 2 and 3	150 percent.
More than 1	Classes 2 and 3	100 percent of all tanks or 150 percent of largest tank, whichever is greater.

(b) For purposes of this section, a covered impounding system serving a single LNG storage tank may have a capacity of 110 percent of the LNG tank's maximum liquid capacity if it is covered by a roof that is separate and independent from the LNG storage tank.

§ 193.2183 Impoundment capacity; equipment and transfer systems.

If an impounding system serves a component under § 193.2149(b) (1)-(3), it must have a minimum volumetric liquid impoundment capacity equal to the sum of—

(a) One-hundred percent of the volume of liquid that could be contained in the component and, where applicable, tank car or tank truck served; and

(b) The maximum volume of liquid which could discharge into the impounding space from any single failure of equipment or piping during the time period necessary for spill detection, instrument response, and sequenced shutdown by the automatic shutdown system under § 193.2439.

§ 193.2185 Impoundment capacity; parking areas, portable containers.

Each impounding system serving an area listed under § 193.2149(b) (4) or (5) must have a minimum volumetric liquid impoundment capacity which complies with the requirements of § 193.2181, assuming each tank car, tank truck, portable container, or dewar vessel to be a storage tank.

LNG Storage Tanks

§ 193.2187 General.

(a) LNG storage tanks must comply with the requirements of this subpart and the other applicable requirements of this part.

(b) A flammable nonmetallic membrane liner may not be used as an inner container in a storage tank.

§ 193.2189 Loading forces.

Each part of an LNG storage tank must be designed to withstand without loss of functional or structural integrity any predictable combination of forces which would result in the highest stress to the part, including the following:

(a) Internal design pressure determined under § 193.2197.

(b) External design pressure determined under § 193.2199.

(c) Weight of the structure.

(d) Weight of liquid to be stored, except that in no case will the density

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assumed be less than 29.3 pounds per cubic foot (470 kilograms per cubic meter).

(e) Loads due to testing required by § 193.2327.

(f) Nonuniform reaction forces on the foundation due to predictable settling and other movement.

(g) Superimposed forces from piping, stairways, and other connected appurtenances.

(h) Predictable snow and ice loads.

(i) The loading of internal insulation on the inner container and outer shell due to compaction and movement of the container and shell over the design life of the insulation.

(j) In the case of vacuum insulation, the forces due to the vacuum.

(k) In the case of a positive pressure purge, the forces due to the maximum positive pressure of the purge gas.

§ 193.2191 Stratification.

LNG storage tanks with a capacity of 5,000 barrels or more must be equipped with means to mitigate a potential for rollover and overpressure such as:

(a) Selective filling at the top and bottom of the tank;

(b) Circulating liquid from the bottom to the top of the same tank; or

(c) Transferring liquid selectively from the bottom of the tank to the bottom or top of any adjacent storage tank.

§ 193.2193 Movement and stress.

(a) Each operator shall determine for normal operations of each LNG storage tank—

(1) The amount and pattern of predictable movement of components, including transfer piping, and the foundation, which could result from thermal cycling, loading forces, and ambient air changes; and

(2) For a storage tank with an inner container, the predictable movement of the inner container and the outer shell in relation to each other.

(b) Storage tanks must be designed to provide adequate allowance for stress due to movement determined under paragraph (a) of this section, including provisions that—

(1) Backfill does not cause excessive stresses on the tank structure due to expansion of the storage tank during warmup;

(2) Insulation does not settle to a damaging degree or unsafe condition during thermal cycling; and

(3) Expansion bends and other expansion or contraction devices are adequate to prevent excessive stress on tank penetrations, especially during cooldown from ambient temperatures.

§ 193.2195 Penetrations.

(a) All penetrations in an LNG storage tank must be designed in accordance with API 620, including Appendix Q.

(b) The loadings on all penetrations must be determined by an analysis of all contributing forces, including those from tank thermal movements, connecting piping thermal movements, hydraulic forces, applicable wind and earthquake forces, and the forces resulting from settlement or movement of the tank foundation or pipe supports.

(c) All penetrations in an LNG storage tank below the design liquid level must be fitted with an internal shutoff valve which is designed and installed so that any failure of the nozzle penetrating the tank will be outside the tank.

(d) The requirements of paragraphs (a) and (c) of this section do not apply to shop fabricated tanks of 70,000 gallons or less capacity. All penetrations in such tanks must be designed and installed in accordance with the applicable provisions of section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

§ 193.2197 Internal design pressure.

(a) Each operator shall establish the internal design pressure at the top of each LNG storage tank, including a suitable margin above the maximum allowable working pressure.

(b) The internal design pressure of a storage tank may not be lower than the highest pressure in the vapor space resulting from each of the following events or combination thereof that predictably might occur, giving consideration to vapor handling equipment, relief devices in accordance with

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§ 193.2429, and any other mitigating measures:

(1) Filling the tank with LNG including effects of increased vaporization rate due to superheat and sensible heat of the added liquid;

(2) Rollover;

(3) Fall in barometric pressure, using the worst combination of amount of fall and rate of fall which might predictably occur;

(4) Loss of effective insulation that may result from an adjacent fire, leak of liquid into the intertank space, or other predictable accident; and

(5) Flash vaporization resulting from pump recirculation.

§ 193.2199 External design pressure.

(a) Each operator shall establish the external design pressure at the top of each LNG storage tank, including a suitable margin below the minimum allowable working pressure.

(b) The external design pressure may not be higher than the lowest vapor pressure in the vapor space resulting from each of the following events or combinations thereof that predictably might occur, giving consideration to gas makeup systems, vacuum relief devices in accordance with § 193.2429, and any other mitigating measures.

(1) Withdrawing liquid from the tank;

(2) Withdrawing gas from the tank;

(3) Adding subcooled LNG to the tank; and

(4) Rise in barometric pressure, based on the worst combination of amount of rise and rate of rise which predictably might occur.

§ 193.2201 Internal temperature.

The liquid container of each LNG storage tank and all tank parts used in contact with LNG or its cold vapor shall be designed for the lowest bulk liquid temperature which can be attained in the LNG storage tank.

§ 193.2203 Foundation.

(a) Each LNG storage tank must have a stable foundation designed in accordance with generally accepted structural engineering practices.

(b) Each foundation must support design loading forces without detrimental settling that could impair the structural integrity of the tank.

§ 193.2205 Frost heave.

If the protection provided for LNG storage tank foundations from frost heave under § 193.2137(a) includes heating the foundation area—

(a) An instrumentation and alarm system must be provided to warn of malfunction of the heating system; and

(b) A means to correct the malfunction must be provided.

§ 193.2207 Insulation.

(a) Insulation on the outside of the outer shell of an LNG storage tank may not be used to maintain stored LNG at an operating temperature during normal operation.

(b) Insulation between an inner container and the outer shell of an LNG storage tank must—

(1) Be compatible with the contained liquid and its vapor;

(2) In its installed condition, be noncombustible; and

(3) Not significantly lose insulating properties by melting, settling, or other means due to a fire resulting from a spill that covers the floor of the impounding space around the tank.

§ 193.2209 Instrumentation for LNG storage tanks.

(a) Each LNG storage tank having a capacity over 70,000 gallons must be equipped with a sufficient number of sensing devices and personnel warning devices, as prescribed, which operate continuously while the tank is in operation to assure that each of the following conditions is not a potential hazard to the structural integrity or safety of the tank:

Condition	Instrumentation
(1) Amount of liquid in the tank.	Redundant liquid level gages and recorders with high level alarms, and a minimum of one independent high level alarm.
(2) Vapor pressure within the tank.	Redundant gages and recorders with high and low pressure alarms.
(3) Temperatures at representative critical points in the foundation.	Temperature indicating and recording devices with alarm.
(4) Temperature of contained liquid at various vertical intervals.	Temperature recorders.
(5) Abnormal temperature in tank structure.	Thermocouples located at representative critical points with recorders.
(6) Excessive relative movement of inner container and outer shell.	Linear and rotational movement indicators located between inner container and outer shell with recorders.

(b) LNG storage tanks with a capacity of 70,000 gallons or less must be equipped with the following:

(1) LNG liquid trycocks, when attended during the filling operation.

(2) Pressure gages and recorders with high pressure alarm.

(3) Differential pressure liquid level gage.

(c) Each storage tank must be designed as appropriate to provide for compliance with the inspection requirements of this part.

§ 193.2211 Metal storage tanks.

(a) Metal storage tanks with internal design pressures of not more than 15 psig must be designed and constructed in accordance with API Standard 620 and, where applicable, Appendix Q of that standard.

(b) Metal storage tanks with internal design pressures above 15 psig must be designed in accordance with the applicable division of section VIII of the ASME Boiler and Pressure Vessel Code.

§ 193.2213 Concrete storage tanks.

Concrete storage tanks must be designed and constructed in accordance with section 4-3 of NFPA-59A.

§ 193.2215 Thermal barriers.

Thermal barriers must be provided between piping and an outer shell when necessary to prevent the outer shell from being exposed during normal operation to temperatures lower than its design temperature.

§ 193.2217 Support system.

(a) Saddles and legs must be designed in accordance with generally accepted structural engineering practices, taking into account loads during transportation, erection loads, and thermal loads.

(b) Storage tank stress concentrations from support systems must be minimized by distribution of loads using pads, load rings, or other means.

(c) For a storage tank with an inner container, support systems must be designed to—

(1) Minimize thermal stresses imparted to the inner container and outer shell from expansion and contraction; and

(2) Sustain the maximum applicable loading from shipping and operating conditions.

(d) LNG storage tanks with an air space beneath the tank bottom or its foundation must be designed to withstand without loss of functional or structural integrity, the forces caused by the ignition of a combustible vapor cloud in this space.

§ 193.2219 Internal piping.

Piping connected to an inner container that is located in the space between the inner container and outer shell must be designed for not less than the pressure rating of the inner container. The piping must contain expansion loops where necessary to protect against thermal and other secondary stresses created by operation of the tank. Bellows may not be used within the space between the inner container and outer shell.

§ 193.2221 Marking.

(a) Each operator shall install and maintain a name plate in an accessible place on each storage tank and mark it in accordance with the applicable code or standard incorporated by reference in § 193.2211 or § 193.2213.

(b) Each penetration in a storage tank must be marked indicating the function of the penetration.

(c) Marking required by this section must not be obscured by frosting.

DESIGN OF TRANSFER SYSTEMS

§ 193.2223 General.

(a) Transfer systems must comply with the requirements of this subpart and other applicable requirements of this part.

(b) The design of transfer systems must provide for stress due to the frequency of thermal cycling and intermittent use to which the transfer system may be subjected.

(c) Slip type expansion joints are prohibited and packing-type joints may not be used in transfer systems for LNG or flammable refrigerants.

(d) A suitable means must be provided to precool the piping in a manner that prevents excessive stress prior to normal transfer of cold fluids.

(e) Stresses due to thermal and hydraulic shock in the piping system must be determined and accommodated by design to avoid damage to piping.

§ 193.2227 Backflow.

(a) Each transfer system must operate with a means to—

(1) Prevent backflow of liquid from a receiving container, tank car, or tank truck from causing a hazardous condition; and

(2) Maintain one-way flow where necessary for the integrity or safe operation of the LNG facility.

(b) The means provided under paragraph (a)(1) of this section must be located as close as practical to the point of connection of the transfer system and the receiving container, tank car, or tank truck.

§ 193.2229 Cargo transfer systems.

(a) Each cargo transfer system must have—

(1) A means of safely depressurizing and venting that system before disconnection;

(2) A means to provide for safe vapor displacement during transfer;

(3) Transfer piping, pumps, and compressors located or protected by suitable barriers so that they are safe from damage by tank car or tank truck movements;

(4) A signal light at each control location or remotely located pumps or compressors used for transfer which indicates whether the pump or compressor is off or in operation; and

(5) A means of communication between loading or unloading areas and other areas in which personnel are associated with the transfer operations.

(b) Hoses and arms for cargo transfer systems must be designed as follows—

(1) The design must accommodate operating pressures and temperatures encountered during the transfers;

(2) Hoses must have a bursting pressure of not less than five times the operating pressure.

(3) Arms must meet the requirements of ANSI B31.3.

(4) Adequate support must be provided, taking into account ice formation.

(5) Couplings must be designed for the frequency of any coupling or uncoupling.

§ 193.2231 Cargo transfer area.

The transfer area of a cargo transfer system must be designed—

(a) To accommodate tank cars and tank trucks without excessive maneuvering; and

(b) To permit tank trucks to enter or exit the transfer area without backing.

§ 193.2233 Shutoff valves.

(a) Shutoff valves on transfer systems must be located—

(1) On each liquid supply line, or common line to multiple supply lines, to a storage tank, or to a cargo transfer system;

(2) On each vapor or liquid return line from multiple return lines, used in a cargo transfer system;

(3) At the connection of a transfer system with a pipeline subject to Part 192 of this chapter; and

(4) To provide for proper operation and maintenance of each transfer system.

(b) Transfer system shutoff valves that are designated for operation in the emergency procedures must be manually operable at the valve and power operable at the valve and at a remote location at least 50 feet from the valve.

Subpart D—Construction

§ 193.2301 Scope.

This subpart prescribes requirements for the construction or installation of components.

§ 193.2303 Construction acceptance.

No person may place in service any component until it passes all applicable inspections and tests prescribed by this subpart.

§ 193.2304 Corrosion control overview.

(a) Subject to paragraph (b) of this section, components may not be constructed, repaired, replaced, or significantly altered until a person qualified under § 193.2707(c) reviews the applicable design drawings and materials specifications from a corrosion control viewpoint and determines that the materials involved will not impair the safety or reliability of the component or any associated components.

(b) The repair, replacement, or significant alteration of components must be reviewed only if the action to be taken—

(1) Involves a change in the original materials specified;

(2) Is due to a failure caused by corrosion; or

(3) Is occasioned by inspection revealing a significant deterioration of the component due to corrosion.

(49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1)

[Amdt. 193-2, 45 FR 70404, Oct. 23, 1980]

§ 193.2305 Procedures.

(a) In performing construction, installation, inspection, or testing, an operator must follow written specifications, procedures, and drawings, as appropriate, that are consistent with this part, taking into account relevant mechanical, chemical, and thermal properties, component functions, and environmental effects that are involved.

(b) All procedures, including any field revisions, must be substantiated by testing or experience to produce a component that is reliable and complies with the design and installation requirements of this part.

§ 193.2307 Inspection.

(a) All construction, installation, and testing activities must be inspected as frequently as necessary in accordance with a written plan to assure that—

(1) Activities are in compliance with all applicable requirements of this subpart; and

(2) Components comply with the applicable material, design, fabrication, installation, and construction requirements of this part.

(b) In addition to the requirements of paragraph (a) of this section, the construction of concrete storage tanks must be inspected in accordance with ACI-311-75.

(c) Each operator shall have a quality assurance inspection program to verify that components comply with their design specifications and drawings, including any field design changes, before they are placed in service.

§ 193.2309 Inspection and testing methods

Except as otherwise provided by this subpart, each operator shall determine, commensurate with the hazard that would result from failure of the component concerned, the scope and nature of—

(a) Inspections and tests required by this subpart; and

(b) Inspection and testing procedures required by § 193.2305.

§ 193.2311 Cleanup.

After construction or installation, as the case may be, all components must be cleaned to remove all detrimental contaminants which could cause a hazard during operation, including the following:

(a) All flux residues used in brazing or soldering must be removed from the joints and the base metal to prevent corrosive solutions from being formed.

(b) All solvent type cleaners must be tested to ensure that they will not damage equipment integrity or reliability.

(c) Incompatible chemicals must be removed.

(d) All contaminants must be captured and disposed of in a manner that does not reduce the effectiveness of corrosion protection and monitoring provided as required by this part.

§ 193.2313 Pipe welding.

(a) Each operator shall provide the following for welding on pressurized piping for LNG and other hazardous fluids:

(1) Welding procedures and welders qualified in accordance with section IX of the ASME Boiler and Pressure Vessel Code or API 1104, as applicable;

(2) When welding materials that are qualified by impact testing, welding procedures selected to minimize degradation of low temperature properties of the pipe material; and

(3) When welding attachments to pipe, procedures and techniques selected to minimize the danger of burn-throughs and stress intensification.

(b) Oxygen fuel gas welding is not permitted on flammable fluid piping with a service temperature below −29°C(−20°F).

(c) Marking materials for identifying welds on pipe must be compatible with the basic pipe material.

(d) Surfaces of components that are less than 6.35 mm (0.25 in.) thick may not be field die stamped.

(e) Where die stamping is permitted, any identification marks must be made with a die having blunt edges to minimize stress concentration.

[45 FR 9203, Feb. 11, 1980, as amended at 47 FR 32720, July 29, 1982; 47 FR 33965, Aug. 5, 1982]

§ 193.2315 Piping connections.

(a) Piping more than 2 inches nominal diameter must be joined by welding, except that—

(1) Threaded or flanged connections may be used where necessary for special connections, including connections for material transitions, instrument connections, testing, and maintenance;

(2) Copper piping in nonflammable service may be joined by silver brazing; and

(3) Material transitions may be made by any joining technique proven reliable under § 193.2305(b).

(b) If socket fittings are used, a clearance of 1.6 to 3.2 mm (0.063 to 0.126 in.) between the pipe end and the bottom of the socket recess must be provided and appropriate measurement reference marks made on the piping for the purpose of inspection.

(c) Threaded joints must be—

(1) Free of stress from external loading; and

(2) Seal welded, or sealed by other means which have been tested and proven reliable.

(d) Compression type couplings must meet the requirements of ANSI B31.3.

(e) Care shall be taken to ensure the tightness of all bolted connections. Spring washers or other such devices designed to compensate for the contraction and expansion of bolted connections during operating cycles shall be used where required.

(f) The selection of gasket material shall include the consideration of fire.

§ 193.2317 Retesting.

After testing required by this subpart is completed on a component to contain a hazardous fluid, the component must be retested whenever—

(a) Penetration welding other than tie-in welding is performed; or

(b) The structural integrity of the component is disturbed.

§ 193.2319 Strength tests.

(a) A strength test must be performed on each piping system and container to determine whether the component is capable of performing its design function, taking into account—

(1) The maximum allowable working pressure;

(2) The maximum weight of product which the component may contain or support;

(b) For piping, the test required by paragraph (a) of this section must include a pressure test conducted in accordance with section 337 of ANSI B31.3, except that test pressures must be based on the design pressure. Carbon and low alloy steel piping must be pressure tested above their nil ductility transition temperature.

(c) All shells and internal parts of heat exchangers to which section VIII, Division 1, or Division 2 of the ASME Boiler and Pressure Vessel Code, applies must be pressure tested, inspected, and stamped in accordance therewith.

§ 193.2321 Nondestructive tests.

(a) The following percentages of each day's circumferentially welded pipe joints for hazardous fluid piping, selected at random, must be nondestructively tested over the entire circumference to indicate any defects which could adversely affect the integrity of the weld or pipe:

Weld type	Cryogenic piping	Other	Test method
Butt weld more than 2 inches in nominal size.	100	30	Radiographic or ultrasonic.
Butt welds 2 inches or less in nominal size.	100	30	Radiographic, ultrasonic, liquid penetrant, or magnetic particle.
Fillet and socket welds.	100	30	Liquid penetrant or magnetic particle.

(b) Evaluation of weld tests and repair of defects must be in accordance with the requirements of ANSI B31.3 or API 1104, as applicable.

(c) Where longitudinally or spiral welded pipe is used in transfer systems, 100 percent of the seam weld must be examined by radiographic or ultrasonic inspection.

(d) The butt welds in metal shells of storage tanks with internal design pressure of not more than 15 psig must be radiographically tested in accordance with section 0.7.6, API 620, Appendix Q, except that for hydraulic load bearing shells with curved surfaces that are subject to cryogenic temperatures, 100 percent of both longitudinal (or meridional) and circumferential or (or latitudinal) welds must be radiographically tested.

(e) The butt welds in metal shells of storage tanks with internal design pressure above 15 psig must be radiographically tested in accordance with section IX of the ASME Boiler and Pressure Vessel Code, except that for hydraulic load bearing shells with curved surfaces that are subject to cryogenic temperatures, 100 percent of both longitudinal (or meridional) and circumferential (or latitudinal) welds must be radiographically tested.

§ 193.2323 Leak tests.

(a) Each container and piping system must be initially tested to assure that the component will contain the product for which it is designed without leakage.

(b) Shop fabricated containers and all flammable fluid piping must be leak tested to a minimum of the design pressure after installation but before placing it in service.

(c) For a storage tank with vacuum insulation, the inner container, outer shell, and all internal piping must be tested for vacuum leaks in accordance with an appropriate procedure.

§ 193.2325 Testing control systems.

Each control system must be tested before being placed in service to assure that it has been installed properly and will function as required by this part.

§ 193.2327 Storage tank tests.

(a) In addition to other applicable requirements of this subpart, storage tanks for cryogenic fluids with internal design pressures of not more than 15 psig must be tested in accordance with sections Q8 and Q9 of API 620, Appendix Q, as applicable.

(b) Metal storage tanks for cryogenic fluids with internal design pressures above 15 psig must be tested in accordance with the applicable division of section VIII of the ASME Boiler and Pressure Vessel Code.

(c) Reference measurements must be made with appropriate precise instruments to assure that the tank is gas tight and lateral and vertical movement of the storage tank does not exceed predetermined design tolerances.

§ 193.2329 Construction records.

For the service life of the component concerned, each operator shall retain appropriate records of the following:

(a) Specifications, procedures, and drawings prepared for compliance with § 193.2305; and

(b) Results of tests, inspections, and the quality assurance program required by this subpart.

EFFECTIVE DATE NOTE: At 45 FR 9184-9185, Feb. 11, 1980, the effectiveness of § 193.2329 was deferred pending further notice.

Subpart E—Equipment

§ 193.2401 Scope.

This subpart prescribes requirements for the design, fabrication, and installation of vaporization equipment, liquefaction equipment, and control systems.

Vaporization Equipment

§ 193.2403 General.

Vaporizers must comply with the requirements of this subpart and the other applicable requirements of this part.

§ 193.2405 Vaporizer design.

(a) Vaporizers must be designed and fabricated in accordance with applicable provisions of section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code.

(b) Each vaporizer must be designed for the maximum allowable working pressure at least equal to the maximum discharge pressure of the pump or pressurized container system supplying it, whichever is greater.

§ 193.2407 Operational control.

(a) Vaporizers must be equipped with devices which monitor the inlet pressure of the LNG, the outlet temperature, and the pressure of the vaporized gas, and the inlet pressure of the heating medium fluids.

(b) Manifolded vaporizers must be equipped with:

(1) Two inlet valves in series to prevent LNG from entering an idle vaporizer; and

(2) A means to remove LNG or gas which accumulates between the valves.

§ 193.2409 Shutoff valves.

(a) A shutoff valve must be located on transfer piping supplying LNG to a vaporizer. The shutoff valve must be located at a sufficient distance from the vaporizer to minimize potential for damage from explosion or fire at the vaporizer. If the vaporizer is installed in a building, the shutoff valve must be located outside the building.

(b) A shutoff valve must be located on each outlet of a vaporizer.

(c) For vaporizers designed to use a flammable intermediate fluid, a shutoff valve must be located on the inlet and outlet line of the intermediate fluid piping system where they will be operable during a controllable emergency involving the vaporizer.

§ 193.2411 Relief devices.

The capacity of pressure relief devices required for vaporizers by § 193.2429 is governed by the following:

(a) For heated vaporizers, the capacity must be at least 110 percent of rated natural gas flow capacity without allowing the pressure to rise more than 10 percent above the vaporizer's maximum allowable working pressure.

(b) For ambient vaporizers, the capacity must be at least 150 percent of rated natural gas flow capacity without allowing the pressure to rise more than 10 percent above the vaporizer's maximum allowable working pressure.

§ 193.2413 Combustion air intakes.

(a) Combustion air intakes to vaporizers must be equipped with sensing devices to detect the induction of a flammable vapor.

(b) If a heated vaporizer or vaporizer heater is located in a building, the combustion air intake must be located outside the building.

Liquefaction Equipment

§ 193.2415 General.

Liquefaction equipment must comply with the requirements of this subpart and the other applicable requirements of this part.

§ 193.2417 Control of incoming gas.

A shutoff valve must be located on piping delivering natural gas to each liquefaction system.

§ 193.2419 Backflow.

Each multiple parallel piping system connected to liquefaction equipment must have devices to prevent backflow from causing a hazardous condition.

§ 193.2421 Cold boxes.

(a) Each cold box in a liquefaction system must be equipped with a means

of monitoring or detecting, as appropriate, the concentration of natural gas in the insulation space.

(b) If the insulation space in a cold box is designed to operate with a gas rich atmosphere, additional natural gas must be introduced when the concentration of gas falls to 30 percent.

(c) If the insulation space of a cold box is designed to operate with a gas free atmosphere, additional air or inert gas, as appropriate, must be introduced when the concentration of gas is 25 percent of the lower flammable limit.

§ 193.2423 Air in gas.

Where incoming gas to liquefaction equipment contains air, each operator shall provide a means of preventing a flammable mixture from occurring under any operating condition.

Control Systems

§ 193.2427 General.

(a) Control systems must comply with the requirements of this subpart and other applicable requirements of this part.

(b) Each control system must be capable of performing its design function under normal operating conditions.

(c) Control systems must be designed and installed in a manner to permit maintenance, including inspection or testing, in accordance with this part.

(d) Local, remote, and redundant signal lines installed for control systems that can affect the operation of a component that does not fail safe must be routed separately or in separate underground conduits installed in accordance with NFPA-70.

§ 193.2429 Relief devices.

(a) Each component containing a hazardous fluid must be equipped with a system of automatic relief devices which will release the contained fluid at a rate sufficient to prevent pressures from exceeding 110 percent of the maximum allowable working pressure. In establishing relief capacity, each operator shall consider trapping of fluid between valves; the maximum rates of boiloff and expansion of fluid which may occur during normal operation, particularly cooldown; and controllable emergencies.

(b) A component in which internal vacuum conditions can occur must be equipped with a system of relief devices or other control system to prevent development in the component of a vacuum that might create a hazardous condition. Introduction of gas into a component must not create a flammable mixture within the component.

(c) In addition to the control system required by paragraphs (a) and (b) of this section—

(1) Each LNG Storage tank must be equipped with relief devices to assure that design pressure and vacuum relief capacity is available during maintenance of the system; and

(2) A manual means must be provided to relieve pressure and vacuum in an emergency.

(d) Relief devices must be installed in a manner to minimize the possibility that release of fluid could—

(1) Cause an emergency; or

(2) Worsen a controllable emergency.

(e) The means for adjusting the set-point pressure of all adjustable relief devices must be sealed.

(f) Relief devices which are installed to limit minimum or maximum pressure may not be used to handle boiloff and flash gases during normal operation.

§ 193.2431 Vents.

(a) Hazardous fluids may not be relieved into the atmosphere of a building or other confined space.

(b) Boiloff vents for hazardous fluids may not draw in air during operation.

(c) Venting of natural gas/vapor under operational control which could produce a hazardous gas atmosphere must be directed to a flare stack or heat exchanger in order to raise its temperature to achieve positive buoyancy and safe venting.

(49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-2, 45 FR 70404, Oct. 23, 1980]

§ 193.2433 Sensing devices.

(a) Each operator shall determine the appropriate location for and install sensing devices as necessary to—

(1) Monitor the operation of components to detect a malfunction which could cause a hazardous condition if permitted to continue; and

(2) Detect the presence of fire or combustible gas in areas determined in accordance with section 500-4 of NFPA 70 to have a potential for the presence of flammable fluids.

(b) Buildings in which potentially hazardous quantities of flammable fluids are used or handled must be continuously monitored by gas sensing devices set to activate audible and visual alarms in the building and at the control center when the concentration of the fluid in air is not more than 25 percent of the lower flammable limit.

§ 193.2435 Warning devices.

Each operator shall install warning devices in the control center to warn of hazardous conditions detected by all sensing devices required by this part. Warnings must be given both audibly and visibly and must be designed to gain the attention of personnel. Warnings must indicate the location and nature of the existing or potential hazard.

§ 193.2437 Pump and compressor control.

(a) Each pump and compressor for hazardous fluids must be equipped with—

(1) A control system, operable locally and remotely, to shut down the pump or compressor in a controllable emergency;

(2) A signal light at the pump or compressor and the remote control location which indicates whether the pump or compressor is in operation or off;

(3) Adequate valving to ensure that the pump or compressor can be isolated for maintenance; and

(4) A check valve on each discharge line where pumps or compressors operate in parallel.

(b) Pumps or compressors in a cargo transfer system must have shutdown controls at the loading or unloading area and at the pump or compressor site.

§ 193.2439 Emergency shutdown control systems.

(a) Each transfer system, vaporizer, liquefaction system, and storage system tank must be equipped with an emergency shutdown control system. The control must automatically actuate the shutdown of the component (providing pressure relief as necessary) when any of the following occurs:

(1) Temperatures of the component exceed the limits determined under § 193.2105;

(2) Pressure outside the limits of the maximum and minimum design pressure;

(3) Liquid in receiving vessel reaches the design maximum liquid level;

(4) Gas concentrations in the area of the component exceed 40 percent of the lower flammable limit;

(5) A sudden excessive pressure change or other condition indicating a potentially dangerous condition; and

(6) Presence of fire in area of component.

(b) For cargo transfer systems where all transfer operations are continuously manned and visually supervised by qualified personnel, actuation of the emergency shutdown control system may be manual after devices warn of the events listed in paragraph (a) of this section.

(c) Except for components that operate unattended and are remote from the control center, a reasonable delay may be programmed in emergency shutdown control systems required by this section between warning and automated shutdown to provide for manual response.

(d) Each LNG plant must have a shutdown control system to shut down all operations of the plant safely. The system must be operable at—

(1) The control center; and

(2) In the case of a plant where LNG facilities other than the control center are designed to operate unattended at the site of these facilities.

§ 193.2441 Control center.

Each LNG plant must have a control center from which operations and warning devices are monitored as required by this part. A control center must have the following capabilities and characteristics:

(a) It must be located apart or protected from other LNG facilities so that it is operational during a controllable emergency.

(b) Each remotely actuated control system and each automatic shutdown control system required by this part must be operable from the control center.

(c) Each control center must have personnel in continuous attendance while any of the components under its control are in operation, unless the control is being performed from another control center which has personnel in continuous attendance.

(d) If more than one control center is located at an LNG Plant, each control center must have more than one means of communication with each other center.

(e) Each control center must have a means of communicating a warning of hazardous conditions to other locations within the plant frequented by personnel.

§ 193.2443 Fail-safe control.

Control systems for components must have a fail-safe design. A safe condition must be maintained until personnel take appropriate action either to reactivate the component served or to prevent a hazard from occurring.

§ 193.2445 Sources of power.

(a) Electrical control systems, means of communication, emergency lighting, and firefighting systems must have at least two sources of power which function so that failure of one source does not affect the capability of the other source.

(b) Where auxiliary generators are used as a second source of electrical power:

(1) They must be located apart or protected from components so that they are not unusable during a controllable emergency; and

(2) Fuel supply must be protected from hazards.

Subpart F—Operations

AUTHORITY: 49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: Amdt. 193-2, 45 FR 70405, Oct. 23, 1980, unless otherwise noted.

§ 193.2501 Scope.

This subpart prescribes requirements for the operation of LNG facilities.

§ 193.2503 Operating procedures.

Each operator shall follow one or more manuals of written procedures to provide safety in normal operation and in responding to an abnormal operation that would affect safety. The procedures must include provisions for:

(a) Monitoring components or buildings according to the requirements of § 193.2507.

(b) Startup and shutdown, including for initial startup, performance testing to demonstrate that components will operate satisfactory in service.

(c) Recognizing abnormal operating conditions.

(d) Purging and inerting components according to the requirements of § 193.2517.

(e) In the case of vaporization, maintaining the vaporization rate, temperature and pressure so that the resultant gas is within limits established for the vaporizer and the downstream piping;

(f) In the case of liquefaction, maintaining temperatures, pressures, pressured differentials and flow rates, as applicable, within their design limits for:

(1) Boilers;

(2) Turbines and other prime movers;

(3) Pumps, compressors, and expanders;

(4) Purification and regeneration equipment; and

(5) Equipment within cold boxes.

(g) Cooldown of components according to the requirements of § 193.2505; and

(h) Compliance with § 193.2805(b).

§ 193.2505 Cooldown.

(a) The cooldown of each system of components that is subjected to cryogenic temperatures must be limited to a rate and distribution pattern that keeps thermal stresses within design limits during the cooldown period, paying particular attention to the performance of expansion and contraction devices.

(b) After cooldown stabilization is reached, cryogenic piping systems must be checked for leaks in areas of flanges, valves, and seals.

§ 193.2507 Monitoring operations.

Each component in operation or building determined under § 193.2805(a)(2) in which a hazard to persons or property could exist must be monitored to detect fire or any malfunction or flammable fluid which could cause a hazardous condition. Monitoring must be accomplished by watching or listening from an attended control center for warning alarms, such as gas, temperature, pressure, vacuum, and flow alarms, or by conducting an inspection or test at intervals specified in the operating procedures.

§ 193.2509 Emergency procedures.

(a) Each operator shall determine the types and places of emergencies other than fires that may reasonably be expected to occur at an LNG plant due to operating malfunctions, structural collapse, personnel error, forces of nature, and activities adjacent to the plant.

(b) To adequately handle each type of emergency identified under paragraph (a) of this section and each fire emergency identified under § 193.2817(a), each operator shall follow one or more manuals of written procedures. The procedures must provide for the following:

(1) Responding to controllable emergencies, including notifying personnel and using equipment appropriate for handling the emergency.

(2) Recognizing an uncontrollable emergency and taking action to minimize harm to the public and personnel, including prompt notification of appropriate local officials of the emergency and possible need for evacuation of the public in the vicinity of the LNG plant.

(3) Coordinating with appropriate local officials in preparation of an emergency evacuation plan, which sets forth the steps required to protect the public in the event of an emergency, including catastrophic failure of an LNG storage tank.

(4) Cooperating with appropriate local officials in evacuations and emergencies requiring mutual assistance and keeping these officials advised of:

(i) The LNG plant fire control equipment, its location, and quantity of units located throughout the plant;

(ii) Potential hazards at the plant, including fires;

(iii) Communication and emergency control capabilities at the LNG plant; and

(iv) The status of each emergency.

§ 193.2511 Personnel safety.

(a) Each operator shall provide any special protective clothing and equipment necessary for the safety of personnel while they are performing emergency response duties.

(b) All personnel who are normally on duty at a fixed location, such as a building or yard, where they could be harmed by thermal radiation from a burning pool of impounded liquid, must be provided a means of protection at that location from the harmful effects of thermal radiation or a means of escape.

(c) Each LNG plant must be equipped with suitable first-aid material, the location of which is clearly marked and readily available to personnel.

§ 193.2513 Transfer procedures.

(a) Each transfer of LNG or other hazardous fluid must be conducted in accordance with one or more manuals of written procedures to provide for safe transfers.

(b) The transfer procedures must include provisions for personnel to:

(1) Before transfer, verify that the transfer system is ready for use, with connections and controls in proper positions, including if the system could contain a combustible mixture, verifying that it has been adequately purged

in accordance with a procedure which meets the requirements of AGA "Purging Principles and Practice."

(2) Before transfer, verify that each receiving container or tank vehicle does not contain any substance that would be incompatible with the incoming fluid and that there is sufficient capacity available to receive the amount of fluid to be transferred;

(3) Before transfer, verify the maximum filling volume of each receiving container or tank vehicle to ensure that expansion of the incoming fluid due to warming will not result in overfilling or overpressure;

(4) When making bulk transfer of LNG into a partially filled (excluding cooldown heel) container, determine any differences in temperature or specific gravity between the LNG being transferred and the LNG already in the container and, if necessary, provide a means to prevent rollover due to stratification.

(5) Verify that the transfer operations are proceeding within design conditions and that overpressure or overfilling does not occur by monitoring applicable flow rates, liquid levels, and vapor returns.

(6) Manually terminate the flow before overfilling or overpressure occurs; and

(7) Deactivate cargo transfer systems in a safe manner by depressurizing, venting, and disconnecting lines and conducting any other appropriate operations.

(c) In addition to the requirements of paragraph (b) of this section, the procedures for cargo transfer must be located at the transfer area and include provisions for personnel to:

(1) Be in constant attendance during all cargo transfer operations;

(2) Prohibit the backing of tank trucks in the transfer area, except when a person is positioned at the rear of the truck giving instructions to the driver;

(3) Before transfer, verify that:

(i) Each tank car or tank truck complies with applicable regulations governing its use;

(ii) All transfer hoses have been visually inspected for damage and defects;

(iii) Each tank truck is properly immobilized with chock wheels, and electrically grounded; and

(iv) Each tank truck engine is shut off unless it is required for transfer operations;

(4) Prevent a tank truck engine that is off during transfer operations from being restarted until the transfer lines have been disconnected and any released vapors have dissipated;

(5) Prevent loading LNG into a tank car or tank truck that is not in exclusive LNG service or that does not contain a positive pressure if it is in exclusive LNG service, until after the oxygen content in the tank is tested and if it exceeds 2 percent by volume, purged in accordance with a procedure that meets the requirements of AGA "Purging Principles and Practice;"

(6) Verify that all transfer lines have been disconnected and equipment cleared before the tank car or tank truck is moved from the transfer position; and

(7) Verify that transfers into a pipeline system will not exceed the pressure or temperature limits of the system.

§ 193.2515 Investigations of failures.

(a) Each operator shall investigate the cause of each explosion, fire, or LNG spill or leak which results in:

(1) Death or injury requiring hospitalization; or

(2) Property damage exceeding $10,000.

(b) As a result of the investigation, appropriate action must be taken to minimize recurrence of the incident.

(c) If the Director or relevant state agency under section 5 of the Natural Gas Pipeline Safety Act of 1968 (49 U.S.C. 1674) investigates an incident, the operator involved shall make available all relevant information and provide reasonable assistance in conducting the investigation. Unless necessary to restore or maintain service, or for safety, no component involved in the incident may be moved from its location or otherwise altered until the investigation is complete or the investigating agency otherwise provides. Where components must be moved for operational or safety reasons, they must not be removed from the plant site and must be maintained intact to the extent practicable until the investigation is complete or the investigating agency otherwise provides.

§ 193.2517 Purging.

When necessary for safety, components that could accumulate significant amounts of combustible mixtures must be purged in accordance with a procedure which meets the provisions of the AGA "Purging Principles and Practice" after being taken out of service and before being returned to service.

§ 193.2519 Communication systems.

(a) Each LNG plant must have a primary communication system that provides for verbal communications between all operating personnel at their work stations in the LNG plant.

(b) Each LNG plant in excess of 70,000 gallons storage capacity must have an emergency communication system that provides for verbal communications between all persons and locations necessary for the orderly shutdown of operating equipment and the operation of safety equipment in time of emergency. The emergency communication system must be independent of and physically separated from the primary communication system and the security communication system under § 193.2909.

(c) Each communication system required by this part must have an auxiliary source of power, except sound-powered equipment.

§ 193.2521 Operating records.

Each operator shall maintain a record of the results of each inspection, test, and investigation required by this subpart. Such records must be kept for a period of not less than 5 years.

Subpart G—Maintenance

AUTHORITY: 49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: Amdt. 193-2, 45 FR 70407, Oct. 23, 1980, unless otherwise noted.

§ 193.2601 Scope.

This subpart prescribes requirements for maintaining components at LNG plants.

§ 193.2603 General.

(a) Each component in service, including its support system, must be maintained in a condition that is compatible with its operational or safety purpose by repair, replacement, or other means.

(b) An operator may not place, return, or continue in service any component which is not maintained in accordance with this subpart.

(c) Each component taken out of service must be identified in the records kept under § 193.2639.

(d) If a safety device is taken out of service for maintenance, the component being served by the device must be taken out of service unless the same safety function is provided by an alternate means.

(e) If the inadvertent operation of a component taken out of service could cause a hazardous condition, that component must have a tag attached to the controls bearing the words "do not operate" or words of comparable meaning.

§ 193.2605 Maintenance procedures.

(a) Each operator shall determine and perform, consistent with generally accepted engineering practice, the periodic inspections or tests needed to meet the applicable requirements of this subpart and to verify that components meet the maintenance standards prescribed by this subpart.

(b) Each operator shall follow one or more manuals of written procedures for the maintenance of each component, including any required corrosion control. The procedures must include:

(1) The details of the inspections or tests determined under paragraph (a) of this section and their frequency of performance; and

(2) A description of other actions necessary to maintain the LNG plant in accordance with the requirements of this subpart and § 193.2805.

§ 193.2607 Foreign material.

(a) The presence of foreign material, contaminants, or ice shall be avoided or controlled to maintain the operational safety of each component.

(b) LNG plant grounds must be free from rubbish, debris, and other material which present a fire hazard. Grass areas on the LNG plant grounds must be maintained in a manner that does not present a fire hazard.

§ 193.2609 Support systems.

Each support system or foundation of each component must be inspected for any detrimental change that could impair support.

§ 193.2611 Fire protection.

(a) Maintenance activities on fire control equipment must be scheduled so that a minimum of equipment is taken out of service at any one time and is returned to service in a reasonable period of time.

(b) Access routes for movement of fire control equipment within each LNG plant must be maintained to reasonably provide for use in all weather conditions.

§ 193.2613 Auxiliary power sources.

Each auxiliary power source must be tested monthly to check its operational capability and tested annually for capacity. The capacity test must take into account the power needed to start up and simultaneously operate equipment that would have to be served by that power source in an emergency.

§ 193.2615 Isolating and purging.

(a) Before personnel begin maintenance activities on components handling flammable fluids which are isolated for maintenance, the component must be purged in accordance with a procedure which meets the requirements of AGA "Purging Principles and Practices," unless the maintenance procedures under § 193.2605 provide that the activity can be safely performed without purging.

(b) If the component or maintenance activity provides an ignition source, a technique in addition to isolation valves (such as removing spool pieces or valves and blank flanging the piping, or double block and bleed valving) must be used to ensure that the work area is free of flammable fluids.

§ 193.2617 Repairs.

(a) Repair work on components must be performed and tested in a manner which:

(1) As far as practicable, complies with the applicable requirements of Subpart D of this part; and

(2) Assures the integrity and operational safety of the component being repaired.

(b) For repairs made while a component is operating, each operator shall include in the maintenance procedures under § 193.2605 appropriate precautions to maintain the safety of personnel and property during repair activities.

§ 193.2619 Control systems.

(a) Each control system must be properly adjusted to operate within design limits.

(b) If a control system is out of service for 30 days or more, it must be inspected and tested for operational capability before returning it to service.

(c) Control systems in service, but not normally in operation (such as relief valves and automatic shutdown devices), must be inspected and tested once each calendar year, but with intervals not exceeding 15 months, with the following exceptions:

(1) Control systems used seasonally, such as for liquefaction or vaporization, must be inspected and tested before use each season.

(2) Control systems that are intended for fire protection must be inspected and tested at regular intervals not to exceed 6 months.

(d) Control systems that are normally in operation, such as required by a base load system, must be inspected and tested once each calendar year but with intervals not exceeding 15 months.

(e) Relief valves must be inspected and tested for verification of the valve seat lifting pressure and reseating.

§ 193.2621 Testing transfer hoses.

Hoses used in LNG or flammable refrigerant transfer systems must be:

(a) Tested once each calendar year, but with intervals not exceeding 15 months, to the maximum pump pressure or relief valve setting; and

(b) Visually inspected for damage or defects before each use.

§ 193.2623 Inspecting LNG storage tanks.

Each LNG storage tank must be inspected or tested to verify that each of the following conditions does not impair the structural integrity or safety of the tank:

(a) Foundation and tank movement during normal operation and after a major meteorological or geophysical disturbance.

(b) Inner tank leakage.

(c) Effectiveness of insulation.

(d) Frost heave.

[Amdt. 193-2, 45 FR 70407, Oct. 23, 1980, as amended at 47 FR 32720, July 29, 1982]

§ 193.2625 Corrosion protection.

(a) Each operator shall determine which metallic components could, unless corrosion is controlled, have their integrity or reliability adversely affected by external, internal, or atmospheric corrosion during their intended service life.

(b) Components whose integrity or reliability could be adversely affected by corrosion must be either—

(1) Protected from corrosion in accordance with §§ 193.2627 through 193.2635, as applicable; or

(2) Inspected and replaced under a program of scheduled maintenance in accordance with procedures established under § 193.2605.

§ 193.2627 Atmospheric corrosion control.

Each exposed component that is subject to atmospheric corrosive attack must be protected from atmospheric corrosion by—

(a) Material that has been designed and selected to resist the corrosive atmosphere involved; or

(b) Suitable coating or jacketing.

§ 193.2629 External corrosion control; buried or submerged components.

(a) Each buried or submerged component that is subject to external corrosive attack must be protected from external corrosion by—

(1) Material that has been designed and selected to resist the corrosive environment involved; or

(2) The following means:

(i) An external protective coating designed and installed to prevent corrosion attack and to meet the requirements of § 192.461 of this chapter; and

(ii) A cathodic protection system designed to protect components in their entirety in accordance with the requirements of § 192.463 of this chapter and placed in operation before October 23, 1981, or within 1 year after the component is constructed or installed, whichever is later.

(b) Where cathodic protection is applied, components that are electrically interconnected must be protected as a unit.

[Amdt. 193-2, 45 FR 70407, Oct. 23, 1980, as amended at 47 FR 32720, July 29, 1982]

§ 193.2631 Internal corrosion control.

Each component that is subject to internal corrosive attack must be protected from internal corrosion by—

(a) Material that has been designed and selected to resist the corrosive fluid involved; or

(b) Suitable coating, inhibitor, or other means.

§ 193.2633 Interference currents.

(a) Each component that is subject to electrical current interference must be protected by a continuing program to minimize the detrimental effects of currents.

(b) Each cathodic protection system must be designed and installed so as to minimize any adverse effects it might cause to adjacent metal components.

(c) Each impressed current power source must be installed and maintained to prevent adverse interference with communications and control systems.

§ 193.2635 Monitoring corrosion control.

Corrosion protection provided as required by this subpart must be periodically monitored to give early recognition of ineffective corrosion protection, including the following, as applicable:

(a) Each buried or submerged component under cathodic protection must be tested at least once each calendar year, but with intervals not exceeding 15 months, to determine whether the cathodic protection meets the requirements of § 192.463 of this chapter.

(b) Each cathodic protection rectifier or other impressed current power source must be inspected at least 6 times each calendar year, but with intervals not exceeding 2½ months, to ensure that it is operating properly.

(c) Each reverse current switch, each diode, and each interference bond whose failure would jeopardize component protection must be electrically checked for proper performance at least 6 times each calendar year, but with intervals not exceeding 2½ months. Each other interference bond must be checked at least once each calendar year, but with intervals not exceeding 15 months.

(d) Each component that is protected from atmospheric corrosion must be inspected at intervals not exceeding 3 years.

(e) If a component is protected from internal corrosion, monitoring devices designed to detect internal corrosion, such as coupons or probes, must be located where corrosion is most likely to occur. However, monitoring is not required for corrosion resistant materials if the operator can demonstrate that the component will not be adversely affected by internal corrosion during its service life. Internal corrosion control monitoring devices must be checked at least two times each calendar year, but with intervals not exceeding 7½ months.

§ 193.2637 Remedial measures.

Prompt corrective or remedial action must be taken whenever an operator learns by inspection or otherwise that atmospheric, external, or internal corrosion is not controlled as required by this subpart.

§ 193.2639 Maintenance records.

(a) Each operator shall keep a record at each LNG plant of the date and type of each maintenance activity performed on each component to meet the requirements of this subpart, including periodic tests and inspections, for a period of not less than five years.

(b) Each operator shall maintain records or maps to show the location of cathodically protected components, neighboring structures bonded to the cathodic protection system, and corrosion protection equipment.

(c) Each of the following records must be retained for as long as the LNG facility remains in service:

(1) Each record or map required by paragraph (b) of this section.

(2) Records of each test, survey, or inspection required by this subpart in sufficient detail to demonstrate the adequacy of corrosion control measures.

Subpart H—Personnel Qualifications and Training

AUTHORITY: 49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: Sections 193.2707—193.2719 appear at 45 FR 70404, Oct. 23, 1980 (Amdt. 193-2), unless otherwise noted.

§ 193.2701 Scope.

This subpart prescribes requirements for personnel qualifications and training.

[45 FR 9219, Feb. 11, 1980]

§ 193.2703 Design and fabrication.

For the design and fabrication of components, each operator shall use—

(a) With respect to design, persons who have demonstrated competence by training or experience in the design of comparable components.

(b) With respect to fabrication, persons who have demonstrated competence by training or experience in the fabrication of comparable components.

[45 FR 9219, Feb. 11, 1980]

§ 193.2705 Construction, installation, inspection, and testing.

(a) Supervisors and other personnel utilized for construction, installation, inspection, or testing must have demonstrated their capability to perform satisfactorily the assigned function by appropriate training in the methods and equipment to be used or related experience and accomplishments.

(b) Each operator must periodically determine whether inspectors performing duties under § 193.2307 are satisfactorily performing their assigned function.

[45 FR 9219, Feb. 11, 1980]

§ 193.2707 Operations and maintenance.

(a) Each operator shall utilize for operation or maintenance of components only those personnel who have demonstrated their capability to perform their assigned functions by—

(1) Successful completion of the training required by §§ 193.2713 and 193.2717; and

(2) Experience related to the assigned operation or maintenance function; and

(3) Acceptable performance on a proficiency test relevant to the assigned function.

(b) A person who does not meet the requirements of paragraph (a) of this section may operate or maintain a component when accompanied and directed by an individual who meets the requirements.

(c) Corrosion control procedures under § 193.2605(b), including those for the design, installation, operation, and maintenance of cathodic protection systems, must be carried out by, or under the direction of, a person qualified by experience and training in corrosion control technology.

§ 193.2709 Security.

Personnel having security duties must be qualified to perform their assigned duties by successful completion of the training required under § 193.2715.

§ 193.2711 Personnel health.

Each operator shall follow a written plan to verify that personnel assigned operating, maintenance, security, or fire protection duties at the LNG plant do not have any physical condition that would impair performance of their assigned duties. The plan must be designed to detect both readily observable disorders, such as physical handicaps or injury, and conditions requiring professional examination for discovery.

§ 193.2713 Training: operations and maintenance.

(a) Each operator shall provide and implement a written plan of initial training to instruct—

(1) All permanent maintenance, operating, and supervisory personnel—

(i) About the characteristics and hazards of LNG and other flammable fluids used or handled at the facility, including, with regard to LNG, low temperatures, flammability of mixtures with air, odorless vapor, boiloff characteristics, and reaction to water and water spray;

(ii) About the potential hazards involvd in operating and maintenance activities; and

(iii) To carry out aspects of the operating and maintenance procedures under §§ 193.2503 and 193.2605 that relate to their assigned functions; and

(2) All personnel—

(i) To carry out the emergency procedures under § 193.2509 that relate to their assigned functions; and

(ii) To give first-aid; and

(3) All operating and appropriate supervisory personnel—

(i) To understand detailed instructions on the facility operations, including controls, functions, and operating procedures; and

(ii) To understand the LNG transfer procedures provided under § 193.2513.

(b) A written plan of continuing instruction must be conducted at intervals of not more than two years to keep all personnel current on the knowledge and skills they gained in the program of initial instruction.

§ 193.2715 Training: security.

(a) Personnel responsible for security at an LNG plant must be trained in accordance with a written plan of initial instruction to:

(1) Recognize breaches of security;

(2) Carry out the security procedures under § 193.2903 that relate to their assigned duties;

(3) Be familiar with basic plant operations and emergency procedures, as necessary to effectively perform their assigned duties; and

(4) Recognize conditions where security assistance is needed.

(b) A written plan of continuing instruction must be conducted at intervals of not more than two years to keep all personnel having security duties current on the knowledge and skills they gained in the program of initial instruction.

§ 193.2717 Training: fire protection.

(a) All personnel involved in maintenance and operations of an LNG plant, including their immediate supervisors, must be trained in accordance with a written plan of initial instruction, including plant fire drills, to:

(1) Know and follow the fire prevention procedures under § 193.2805(b);

(2) Know the potential causes and areas of fire determined under § 193.2805(a);

(3) Know the types, sizes, and predictable consequences of fire determined under § 193.2817(a); and

(4) Know and be able to perform their assigned fire control duties according to the procedures established under § 193.2509 and by proper use of equipment provided under § 193.2817.

(b) A written plan of continuing instruction, including plant fire drills, must be conducted at intervals of not more than two years to keep personnel current on the knowledge and skills they gained in the instruction under paragraph (a) of the section.

§ 193.2719 Training: records.

(a) Each operator shall maintain a system of records which—

(1) Provide evidence that the training programs required by this subpart have been implemented; and

(2) Provide evidence that personnel have undergone and satisfactorily completed the required training programs.

(b) Records must be maintained for one year after personnel are no longer assigned duties at the LNG plant.

Subpart I—Fire Protection

AUTHORITY: 49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: Amdt. 193-2, 45 FR 70408, Oct. 23, 1980, unless otherwise noted.

§ 193.2801 Scope.

This subpart prescribes requirements for fire prevention and fire control at LNG plants other than waterfront LNG plants.

§ 193.2803 General.

Each operator shall use sound fire protection engineering principles to minimize the occurrence and consequences of fire.

§ 193.2805 Fire prevention plan.

(a) Each operator shall determine—

(1) Those potential sources of ignition located inside and adjacent to the LNG plant which could cause fires that affect the safety of the plant; and

(2) Those areas, as described in section 500-4 of MFPA-70, where the potential exists for the presence of flammable fluids in an LNG plant. Determinations made under this paragraph must be kept current.

(b) With respect to areas determined under paragraph (a)(2) of this section, each operator shall include in the operating and maintenance procedures under § 193.2503 and § 193.2605, as appropriate, steps necessary to minimize—

(1) The leakage or release of flammable fluids; and

(2) The possibility of flammable fluids being ignited by sources identified under paragraph (a)(1) of this section.

§ 193.2807 Smoking.

(a) (1) Smoking is prohibited at an LNG plant in areas identified under § 193.2805(a)(2).

(2) Smoking is permitted only in such locations that the operator designates as a smoking area.

(b) Signs marked with the words "smoking permitted" must be displayed in prominent places in each smoking area designated under paragraph (a) of this section.

(c) Signs marked with the words "NO SMOKING" must be displayed in prominent places in areas where smoking is prohibited.

§ 193.2809 Open fires.

(a) No open fires are permitted at an LNG plant, except at flare stacks and at times and places designated by the operator.

(b) Whenever an open fire is designated, there must be at the site of the fire—

(1) Trained fire fighting personnel; and

(2) Fire control equipment which has the capability of extinguishing the fire.

(c) The fire fighting personnel and equipment must remain at the fire site until the fire is extinguished and there is no possibility of reignition.

§ 193.2811 Hotwork.

Welding, flame cutting, and similar operations are prohibited, except at times and places that the operator designates in writing as safe and when constantly supervised in accordance with NFPA-51B.

§ 193.2813 Storage of flammable fluids.

Flammable fluids may not be stored in areas where ignition sources are present, unless stored in accordance with the requirements of Chapter 4 of NFPA 30.

§ 193.2815 Motorized equipment.

Use of motor vehicles and other motorized equipment which constitute potential ignition sources is prohibited in an impounding space, in areas within 15 m (49.2 ft) of a storage tank, and in areas within 15 m (49.2 ft) of processing equipment containing a flammable fluid except–

(a) At times the operator designates in writing as safe; and

(b) When the motorized equipment is constantly attended.

§ 193.2817 Fire equipment.

(a) Each operator shall determine: (1) the types and sizes of fires that may reasonably be expected to occur within and adjacent to each LNG plant that could affect the safety of components; and

(2) The foreseeable consequences of these fires, including the failure of components or buildings due to heat exposure.

(b) Each operator shall provide and maintain fire control equipment and supplies in accordance with the applicable requirements of NFPA 59A to protect or cool components that could fail due to heat exposure from fires determined under paragraph (a) of this section and either worsen an emergency or endanger persons or property located outside the plant. Protection or cooling must be provided for as long as the heat exposure exists. The fire control equipment and supplies must include the following:

(1) Portable fire extinguishers suitable for types of fires identified under paragraph (a) of this section; and

(2) If the total inventory of LNG is 265 m^3 (70,000 gal.) or more, a water supply and associated delivery system.

(c) Each operator shall determine the type, size, quantity and location of the fire control equipment and supplies required under paragraph (b) of this section.

(d) Each operator shall provide each facility person who may be endangered by exposure to fire or the products of combustion in performing fire control duties protective clothing and equipment, including, if necessary, a self-contained breathing apparatus.

(e) Portable fire control equipment, protective clothing and equipment for personnel use, controls for fixed fire control equipment, and fire control supplies must be conspicuously located, marked for easy recognition, and readily available for use.

(f) Fire control equipment must have operating instructions. Instructions must be attached to portable equipment and placed at the location of controls for fixed equipment.

§ 193.2819 Gas detection.

(a) All areas determined under § 193.2805(a)(2) in which a hazard to persons or property could exist must be continuously monitored for the presence of flammable gases and vapors with fixed flammable gas detection systems provided and maintained according to the applicable requirements of NFPA 59A.

(b) Each fixed flammable gas detection system must be provided with audible and visible alarms located at an attended control room or control station, and an audible alarm in the area of gas detection.

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(c) Flammable gas detection alarms must be set to activate at not more than 25 percent of the lower flammable limit of the gas or vapor being monitored.

(d) Gas detection systems must be installed so that they can be readily tested as required by NFPA 59A.

(e) A minimum of two portable flammable gas detectors capable of measuring the lower flammable limit must be available at the LNG plant for use at all times.

(f) All enclosed buildings located on an LNG plant must be continuously monitored for the presence of flammable gases and vapors with a fixed flammable gas detection system that provides a visible or audible alarm outside the enclosed building. The systems must be provided and maintained according to the applicable requirements of NFPA 59A.

§ 193.2821 Fire detection.

(a) Fire detectors that continuously monitor for the presence of either flame, heat, or products of combustion must be provided in all areas determined under § 193.2805(a)(2) in which a hazard to persons or property could exist and in all other areas that are used for the storage of flammable or combustible material.

(b) Each fire detection system must be provided with audible and visible alarms located at an attended control room or control station, and an audible alarm in the area of fire detection. The systems must be provided and maintained according to the applicable requirements of NFPA 59A.

Subpart J—Security

AUTHORITY: 49 U.S.C. 1674(a); 49 CFR 1.53 and Appendix A to Part 1.

SOURCE: Amdt. 193-2, 45 FR 70409, Oct. 23, 1980, unless otherwise noted.

§ 193.2901 Scope.

This subpart prescribes requirements for security at LNG plants other than waterfront LNG plants.

§ 193.2903 Security procedures.

Each operator shall prepare and follow one or more manuals of written procedures to provide security for each LNG plant. The procedures must be available at the plant in accordance with § 193.2017 and include at least:

(a) A description and schedule of security inspections and patrols performed in accordance with § 193.2913;

(b) A list of security personnel positions or responsibilities utilized at the LNG plant;

(c) A brief description of the duties associated with each security personnel position or responsibility;

(d) Instructions for actions to be taken, including notification of other appropriate plant personnel and law enforcement officials, when there is any indication of an actual or attempted breach of security;

(e) Methods for determining which persons are allowed access to the LNG plant;

(f) Positive identification of all persons entering the plant and on the plant, including methods at least as effective as picture badges; and

(g) Liaison with local law enforcement officials to keep them informed about current security procedures under this section.

§ 193.2905 Protective enclosures.

(a) The following facilities must be surrounded by a protective enclosure:

(1) Storage tanks;

(2) Impounding systems;

(3) Vapor barriers;

(4) Cargo transfer systems;

(5) Process, liquefaction, and vaporization equipment;

(6) Control rooms and stations;

(7) Control systems;

(8) Fire control equipment;

(9) Security communications systems; and

(10) Alternative power sources.

The protective enclosure may be one or more separate enclosures surrounding a single facility or multiple facilities.

(b) Ground elevations outside a protective enclosure must be graded in a manner that does not impair the effectiveness of the enclosure.

(c) Protective enclosures may not be located near features outside of the facility, such as trees, poles, or buildings,

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which could be used to breach the security.

(d) At least two accesses must be provided in each protective enclosure and be located to minimize the escape distance in the event of emergency.

(e) Each access must be locked unless it is continuously guarded. During normal operations, an access may be unlocked only by persons designated in writing by the operator. During an emergency, a means must be readily available to all facility personnel within the protective enclosure to open each access.

§ 193.2907 Protective enclosure construction.

(a) Each protective enclosure must have sufficient strength and configuration to obstruct unauthorized access to the facilities enclosed.

(b) Protective enclosures must be fences or walls constructed as follows:

(1) Fences must be chainlink security fences constructed of No. 11 American wire gauge or heavier metal wire.

(2) Walls must be vertical and constructed of stone, brick, cinder block, concrete, steel or comparable materials.

(3) Protective enclosures must be topped by three or more strands of barbed wire or similar materials on brackets angled outward between 30° and 45° from the vertical, with a height of at least 2.4m (8 ft.) including approximately one foot of barbed topping.

(4) Openings in or under protective enclosures must be secured by grates, doors or covers of construction and fastening of sufficient strength such that the integrity of the protective enclosure is not reduced by any opening.

(c) Paragraphs (b) (1) through (3) of this section do not apply to protective enclosures constructed before October 23, 1980.

(1) Are made of noncombustible materials;

(2) Are at least 2.1m (7 ft.) in height including approximately one foot of barbed or similar topping; and

(3) Have served to protect the LNG plant without having been breached during their history of service.

§ 193.2909 Security communications.

A means must be provided for:

(a) Prompt communications between personnel having supervisory security duties and law enforcement officials; and

(b) Direct communications between all on-duty personnel having security duties and all control rooms and control stations.

§ 193.2911 Security lighting.

Where security warning systems are not provided for security monitoring under § 193.2913, the area around the facilities listed under § 193.2905(a) and each protective enclosure must be illuminated with a minimum in service lighting intensity of not less than 2.2 lux (0.2 ft^c) between sunset and sunrise.

§ 193.2913 Security monitoring.

Each protective enclosure and the area around each facility listed in § 193.2905(a) must be monitored for the presence of unauthorized persons. Monitoring must be by visual observation in accordance with the schedule in the security procedures under § 193.2903(a) or by security warning systems that continuously transmit data to an attended location. At an LNG plant with less than 40,000 m^3 (250,000 bbl) of storage capacity, only the protective enclosure must be monitored.

§ 193.2915 Alternative power sources.

An alternative source of power that meets the requirements of § 193.2445 must be provided for security lighting and security monitoring and warning systems required under §§ 193.2911 and 193.2913.

§ 193.2917 Warning signs.

(a) Warning signs must be conspicuously placed along each protective enclosure at intervals so that at least one sign is recognizable at night from a distance of 30m (100 ft.) from any way that could reasonably be used to approach the enclosure.

(b) Signs must be marked with at least the following on a background of sharply contrasting color:

The words "NO TRESPASSING," or words of comparable meaning.

[Amdt. 193-2, 45 FR 70409, Oct. 23, 1980, as amended at 47 FR 32720, July 29, 1982]

Appendix A to Part 193—Incorporation by Reference

I. List of Organizations and Addresses

A. American Concrete Institute (ACI), P.O. Box 19150, Redford Station, Detroit, Michigan 48219.

B. American Gas Association (AGA), 1515 Wilson Boulevard, Arlington, Virginia 22209.

C. American National Standards Institute (ANSI), 1430 Broadway, New York, New York 10018.

D. American Petroleum Institute (API), 2101 L Street, NW., Washington, D.C. 20037.

E. American Society of Mechanical Engineers (ASME), United Engineering Center, 345 East 47th Street, New York, New York 10017.

F. National Fire Protection Association (NFPA), Batterymarch Park, Quincy, Massachusetts 02269.

G. International Conference of Building Officials, 5360 South Workman Hill Road, Whittier, California 90601.

II. Documents Incorporated by Reference

A. American Concrete Institute (ACI)

1. ACI Standard 311-75—Recommended Practice for Concrete Inspection, (1975 edition).

B. American Gas Association (AGA)

1. Evaluation of LNG Vapor Control Methods, (October 1974 edition).

2. Purging Principles and Practice (1975 edition).

C. American National Standards Institute (ANSI)

1. ANSI A 58.1 Building Code Requirements for Minimum Design Loads in Buildings and Other Structures.

D. American Petroleum Institute (API)

1. API 620-Recommended Rules for Design and Construction of Large, Welded, Low Pressure Storage Tanks (6th edition, July 1977).

2. API 1104 Standard for Welding Pipelines and Related Facilities (14 edition, 1977).

3. API 6D Specifications for Pipeline Valves (17 edition, 1977).

E. American Society of Mechanical Engineers (ASME)

1. ANSI B31.3 Chemical and Plant Petroleum Refinery Piping (1976 edition).

2. ASME Boiler and Pressure Vessel Code, Section 1 Power Boilers (1977 edition).

3. ASME Boiler and Pressure Vessel Code, Section 8 Division 1 (1977 edition).

4. ASME Boiler and Pressure Vessel Code, Section 8 Division 2, Alternative Rules (1977 edition).

5. ASME Boiler and Pressure Vessel Code, Section 9 Welding and Brazing Qualifications (1977 edition).

6. ASME Boiler and Pressure Vessel Code, Section 4 Heating Boilers.

7. ANSI B31.5 Refrigeration Piping (1974 edition).

8. ANSI B31.8 Gas Transmission and Distribution Piping Systems (1975 edition).

F. International Conference of Building Officials

1. UBC, Uniform Building Code (1979 edition).

G. National Fire Protection Association (NFPA)

1. NFPA No. 37 Stationary Combustion Engine and Gas Turbines (1979 edition).

2. NFPA No. 59A Storage and Handling of LNG (1979 edition).

2. NFPA No. 59A, Storage and Handling of LNG (1972 edition for § 193.2005(c), otherwise 1979 edition).

3. NFPA No. 70, National Electric Code (1978 edition).

4. NFPA No. 30 Flammable Liquids.

4. NFPA No. 30, Flammable Liquids (1977 edition).

5. NFPA No. 51 B, Cutting and Welding Processes (1977 edition).

(49 U.S.C. 1674 (a); 49 CFR 1.53 and Appendix A to Part 1)

[45 FR 9203, Feb. 11, 1980, as amended by Amdt. 193-2, 45 FR 70410, Oct. 23, 1980; Amdt. 193-3, 47 FR 44264, Oct. 7, 1982]

Federal LNG Safety Standards— Philosophies, Facts and Features

WALT DENNIS, Petroleum Engineer, OPSR, MTB
U.S. Department of Transportation (DOT)

ABSTRACT

Legislative history justified Department of Transportation (DOT) jurisdiction over liquefied natural gas (LNG) facilities under the Natural Gas Pipeline safety Act of 1968 (N6GSA), making them subject to Parts 191 and 192 since publication in 1970. However, in amendments and legislative history of the Act in 1979, Congress mandated development of comprehensive and more stringent LNG standards within a prescribed time frame.

In developing the standards, assuring that LNG industry success be dependent on its own economic merit and societal benefit, free of unreasonable obstruction, was a guiding DOT philosophy. Public concern would not be assuaged by probabilistic risk analyses of questionable merit. Rather, credible federal standards were necessary for achievement.

BACKGROUND

Jurisdictional Authority and Congressional Order

Response to the LNG regulatory action and other correspondence has shown that some question still remains in the private sector about DOT's regulatory authority. Some still contend that the Natural Gas Pipeline Safety Act (NGPSA) of 1968 did not apply to LNG because of its liquid state. Others argued that DOT should not become involved with LNG safety because of the good industry record. Rather, LNG safety should rely on operator integrity and industry generated standards. And, as recently as this year, a major New England company questioned Materials Transportation Bureau (MTB) authority when notified to provide specific information for an enforcement action relating to an LNG plant.

Perhaps I can put this question permanently to rest. The safety regulation of LNG facilities has been DOT's responsibility since Congress enacted the NGPSA of 1968. LNG facilities, thereby, were subject to applicable sections of Part 191 and 192 in Title 49 CFR, since it was first issued in 1970, and subsequently to Amendment 192-10, issued in 1972. This amendment added § 192.12, which in addition to clarifying the applicability of Part 192 to LNG facilities, incorporated NFPA 59A (59A) for design, modification, and repair.

In the matter of LNG, a liquid, being made subject to a gas act, (the NGPSA) earlier court decisions had fully resolved this issue, decreeing that LNG must be treated as a liquid phase of natural gas for regulatory purposes. Probably the most significant, in this respect, was the Permian Basin Area Rate Cases, 390 U.S. 747 (1967), where the Supreme Court said: "—as LNG distribution becomes widespread, the underlying statute's effectiveness would be destroyed if it were not regulated in the same manner as other natural gas."

If any doubts regarding DOT's jurisdiction still remain, ultimate resolution was provided when, in 1979, Congress enacted certain amendments to the original Act, creating the NGPSA of 1968 as amended in 1979. Among the amendments, Section 6 of the Act specifically requires that DOT establish by regulation, minimum LNG safety standards for three basic categories, siting, design-related functions, and operation-related functions. Standards relating to siting and design were ordered to be established within 180 days of enactment. Those relating to operation were given a 270 day deadline. Thus, promulgation by DOT of independent Federal safety standards was not whimsical or even subject to discretion by DOT. Rather, the promulgation was required by Federal law.

Need for Federal Standards and Development

The need for a comprehensive set of federal standards governing LNG safety was recognized early in the history of DOT's jurisdiction over pipeline safety. Public response to the notice of proposed rulemaking (NPRM) to add § 192.12 incorporating 59A, showed that the consensus standard was not uniformly accepted by members of the regulated industry. Adoption was opposed by some industry members on the grounds that 59A was a "specification" standard, thereby inhibitive to technological development. A variety of modifications to 59A were proposed and, in some instances, broadly expanded coverage was advocated.

A major problem with 59A was that its language often made noncompliance permissible by the use of terms such as "should" or other non-mandatory expressions. This was not suitable for federal regulations. Also, potential conflict between DOT and 59A committee interpretations could cause major enforcement difficulties. In addition, the NFPA process provides only a limited forum for standards development. Most of the members, through various ties, owe some allegiance to the regulated industry. And since, the 59A process requires a majority of two-thirds of the voting membership to establish a rules change, only a few (10–11), could prevent adoption of a standard, crucial to public safety, without accountability to the public. And safety, particularly for the offsite public, appeared to be inadequate under 59A. Accordingly, in the preamble of Amendment 192-10, DOT explained that adoption of 59A was an interim measure pending development of comprehensive federal standards.

Issuance of the advance notice of proposed rulemaking (ANPRM) on LNG safety was the first major step in fulfilling that obligation. It is evident that DOT anticipated the order by Congress in the NGPSA, 1979, when it began this rulemaking action. However, the anticipation was not without cause. Oversight hearings by Congress, Congressional committees and individual representatives, other government agencies, non-government organizations and the public in general indicated growing concern over LNG safety. (At times, it seemed the standards might never reach fruition because of the required response to inquiries.)

Following publication of the ANPRM, the General Accounting Office prepared extensive draft and final reports on "Liquefied Energy Gases" (LEG). The draft report included over 58 recommendations, most of which applied to LNG, calling for DOT to establish standards and procedures covering a variety of specific issues relating to LNG safety.

Some of the proposals were consistent with DOT's suggested standards. Others, however, were extremely burdensome, without commensurate benefit. Typifying the latter group, LNG plants would be built and operated like nuclear plants, and prohibited from urban areas unless tanks were below ground. For security, forces large enough to prevent unlawful entry would be necessary, and vehicles entering plants would be searched for weapons and explosives. One can speculate that LNG in a tank truck might vaporize and vent before plant entry could be accomplished.

A response by DOT provided rationale and argument in refutation, to prevent such proposals from becoming regulations. Public comments on the ANPRM were considered and addressed in an NPRM. Final rules were developed, following consideration of public comments on the NPRM, consistent with economic factors and critical safety issues. Completing the action on regulations for siting and design, petitions for reconsideration were received, deliberated and findings issued.

Continuing inquiries indicate there are still some in industry who either are unaware that final federal LNG standards have been published, or are uncertain of the number and type of publications. Concluding the background of this regulatory action, identification of the relevant publications seems worthwhile.

The complete set of final federal LNG standards has been issued in three separate publications:

1. Siting, design, construction and related personnel qualifications; publishedFebruary 11, 1980, FR 45/29-9184.
2. Disposition of petitions for reconsideration on siting and design-related issues; published August 28, 1980, FR 45/169-57402.
3. Operations, maintenance, fire protection, security, and related personnel requirements, published October 23, 1980, FR 45/207-70390.

To alleviate possible confusion or nisunderstanding, be aware that the first publication also includes the NPRM on operation-related requirements. Both of the other publications include some amendments o the first set of standards, and § 193.2005 'Applicability," is amended, albeit differently, in each. Finally, although an amendment may appear in the publication rimarily devoted to operations, it is still overed by the grandfathering provisions and effective date of the original section.

'HILOSOPHY

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The fundamental philosophy underlying the levelopment of the LNG standards was that rowth of a healthy LNG industry was conomitant with the health of this country's energy dependent economy and living standards. If LNG could safely improve the naon's economy, DOT wanted the industry to ucceed. At least it was DOT's intent that the industry's success be dependent on its own economic merit and societal benefit, free to he maximum practical extent, from impedinents of overlapping regulatory interference nd injunctive restraints by uninformed nongovernmental organizations or individuals. Federal LNG standards assuring an adequate vel of public safety provided the only credie and equitable means of achievement.

Obstructions

ue principally to curtailments in winter ipply of pipeline gas, LNG industry growth, primarily in the northeast, abounded during the late 1960's and very early 970's. In 1973, however, the accident at an NG facility on Staten Island triggered a strong public reaction. Although the industry enjoyed an otherwise good safety record, and the accident neither resulted in ffsite casualties, nor was directly related to NG operation, public action groups quickly formed in opposition to LNG facility construction. They were joined by members of e academic and scientific community, gether with public officials. As a result, LNG industry growth was severely fettered.

Construction of planned new facilities were often prevented or abandoned because of opposition. In some instances, facilities under construction or repair were prevented from being completed or operated. In others, even planning was stymied, unable to get off the ground. They include both base load and peakshaving plants. Preliminary planning, conceptual design and hearings alone have been costly. In the cases where detail design was nearly complete, or carried into construction, costs have been prohibitive, considering that it represents an out-and-out loss. Clearly such losses accelerate energy inflation; in turn, exacerbate inflation of the overall energy dependent economy; and ultimately must be borne by the productive consumer, if the affected company is to be able to raise capital and remain independently viable. Opposition to LNG by public action groups, though perhaps more intuitive than rational, served to instigate more rigorous scrutiny of the more crucial issues of LNG safety. Industry had flagged in its responsibility for research in these critical safety matters.

It was DOT's philosophy that federal LNG standards, adequately addressing these most critical and controversial aspects of public safety, was the only feasible measure that could establish credibility in government regulations; assuage opposing public sentiment; gain broader acceptability of LNG plants; and thereby mitigate the likelihood of public opposition so the LNG industry could again get going to seek its natural level of activity in our economy.

A Single Major Failure

As every society is a mix, so too is the LNG industry comprised of people with various characteristics. Many are people of high integrity and intelligence. But like society in general, there are some, who due to economics, ignorance, or less integrity, would cut corners here and there or err with ignominy.

Recently, I was told of an event at an LNG plant which employed neither engineers, nor others with adequate technical training. The operator had suddenly become faced with a strange dilemma. Like the Grail of Celtic legend, an unknown source appeared to be gradually filling his partly empty LNG tank. First joyous at this bountiful fortune, concern that it might not stop soon developed. A quick check of the fill rate showed that the tank might overflow or burst in a scant four hours. Panicked, he considered immediate evacuation of nearby townspeople. Fortunately, he reconsidered. He phoned a qualified consultant. A minor failure in the pneumatic liquid level gauge was causing a gradual pressure increase and so had indicated increased liquid height.

I don't know how true, but the tale while seeming innocent and entertaining, illustrates inadequate technical training. The lack of a back up liquid level indicator, shows a bit of corner cutting. In another scenario, shortcomings of this kind could cause serious failure.

Over the past few years, a number of books or articles about LNG have been published or produced on television. Some are fiction. Others are of a more documentary nature. Although the authors may have been well intentioned, all seemed designed by their sensationalism to elicit emotional response with resulting enmity toward LNG. The formation of opposing public action groups and distinguished supporters attests in part to the effects.

In this environment, a single major accident with or without casualties, could easily disrupt LNG industry development and even existing operation. Stronger opposition to new facilities would be expected. Excessively expensive and unwarranted retrofitting of existing facilities might become necessary. Even the shutdown of some, or all, plants could result.

It is DOT's philosophy that an operator should not be permitted to jeopardize public safety as a result of imprudence or ignorance. Nor should he be permitted to disrupt the natural economic status of LNG as an entity in the energy business. It simply would be grossly unfair to the greater number of prudent operators.

DOT believes that comprehensive, technically sound federal standards is the single best means of assuring, on a national basis, that a major accident due to corner cutting or sloppy operation will not be likely. It believes, also, that the many prudent operators will agree.

Probabilistics

During the course of rulemaking, many commenters opposed certain proposed regulations on the grounds that occurrence of the related event would be most unlikely. Others in opposition contended risk was minor. Such contentions were intuitively probabilistic, but none were supported by probability determinations.

Risk analyses based on probabilistic values have been widely used in preparing environmental impact statements for proposed LNG plants, in making energy exploration decisions, and in many other ways. Also, systems analysis with its various analytical methods, has often been recommended by NTSB for application in LNG safety. Here too, the probability of event occurrence is a necessary element in each of the basic methods.

Risk, in the classical sense, is the product of the probability of event occurrence and its consequence. Essentially, a fault tree analysis, using a failure mode and assigned probability of occurrence to each element leading to the event is applied. Consequence is dependent on environment and effects of the event.

Most physical phenomena follow laws of normal probabilistic behavior. With behavioral phenomena subject to non-random influence, distribution other than Gaussian, (quincunx distribution) will apply. Probabilistic methodologies, historically, are widely recognized and highly respected predictive techniques used in physics, engineering, chemistry, biology and many other fields. (i.e. atomic/molecular distribution, quality control, structural design, insurance actuarials, etc.) The technique is very valid when applied to a large number of discrete events (or event combinations) within a body of definitive possibilities that either are randomly determinate and mutually exclusive (i.e. toss of coins, other random behavior), or for non-random behavior, have a sufficient event history to assure an adequate degree of predictive reliability (i.e. auto deaths, acts of nature, material/equipment failure).

Where events are random or event history is sufficient for a fit with established distribution patterns or to establish independent patterns, and properly applied, DOT strongly supports the use of probabilistic methodologies in safety matters. It has demonstrated its disposition, in this respect, by the application of probabilistic methodologies in the proposed and final LNG standards to achieve, to the extent possible, a uniform level of risk.

On the other side of the coin, however, the necessary failure history is clearly inadequate for a probabilistic approach in risk or systems analysis of LNG facilities. The Office of Technology Assessment (OTA) report on LNG references a DOT study to point out that 500,000 event free plant years are needed to establish reliable probabilities of a specific event occurrence in the range of 10^{-5} per year (e.g. the risk of fatalities associated with machinery).

Even with another decade of experience and major industry growth, statistical data would be insufficient by one to two magnitudes and compounding the problem, while LNG facility design is changing, "sameness" of facilities is necessary to the determination of failure mode probabilities. For example, experience data for Fords and Plymouths are not usually applicable to the durability of parts in Chevrolets. Yet a risk assessment for FPC certification of LNG facilities, submitted by one consultant, shows a probability of one chance in 710 septendecillion (710 followed by 54 zeros). The assessment was cited by the Administrative Law Judge to support his decision.

Several other characteristics tend to disqualify broad application of risk and systems analysis to LNG facilities, also, such as:

(1) Estimating

Because event history is so severely limited, assumptions or guesses are necessary to establish both mode and probability of causal elements along the branches of the logic tree leading to the resultant event and its probability. Even the Delphi technique is not rigorously implemented. Anticipation of all causal elements and their probability by imaginative effort is unlikely. Consequently, discovery and identification of all failures and malfunctions leading to the resultant risk has a very high degree of uncertainty.

Although alleged advantages of probabilistic analysis in aviation and aerospace have been widely proclaimed, testimony before the Federal Power Commission (FPC) by a reliable safety analyst with 11 years experience in the aerospace industry contravenes this view. He pointed out that "in the late 1950's, the aerospace industry was quite optimistic about risk assessment methodology." A quotation from his testimony continues, "This optimism was soon dispelled (in the early 1960's) by hundreds of cases of unexpected test and operational failures and thousands of system malfunctions. Many of the failures and malfunctions modes had either been previously analyzed and seemed to be non-credible events or had come as a complete surprise which previous analyses had not identified at all. Consequently, the failure rates were consistently underestimated."

(2) Uniform methodology

As pointed out in a report by Ecology and Environment Inc., a consulting firm which performs risk analyses, "the risk values and methodologies submitted (to FPC) differed among applicants to the extent that the "risks" differed by *several orders of magnitude* among LNG projects."

Clearly, the lack of uniform agreement (on methodology) among practitioners further lowers the level of confidence in the results.

(3) Acceptable level of risk

No uniformly acceptable level of risk has been established for LNG facility operation. For comparison, analysts generally cite the risk of death from autos, electric wiring, lighting and other activities. However, these other risks may not be comparable from the standpoint of their voluntary-involuntary nature or their distribution. Also, simple comparison may be inappropriate because of the accrual of overall risk.

(4) Voluntary versus involuntary risk

LNG risk analyses do not address the critical aspect of whether or not the risk is voluntary. And where risk is involuntary, no differentiation is made for risks imposed by nature and those willfully imposed by mankind.

(5) Risk distribution

Risks, concomitant with LNG operations are not, like risks associated with most other activities, uniformly distributed among beneficiaries of the activity. For example, where a certain amount of rat dung is considered permissible in commercial wheat flour, all who enjoy the benefit of the flour are subject to risk of encountering the impurity, proportional to the benefit of use. Similarly, the risk of rider death or injury from auto (or other transportation mode) accident is, in general, proportionate to the travel mode benefits. With LNG, however, benefits are not commensurate with risk, since all who enjoy the direct or indirect supply of LNG are beneficiaries of the operation, yet risk is imposed on a relatively few, located within the risk zone of a facility.

(6) Collective risk

Risk analyses of LNG facilities have considered the estimated risk as separate and disconnected from other societal risks, ignoring the cumulative effect of introducing a new risk that is in addition to such involuntary risks previously existing.

(7) Generic approach

Although major design features such as size of impoundment may be taken into account, the analyses can rarely consider the quality and characteristics of specific elements of the facility due to the added complexity and precision uncertainty. As a result, better quality and special features provided by the operator to enhance safety will not be given credit. Correspondingly, poor quality is not discredited. Safety interests will be harmed.

In summing up, the OTA report expresses the conclusion, ". . . the use of fault tree analysis and risk analysis to determine whether LNG facilities are safe is most questionable; *worst of all such inappropriate use of the research techniques leads to a false sense of knowledge about the possible risks.*" DOT shares this concern. Even the Reactor Safety Study, Wash-1400 (also known as the "Rasmussen Report"), which fathered these types of risk analyses became subject, in 1979, to criticism, in some cases severely, for similar reasons.

When the number of discrete events is reduced, the probabilistic concept becomes more abstract, and is a total abstraction when applied to a single specific event (i.e. single flip of a coin, failure at a specific time). In the case of non-random behavior, if there is insufficient event history, a probabilistic approach is invalid for critical determinations involving casualty or death.

When event history is inadequate, attempts to apply probabilistic methodologies is a miscreance, denegrating an otherwise esteemed and respected tool of applied math and statistical analyses. While such an approach, adjusted according to the degree of uncertainty, may be appropriate in determining insurance liability, when needed history is unavailable, application as a determinant for safety is unacceptable.

DOT has made this position clear in response to Congressional inquiries and to recommendations by other agencies, and, in the preamble and character of its regulations or notices. It was clearly recognized by OTA, as noted in its report. DOT strongly opposes the misapplication of probabilistic methodologies in safety matters when the data base is inadequate for viable predictability.

FACTS AND FEATURES

Rulemaking

When I first entered government, I believed regulators to be entrenched bureaucrats, imposing regulations on individuals and industry from an "ivory tower" without perspective for the real world, and often without reason.

I have learned much. If nothing else, the regulatory action is eminently more fair to all sides of an issue than I realized.

MTB assiduously follows rulemaking procedures prescribed in the Administrative Procedures Act. These are regulations that prescribe precisely how other regulations are to be developed. Overall, the procedures are not wholly unlike those of standards committees, such as B31.3, except that greater involvement by the public produces a wide range of interest and greater dissimilarity in viewpoint, which must be resolved.

Under the procedures, an NPRM must be published, a time for response provided, and public comments must be duly considered before issuing final rules. In the case of 49 CFR Part 193, as discussed in "Background," rulemaking action was initiated by an ANPRM as an extra step. Published in the format of a comprehensive set of specific suggested standards to elicit maximum public response, its intent was made explicit in the preamble. Two NPRM's and final rules, with a disposition of petitions for reconsideration—yet another added step, were subsequently published with discussions of public comments as appropriate.

The notices and final rules covered all of the three general areas subsequently designated by the 1979 Act. Procedures were in complete accord with the Administrative Procedures Act. Thus, the standards were both required by, and developed in a manner prescribed by federal law.

The notices and final rules covered all of the three general areas subsequently designated by the 1979 Act. Procedures were in complete accord with the Administrative Procedures Act. Thus, the standards were both required by, and developed in a manner prescribed by federal law.

When not involved in the rulemaking or its application, confusion or mind set about applicable provisions due to the various steps, is probably quite normal. Several specific circumstances, a variety of communications, and even comments on the notices, demonstrated this potential. Parenthetically, a number of comments on the NPRM were instead applicable to the ANPRM. Therefore, awareness of the various steps in a rulemaking action could be of real benefit in time saving, if not in actual application.

Response to proposals

Comments from industry, government agencies and other people interested in LNG standards reached several thousand pages for the ANPRM. Fewer commenters responded to the NPRM(s), and the volume was much less.

The provision for public response to proposed rules is the most important aspect in rulemaking. It makes a process, which might otherwise be autocratic, as democratic as possible, and therefore, is an opportunity that should not be overlooked or taken lightly, for valid well-developed comments are given serious consideration by DOT.

Rulemaking for Part 193 was somewhat unique in that coverage of crucial issues, not yet mature technologically, was necessary. Uniform agreement or even consensus among experts was lacking. As a result, response was often emotional rather than rational. A large number of comments were quite useful. However, some comments which might have been otherwise valid were not adequately supported by derivation, rationale or documentation. Often commenters merely expressed objections to the regulations or to being regulated. Some expressed support of comments made by several others, but those referenced were frequently contradictory, each to the other.

In a few instances, comments were more vituperative than informative. With respect to a particular proposal, one commenter claimed it was, (sic) " . . . a graphic example why the public should not place their trust in MTB's rulemaking process." He continued, contending it placed, (sic) " . . . an otherwise respected agency (The Department of Transportation) in a position of public ridicule," asserting that the referenced formula, (sic) ". . . defies the most simple concepts which are taught in high school physics class." Pretty strong language, but to what purpose? No alternative was offered.

The formula attacked, was presented in the A.G.A. report IS-3-1, as representative of a particular phenomena. Its application was suggested by a reputable commenter who had prepared an extensive and valued commentary on prior proposals. And it was used by another respected commenter as the basis for derivation of a modified formula, which was well thought out and supported with derivation and documentation. All in all, the formula was really quite valid.

My point is that comments, such as the one quoted, offer nothing positive and therefore are wasteful for both the writer, the reader and the public. Alternatively, comments that are well thought out and intelligently developed are given most serious consideration by DOT.

For greatest effectiveness, the following guidelines are suggested:

1. Where you find agreement with an NPRM, say so. Otherwise, negative comments may result in unwanted changes.
2. Where you don't agree, propose an alternate, indicating the specific change and using regulatory language to the extent possible as a test for viability. The format of comments by the major industry associations are a good example.
3. Support your proposal to the fullest extent possible with rationale, derivation, analyses, and documentation. It has a major effect on value ranking.
4. Seek unanimity of position with peers, and make similar presentations. It will serve to test the validity of a position and can give it weight in ranking.
5. Don't simply state support for another's comments. It gives no assurance that a position is even known by the supporter, particularly when two or more contradictory positions are supported. Rather, present the proposal together with rationale. A new idea clearly enhances justification. More than an opportunity, the right to comment and be heard should be considered an obligation in the effort to produce better regulations.

Performance standards

Specification standards are employed by many regulatory agencies to prescribe a requirement. They may be in the form of adopted consensus specifications or independently established design, construction or similar specification with a highly definitive pattern or procedure. In some cases, such standards could result in restricting technological development. In others, authorized components or equipment could have very different safety values, depending on application. Because of more precise definition, however, specification standards usually have the benefit of easier enforcement.

Performance standards are intended to provide an appropriate level of reliability according to the capability of the equipment, its environment, and the relative hazard to the public in the event of failure. This provides more flexibility in meeting a requirement. Also, technological advancement is less inhibited. A determination of compliance may require measurement, testing, analytical evaluation and reasoned judgement. Clearly enforcement is likely to be more difficult.

While specification standards are sometimes necessary, such as for protective enclosures, or where differences in predictive methodologies have not been resolved, the use of performance standards where appropriate, has been a policy of long standing with DOT.

I have received innumerable phone calls and visits regarding the LNG standards since they were published. As time draws closer to the effective dates, the tempo has increased. In most instances, a performance standard is the issue. Often, it seems that the caller would like a specification type answer that will assure compliance.

It is important to note the difference between a preinstallation compliance evaluation and interpretation. Requests for interpretation, more often that not, actually have been requests for a preinstallation compliance evaluation. The Act does not give authority for such evaluation. Therefore, DOT is not staffed to offer such service on demand. It may, however, elect on its own volition to honor such requests according to the merit of the issue.

Either way, a determination is needed. In most instances, problems can be resolved by informal review and discussion rather than formal interpretations or evaluations. In this way, the operator retains the intended flexibility as well as the responsibility for compliance.

Performance standards are not intended for scrutiny by "Philadelphia lawyers" in search of loop holes. The concept of integrity and esoteric comprehension by competent engineers is implicit in many such standards. Reasoned judgement is thereby a key element.

The standard should be reviewed with care, precisely as written with the purpose of understanding intent. Don't add or subtract words or preconceived notions. It usually means just what is said. Then consider a possible influence from other relevant standards on the determination of compliance. The evaluation must be in accordance with reasoned judgement by reasonable men.

As a final consideration, the Act in recognition of possible differences of view, provides that good faith effort in attempting to achieve compliance will be considered in any compliance action. Following these guidelines, most of the concern, so far made evident, should be alleviated.

Format

Even the style for federal standards is carefully prescribed by the Office of the Federal Register. The form and structure for all categories, from Document headings and Preamble to the Regulatory text and Amendments, are specified by case examples in a Document Drafting Handbook. The concept of performance standards in the preparation of documents for the Federal Register is unrecognized. Specification type standards only, prevail. And the authority is preeminent. If you don't do it as prescribed, it won't be published.

While in industry, I most always found rewriting of federal standards to be desirable, if not necessary, for generic structure and a fuller and more complete understanding of intent. I hoped to one day effectuate change, if only by replacing the federal generic order defined by small case letter, number, large case letter, and multiple small i(s) or iv(s) with the cogent, generically representative numeric decimal format, in order to preclude back searching to determine the nature of the primary issue. When, as a government fledgling I tried, I discovered immediately that it was not acceptable for technical people to write in a technical manner about technical matters for technical readers. The style must be concise. Thus, a regulation in the form "speed must be limited to 30 MPH because of reverse banking on curves" is preempted by "speed must be 30 MPH or less."

In response to notices on the LNG standards, several commenters proposed changes in format, some quite extensive. Don't feel badly. Even if preferable, such proposals are not adoptable.

But there is a bright side. All standards are produced in a standard style, and the Office of the Federal Register does work at its job. Specifically, I often have been asked, in view of the three publications comprising the LNG standards and associated amendments, if a single corrected publication was in the works. The Federal Register publishes up-to-date standards collocated for amendments and additions each year. The most recent publication includes a complete and corrected version of Part 193 together with 191, 192 and other parts (178 to 199). At just $7.50, it may be obtained through the Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Intent of Congress

The most serious limitation of continued incorporation, or attempts in modification, of 59A was the failure of 59A to effectively address the most critical (and controversial) problems relating to safety of the offsite public, and was probable cause of public opposition to LNG. This aspect was discussed in both the ANPRM and NPRM. Thermal radiation, vapor dispersion, and seismic design were specifically cited. Other issues, such as dike design to prevent kinetic overflow, rollover vapor generation and prevention, rapid phase transition, vapor cloud combustion under partial confinement, security, operation, maintenance, control systems, and many more, were either completely overlooked or not adequately addressed by 59A. To illustrate, the 59A (1975 edition) thermal exclusion distance would have limited incident flux to only about 10,000 to 13,000 BTU/ft.^{2}hr. Exposure to this intensity causes unbearable pain in humans in 0.4 seconds or less. And this is based on tests of least sensitive parts of the human anatomy.

Following the initiative of the ANPRM and the NPRM, the 1979 edition of 59A made dramatic improvements in some of the critical areas. However, even the improved standards were insufficient to provide an appropriate level of public safety, as explained in the preamble of the final rule.

But most significant, the legislative history of the Act clarifies Congressonal intent that DOT develop independent standards that are more stringent than 59A in critical areas of public safety. The Report by the Committee on Interstate and Foreign Commerce on the Fuels Transportation Safety Amendment Act of 1979, states in part, (sic) ". . . the Secretary may adopt as interim measures any appropriate existing industry codes such as those adopted by the American Petroleum Institute or other standards established by such standards setting groups as The National Fire Protection Association. The committee intends, however, that the final standards to be issued by DOT represent a significant improvement in public safety. The committee will continue to look actively at the Department's performance in this respect."

The 1978 report by this committee contained identical language showing the intent of Congress to have been consistent and enduring in this respect.

The Congress expressed its intent with clarity. Thus, DOT developed the LNG standards, required by a federal law, following procedures under other laws, and in accord ance with the intent of Congress.

Reasonableness, Controversy and Research

In addition to following prescribed procedures, the standards also were developed in a reasoned and reasonable way. For example, in resolving the petitions for reconsideration, the Director accorded the petitioners considerable latitude since none met the required criteria for petitioning under the Administrative Procedures Act. Public comments, particularly those relating to the most serious safety aspects, were rigorously reviewed and applied where appropriate in modifying proposed standards, and the basis for related action was discussed in the preambles of the various documents.

Clearly, some controversy was evident in the development of certain rules most critical to public safety. However, this was expected because of the dissimilarity in special interests; the variations in technical knowledgeability on the part of many interested parties; and most particularly, the lack of uniform agreement among researchers and modelers in many of the most critical aspects of LNG safety. Considering these factors, I believe the LNG standards were established both rationally and equitably.

The federal standards may still not adequately address all critical safety issues, due to insufficient research and testing in certain areas of LNG phenomena. For example, recent field testing at China Lake indicates that emissive thermal flux from LNG pool fires may greatly exceed levels anticipated in 49 CFR 193 based on industry sponsored testing. DOT's interaction with other Government agencies and publication of federal standards, has been instrumental in initiating or expanding, research in many of the critical areas.

However, this may not provide the information necessary. A DOE proposal, "Recommended Research on LNG Safety" March 1981, recommends $21 million over the next three years in areas of "major uncertainty." Essentially the research would address only boil off, spread, dispersion, thermal radiation from pool and cloud fires plus explosion phenomena from clouds. GRI has proposed other safety research.

However, other critical research such as dike face configurations to prevent overflow under kinetic frictionless flow and bubble li effect in large high columns are not con templated. And in a recent National Acad emy of Sciences panel report, research on planned ignition was recommended. Moreover, with the Administration's interest frugality, reductions in the DOE resear budget is not unlikely.

President Reagan has stated his intent to eliminate unjustifiable regulations. However, on several occasions, he has made ve clear that deregulation would not carry over into areas directly affecting public safety. Since LNG standards are of the latter type, it seems unlikely that they will be affected.

Price deregulation, however, has been a tively on his agenda. Considering the President's intent to "get government off the public's back," as a corollary, indust might be expected to reassume the domina responsibility for safety research affecting its business.

In the most crucial and costly areas safety, the regulations are geared to adc new approaches where demonstrable techn logical advancement provides justification. I believe DOT will be very receptive to modifi cations in other areas, as well, where justi cation is provided by new and tested info mation, and expect the industry, and therefore, the public, might enjoy measureable economic benefit as a result.

RESULTS OF YPC THERMAL RADIATION PROTECTION AND FLAMMABLE VAPOR-GAS DISPERSION PROTECTION STUDY

Thermal Radiation Protection

Significant to siting of an LNG plant, thermal exclusion zones are postulated worst case radiant heat flux areas inside of which specified public or private facilities may not be located, unless an LNG facility of the operator.

Calculation of thermal exclusion zones for the proposed TAGS LNG plant shows that the proposed facility can be safely sited at Anderson Bay and meet the thermal radiation protection requirements of 49 CFR 193. Maximum incident radiant flux values from postulated LNG pool fires have been calculated to assess the effect on publicly or privately used lands in the Port Valdez area. Results of the thermal radiation analyses have been used to further refine the LNG plant facilities definition.

Thermal exclusion distances were calculated for an LNG pool fire within a typical storage tank dike, LNG pool fires within transfer system impoundment areas, and a pool fire for a loading arm spill onto water. Calculations were initially performed for the LNG plant conceptual layout, and subsequently after the conceptual layout was modified based on the results of various LNG safety analyses.

Several "target" areas of public or private use were identified within the vicinity of Port Valdez. Analysis indicates that each of these target areas is located outside of the plant thermal exclusion zone associated with incident flux greater than 1,600 Btu/hr-ft^2 for each postulated LNG pool fire. The target areas were as follows:

North Shoreline of Port Valdez	14,300'
Entrance Island	14,800'
Shoup Bay Spit	15,000'
Alyeska Pipeline Service Company Property Line	16,500'
Mouth of Mineral Creek	25,600'
City of Valdez	31,400'
Old Valdez	44,000'

Thermal radiation calculations were performed for both conditions of atmospheric attenuation as well as for unattenuated conditions. Unattenuated flux considers no adsorption or scattering of the radiation as it travels from the flame through the atmosphere. Wind speed and relative humidity are significant parameters affecting the flux levels from an LNG pool fire. These parameters were used in the analysis to develop a prediction of longer exclusion distances than would be created by other weather condiitons at the site at least 95 percent of the time, based on Valdez climate data.

Thermal radiation analyses were performed using an American Gas Association methodology. This methodology has been validated with large-scale tests on LNG and liquefied petroleum gas (LPG) fires, and has been accepted by the Materials Transportation Bureau of the U.S. Department of Transportation.

Results of thermal radiation analyses for each postulated LNG pool fire indicated that the greatest thermal exclusion distances were for the contents of an 800,000 barrel LNG storage tank spilled and burning within its impoundment. Utilizing a 450' x 450' x 35' high dike (modified from a 670' x 580' x 18' high dike), thermal radiation calculations indicated that unattenuated incident radiant flux levels of 1,600 Btu/hr-ft^2 extend a maximum distance of 1,726 feet from the center of any tank dike. Attenuated flux levels of 1600 Btu/hr-ft^2 extended a maximum distance of 1,509 feet from the center of any dike. For all of the other postulated pool fires, maximum distances for unattenuated flux levels of 1600 Btu/hr ft^2 were less than 1,726 feet.

As prescribed by 49 CFR 193, 1600 Btu/hr-ft^2 is the lowest limiting value for incident radiant flux on an offsite target. All public and private land-use target areas lie outside of the 1600 Btu/hr-ft^2 unattenuated flux isopleth. Based upon the results of thermal radiation analyses, development of the Anderson Bay site will comply with the radiation protection requirements of 49 CFR 193. Final thermal exclusion zones will be determined during detailed project design, along with optimization of process, storage tank, transfer system and related impoundment designs.

Flammable Vapor-Gas Dispersion Protection

Dispersion exclusion zones have been calculated for the proposed TAGS LNG plant, showing that the proposed facility will meet the flammable vapor-gas dispersion protection requirements of 49 CFR 193. Significant to siting of an LNG plant, dispersion exclusion zones are postulated worst-case vapor-gas dispersion areas inside of which specified public or private facilities may not be located, unless an LNG facility of the operator. Maximum downwind dispersion distances from postulated LNG spills have been computed to assess the effect on publicly or privately used land areas in Port Valdez. Results of the vapor dispersion analyses have been utilized in further refinement of LNG plant facilities definition.

Dispersion distances were computed for an LNG spill from a typical storage tank into impoundment, for LNG spills from transfer systems into impoundment areas, and for a loading arm spill onto water. Distances were computed initially for the LNG plant conceptual layout, and subsequently after modification of the conceptual layout based upon initial vapor dispersion analyses.

Several "target" areas of public or private use were identified within the vicinity of Port Valdez. Analysis indicates that each target area is located outside of the plant dispersion exclusion zone associated with average gas concentrations of 2.5 percent in air for each postulated LNG spill. The target areas are as follows:

North Shoreline of Port Valdez	14,300'
Entrance Island	14,800'
Shoup Bay Spit	15,000'
Alyeska Pipeline Service Company Property Line	16,500'
Mouth of Mineral Creek	25,600'
City of Valdez	31,400'
Old Valdez	44,000'

Vapor dispersion analyses were performed for atmospheric conditions which result in longer predicted downwind dispersion distances than would be created by other weather conditions at the site at least 95 percent of the time, based on Valdez climate data. Analyses were also performed for the most prevalent atmospheric conditions.

Vapor dispersion analyses were performed utilizing two models to evaluate each postulated spill, and were run for each set of atmospheric conditions. An American Gas Association model, "Evaluation of LNG Vapor Control Methods", 1974 was used in order to assess compliance with respect to 49 CFR 193.2059(c), published in 1980. A model developed by the U.S. Coast Guard, "Development of an Atmospheric Dispersion Model for Heavier-Than-Air Gas Mixtures", 1985, was also used in order to consider recent developments in vapor dispersion technology.

The American Gas Association method does not consider many of the physical phenomena that occur in the dispersion of heavier-than-air vapor clouds. This method provides conservative values, predicting greater vapor dispersion distances than an actual vapor cloud would travel. In some cases where model results were compared with actual spills, predicted distances to the lower flammable limit have been almost an order of magnitude greater than actual distances.

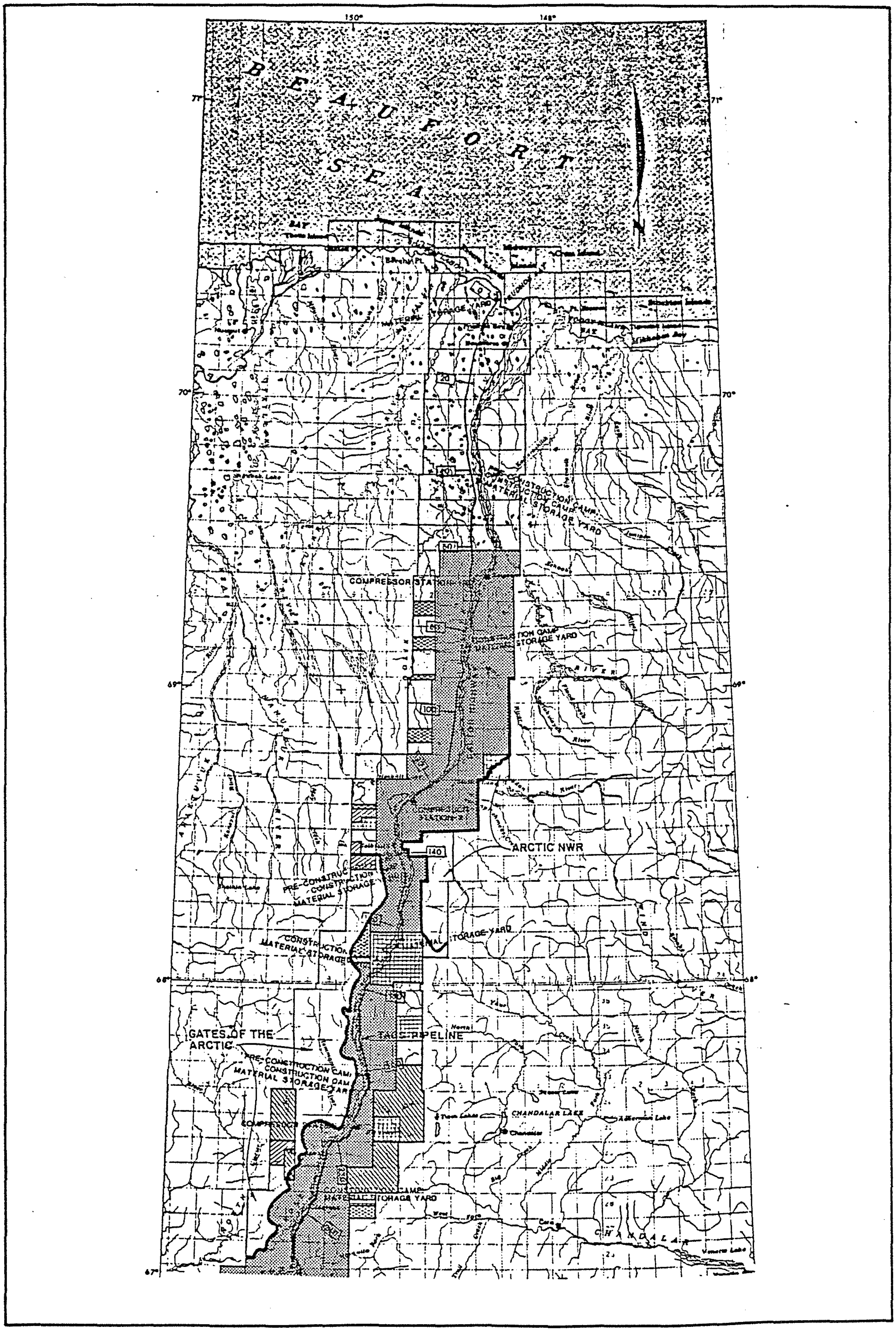
Regulations provide for the use of other calculation methods if proper validation of the method can be provided. The U.S. Coast Guard model provides proper documentation and validation for the acceptance by 49 CFR 193 regulators to be used in vapor dispersion prediction. This model provides predictions of downwind gas concentration decay which agree with the full range of field experimental data currently available.

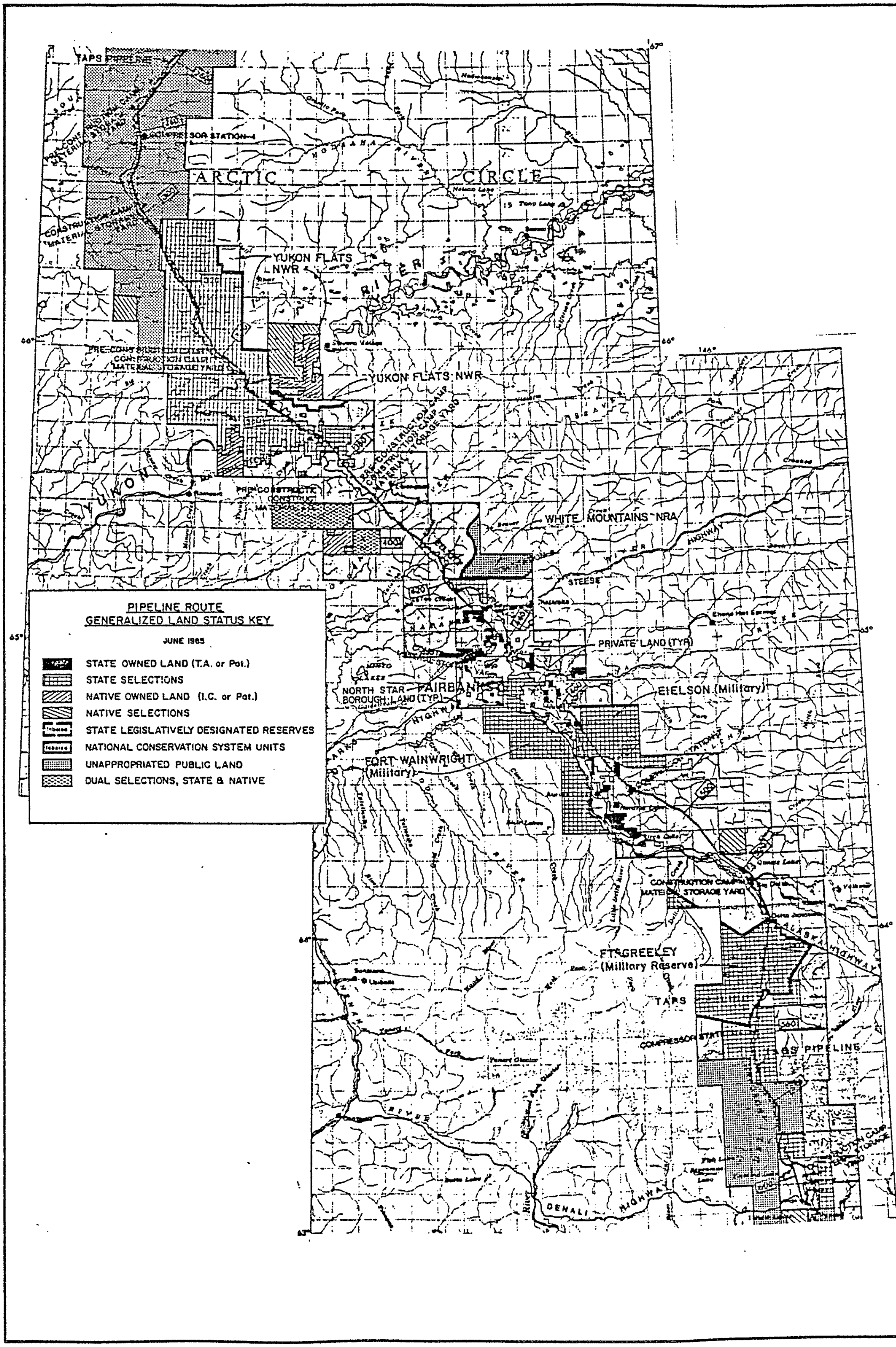
Results of vapor dispersion analyses for each postulated LNG spill indicated that the greatest vapor dispersion distances were for the case of an 800,000 barrel storage tank spill into impoundment, or for the case of a ten minute loading arm spill onto water at the rate of 12,000 gallons per minute. Considering a 450' x 450' x 35' high dike (modified from a 670' x 580' x 18' high dike), results of the American Gas Association (1974) Model indicated that the maximum dispersion distance would extend 11,700' from the dike wall for the case of a storage tank spill into impoundment. Using the U.S. Coast Guard model (1985), a maximum vapor dispersion distance of 6,854' was predicted for this case. For the case of a ten minute loading arm spill onto water, predicted maximum vapor dispersion distances were 11,920' and 6,243' for the American Gas Association and U.S. Coast Guard models, respectively.

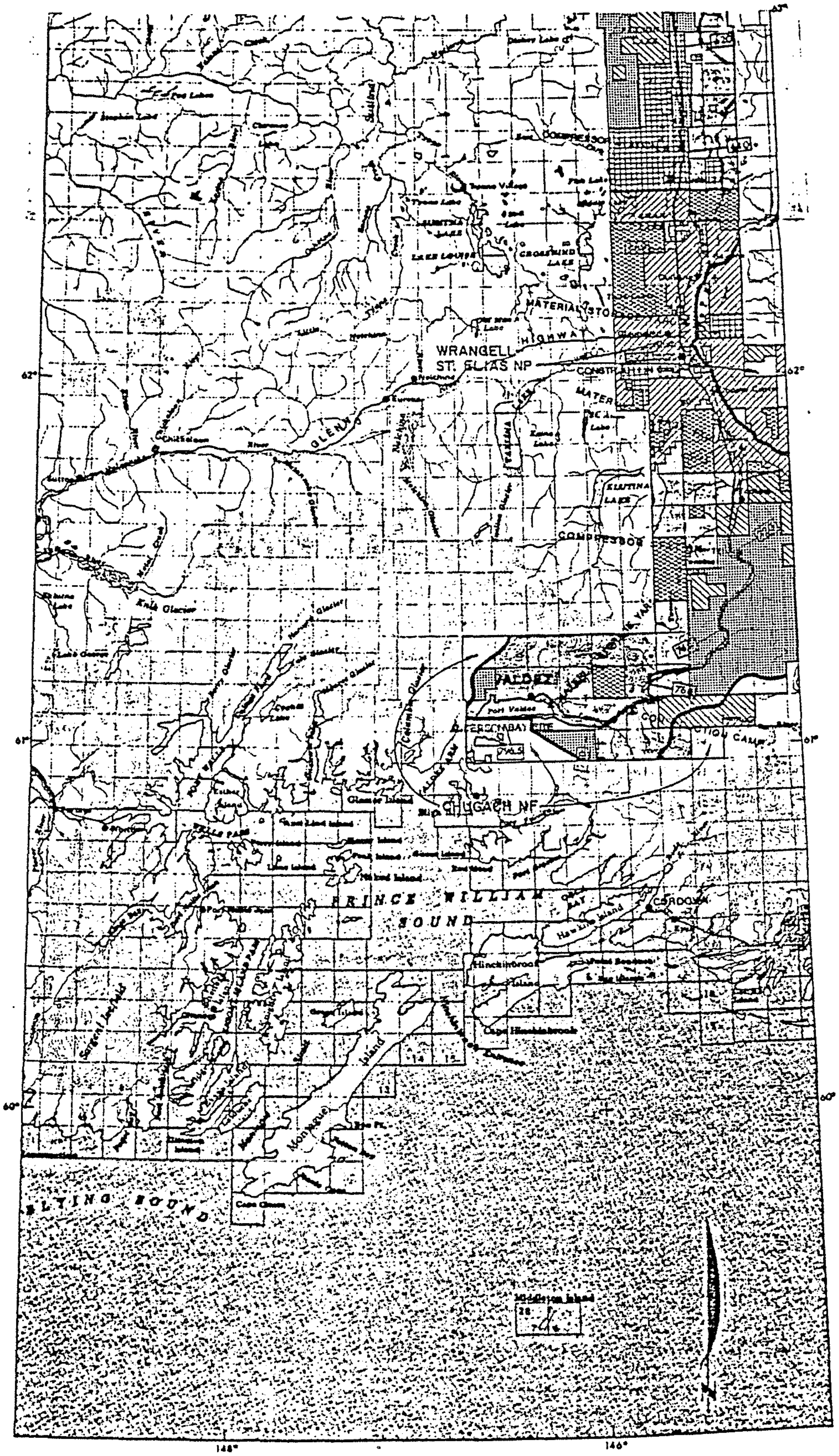
For all other postulated spills, maximum vapor dispersion distances predicted by the American Gas Association model were less than 5,000', and less than 2,200' as predicted by the U.S. Coast Guard model. The maximum vapor dispersion distance considering all cases for the most prevalent weather conditions was predicted to be 3,550' (American Gas Association model). Utilizing worst case weather conditions and the U.S. Coast Guard model for computing vapor travel over land, maximum vapor dispersion distances were predicted to be 3,600'. This value was used as an input to determining the TAGS LNG Plant land requirement.

When the results of vapor dispersion analyses are compared with the location of identified target areas, it is shown that development of the Anderson Bay site will comply with the flammable vapor-gas dispersion protection requirements of 49 CFR 193. All public and private land-use target areas lie outside the computed maximum vapor dispersion distances. Final dispersion exclusion zones will be determined during detailed project design, along with optimization of process, storage tank, transfer system and related impoundment designs.

LAND STATUS ALONG PROPOSED TAGS ROUTE




PIPELINE ROUTE
GENERALIZED LAND STATUS KEY
JUNE 1985
STATE OWNED LAND (T.A. or Pat.)
STATE SELECTIONS
NATIVE OWNED LAND (I.C. or Pat.)
NATIVE SELECTIONS
STATE LEGISLATIVELY DESIGNATED RESERVES
NATIONAL CONSERVATION SYSTEM UNITS
UNAPPROPRIATED PUBLIC LAND
DUAL SELECTIONS, STATE & NATIVE
TAPS PIPELINE
ARCTIC CIRCLE
YUKON FLATS NWR
YUKON FLATS NWR
WHITE MOUNTAINS NRA
STEESE
PRIVATE LAND (TYP.)
NORTH STAR BOROUGH LAND (TYP.)
EIELSON (Military)
FORT WAINWRIGHT (Military)
FT. GREELEY (Military Reserve)
TAPS
COMPRESSOR STATION
TAPS PIPELINE
CONSTRUCTION CAMP MATERIAL STORAGE YARD
DENALI HIGHWAY
ALASKA HIGHWAY



LEGEND

PROPOSED TAGS PIPELINE
EXISTING TAPS PIPELINE
200 TAGS MILEPOST
COMPRESSOR STATIONS
TEMPORARY FACILITIES

SCALE 1:1,000,000

0 10 20 30 40

MILES

US Army Corps
of Engineers
Alaska District

Regulatory Functions Branch
Pouch 898
Anchorage, Alaska 99506

Public Notice of Application for Permit

PUBLIC NOTICE DATE: May ___, 1987

EXPIRATION DATE: June ___, 1987

REFERENCE NUMBER: 2-840222

WATERWAY NUMBER: Valdez Harbor 105

Interested parties are hereby notified that an application has been received for a Department of the Army permit for certain work in waters of the United States, as described below and shown on the attached plans.

APPLICANT: Yukon Pacific Corporation, Post Office Box 101700, Anchorage, Alaska 99510; contact Mr. Harry Noah.

LOCATION: Pipeline route generally parallel to the existing highway system, Trans-Alaska Pipeline System (TAPS), and the authorized Alaska Natural Gas Transportation System (ANGTS) to Delta Junction, as generally depicted by the overview map (Figure 1) and more specifically shown in Figures 2 through 7, from Prudhoe Bay to Port Valdez with a liquified natural gas LNG plant and port facilities located at Anderson Bay, approximately 5 air miles southwest of Valdez, Alaska, as shown in Figure 8.

WORK: To place uncontaminated clean gravel fill in or adjacent to wastes and wetlands of the United States for workpads, access roads, and an LNG plant site associated with the permanent structures of the Trans-Alaska Gas System (TAGS), including a 796.5-mile buried pipeline, LNG plant site, and marine terminal. This would include workpads for the placement of the TAGS pipeline, pads for the 10 compressor stations, metering stations, erosion protection structures, access roads, temporary culvert crossings, low water crossings, permanent buried stream crossings, expansion of shoreline at Anderson Bay at an area adjacent to the LNG plant site, and expansion of temporary facilities such as airfields, temporary construction camp pads, and material storage sites.

The construction of the pipeline workpad would have a width of approximately 50 feet and a side slope of approximately 2:1 as shown in Figure 9. The workpad would parallel the center line of the pipeline. Access roads would have a top width of approximately 42 feet and side slopes of 2:1. Existing gravel pads and access roads would be used to the maximum extent practicable.

Of the total estimated borrow material required for the TAGS project, as shown in Table 1, it is estimated that approximately 16.5 million banked cubic yards (bcy) of gravel for pipeline and related facilities would be placed in waters or wetlands of the United States.

Also included in this notice is the intent temporarily to store ditch spoil and material imported for backfill of pipe trench in or adjacent to wetlands, permanent spoil disposal sites, and temporary structures.

A typical example of a pipeline construction spread is shown in Figure 10. More than 200 river crossings occur along the length of the pipeline. Figure 11 depicts a typical river or stream crossing. There are four elevated river crossings.

A site of approximately 300 acres at Anderson Bay in Port Valdez would be developed for the LNG plant, and the adjacent ocean water areas would be developed as the marine terminal location, as shown in Figures 12 and 13. The LNG plant would be graded into three benches to optimize site development and safety. An off-loading and laydown area adjacent to the shore would be filled with approximately 2 million yards of clean uncontaminated fill from site development. An area filled would be less than 50 acres of nearshore as shown in Figure 12.

PURPOSE:

To provide a pipeline system to move natural gas from Prudhoe Bay to Anderson Bay in Port Valdez at a liquefaction plant, the natural gas would be converted into LNG for export shipment by tanker for sale to Asian Pacific Rim Markets.

ADDITIONAL INFORMATION:

The Bureau of Land Management (BLM) and the U.S. Army Corps of Engineers (USACE) are preparing an Environment Impact Statement (EIS) for the TAGS project. A permit decision regarding the TAGS projects will not be made until after the final EIS has been prepared. This public notice reflects the applicant's proposed project. Other alternatives are being considered in the EIS process and a discussion of these alternatives can be found in Sections 1 through 4 of the EIS.

AUTHORITY:

This permit will be issued or denied under the following authorities:

(X) Perform work in or affecting navigable waters of the United States; Section 10, River and Habor Act 1899 (33 U.S.C. 403).

(X) Discharge dredged or fill material into waters of the United States; Section 404, Clean Water Act (33 U.S.C. 1344). Therefore, our public interest review will consider the guidelines set forth under Section 404(b) of the Clean Water Act (40 CFR 230).

WATER QUALITY CERTIFICATION: A permit for the described work will not be issued until a certification or waiver of certification, as required under

Section 401 of the Clean Water Act (Public Law 95-217), has been received from the Alaska Department of Environmental Conservation.

COASTAL ZONE MANAGEMENT: Section 307(c)(3) of the Coastal Zone Management Act of 1972, as amended by 16 U.S.C. 1456(c)(3), requires the applicant to certify that the described activity affecting land or water uses in the coastal zone complies with the Alaska Coastal Management Program. A permit will not be issued until the Office of Management and Budget, Division of Governmental Coordination, has concurred with the applicant's certification.

PUBLIC HEARING: The Corps of Engineers (USCE) and the BLM will hold joint public hearings on the draft EIS. The dates and locations of these public hearings can be found in the draft EIS.

CULTURAL RESOURCES: The applicant's perferred alternative may affect cultural resources located within and adjacent to the pipeline right-of-way. Formal consultation pursuant to Section 106 of the National Historic Preservation Act (33 CFR 800) is required.

ENDANGERED SPECIES: Preliminarily, this described activity may affect endangered species, and their critical habitat designated as endangered or threatened, under the Endangered Species Act of 1973 (87 Stat. 844). Formal consultation under Section 7 of the act was initiated for the described activity in January, 1987.

FLOODPLAIN MANAGEMENT: Evaluation of the described activity will include conformance with appropriate state or local floodplain standards; consideration of alternative sites and methods of accomplishments; weighing of the positive short-, and long-term impacts on the floodplain.

EVALUATION: The decision whether to issue a permit will be based on an evaluation of the probable impact including cumulative impacts of the proposed activity on the public interest. That decision will reflect the national concern for both protection and utilization of important resources. The benefit which reasonably may be expected to accrue from the proposals must be balanced against its reasonably foreseeable detriments. All factors which may be relevant to the proposal will be considered including the cumulative effects thereof; among these are conservation, economics, aesthetics, general environmental concerns, wetlands, cultural values, fish and wildlife values, flood hazards, floodplain values, land use, navigation, shoreline erosion and accretion, recreation, water supply and conservation, water quality, energy needs, safety, food and fiber production, mineral needs, and, in general, the needs and welfare of the people. The Corps of Engineers would process the TAGS permit application in two phases. The first phase would consist of approval/disapproval of the project as described in the permit application and the EIS. This approval/disapproval would deal with design concept and project alignment alternatives. Should a permit be issued, it would contain stipulations which preclude any construction work until such time as the second-phase approvals take place.

The second phase would consist of approval/disapproval of civil engineering design for the TAGS project. The level of detail would have to be sufficient for the USACE, in consultation with federal and state resource agencies, to identify site-specific impacts which might require mitigation that were not identified in phase one.

By using this two-phase approach, USACE and the resource agencies can focus their review and evaluation first on design and major alignment alternatives. Next, the impacts at site-specific locations along the approved route can be addressed. This method would allow focusing of environmental evaluations on the project as a whole before shifting to smaller, site-specific concerns.

Comments on the described work, with the reference number, should reach this office no later than 30 days after the publication of the notice of availability of the final EIS to become part of the record and be considered in the permit decision. Copies of any comments should be sent to Mr. William Fowler, Regulatory Branch, Post Office Box 898, Anchorage, Alaska 99506-0898, or by calling (907) 753-2712.

The Notice of Application for State Water Quality Certification and Certification of Consistency with the Alaska Coastal Management Program, will be made a public notice by the State of Alaska at a later date.

District Engineer
U.S. Army Corps of Engineers

Attachments

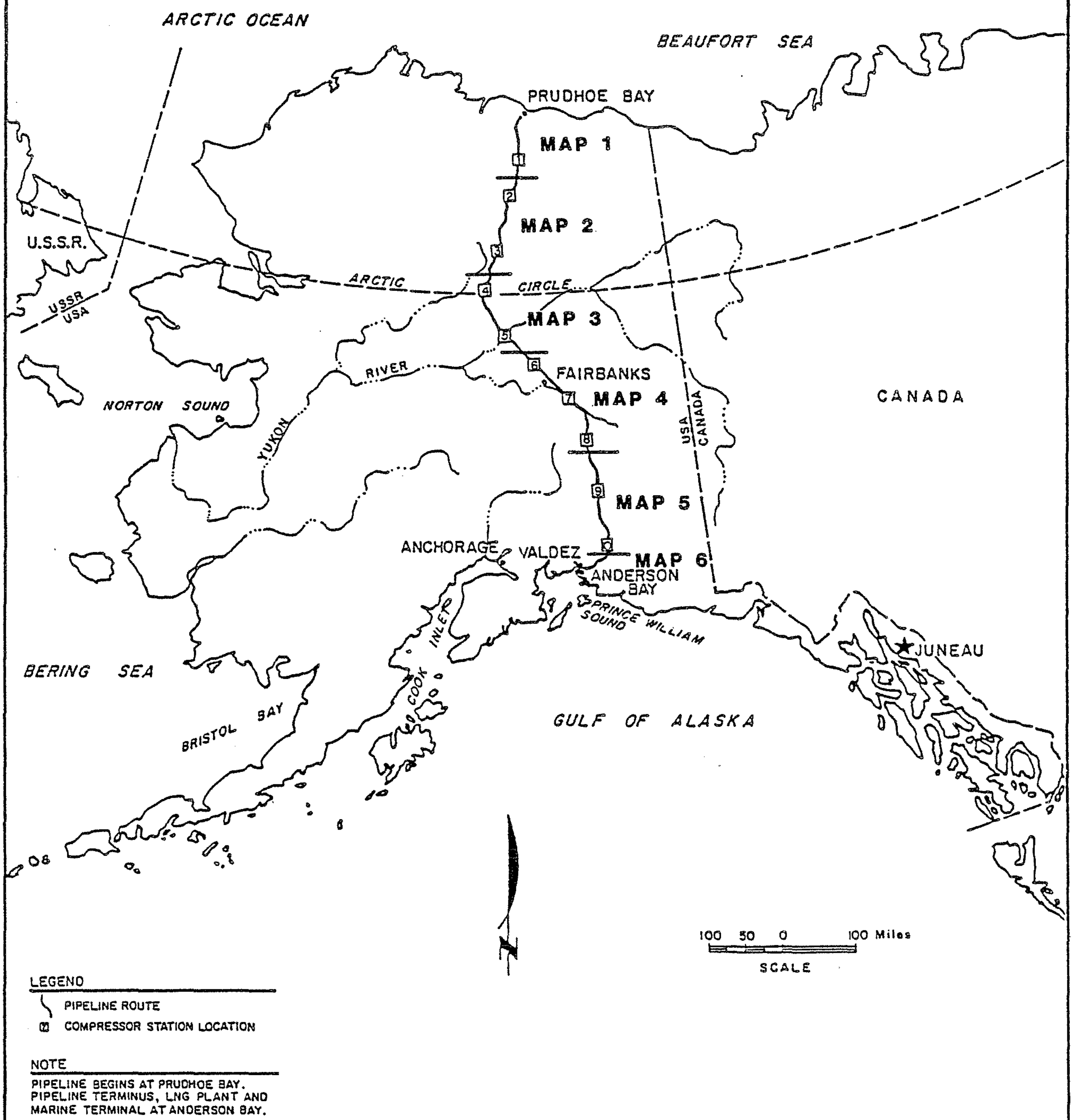


Figure 1 . Trans-Alaska Gas System Facilities Location Overview Map

Figure 2 Alignment Map 1

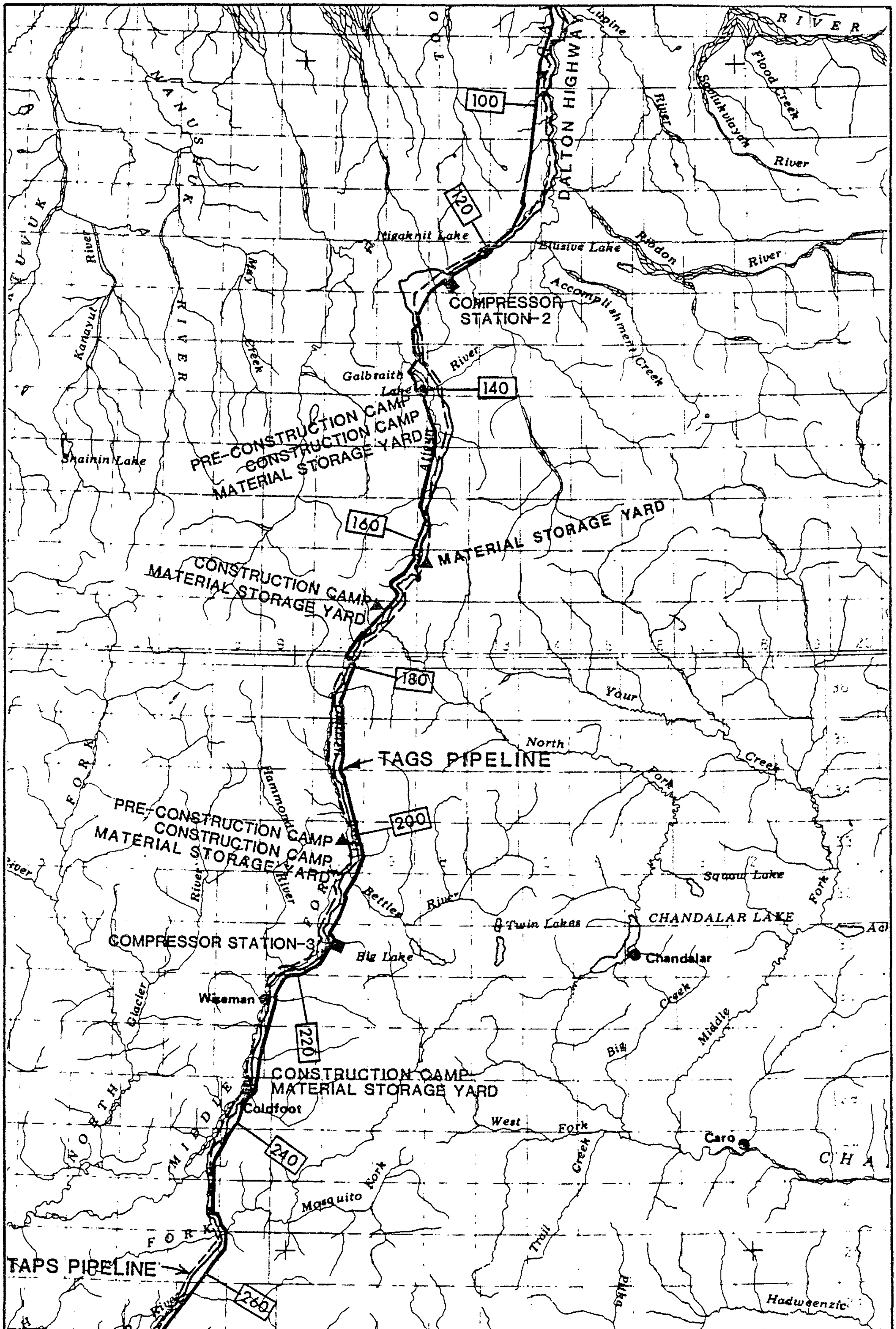


Figure 3 Alignment Map 2

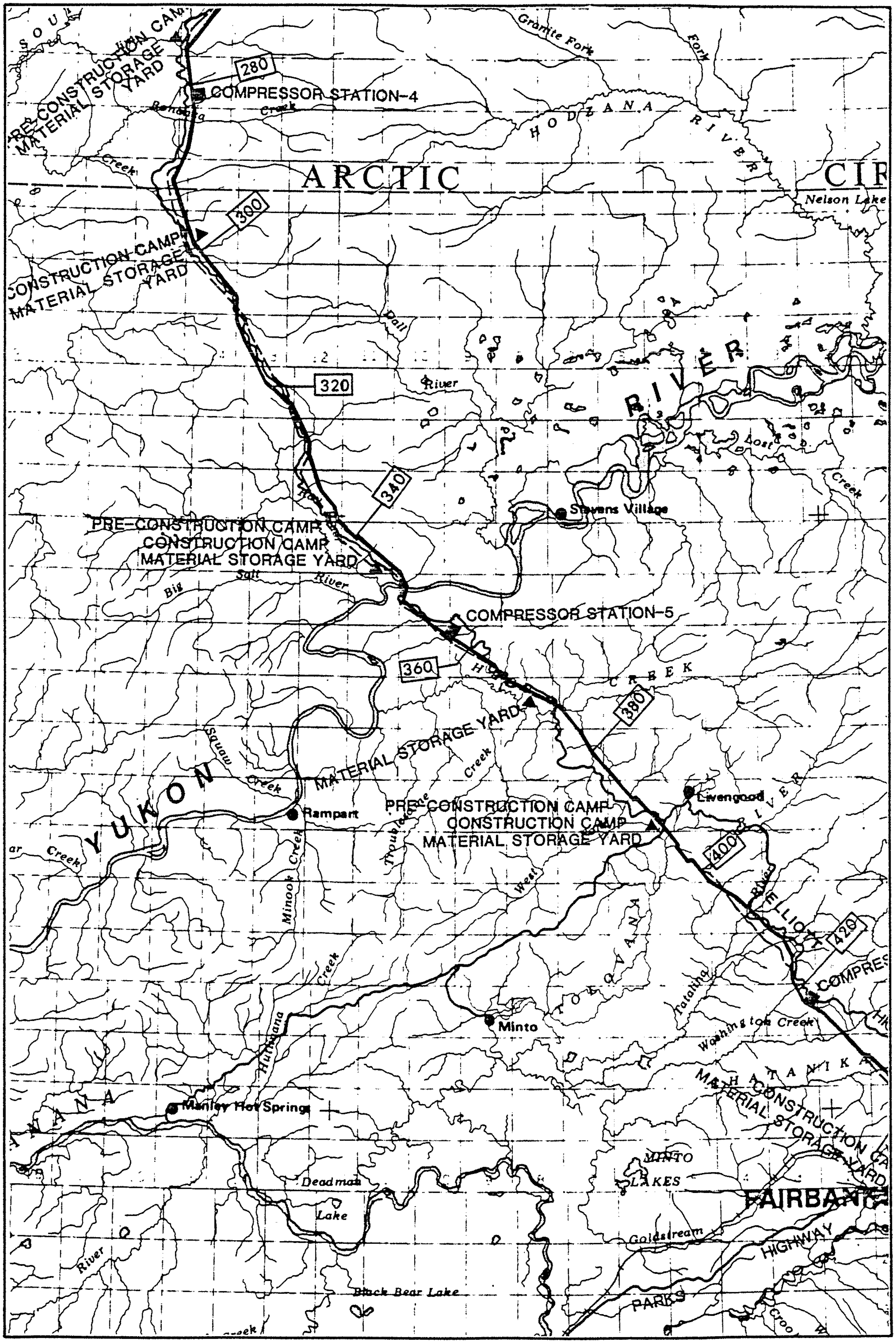


Figure 4 Alignment Map 3

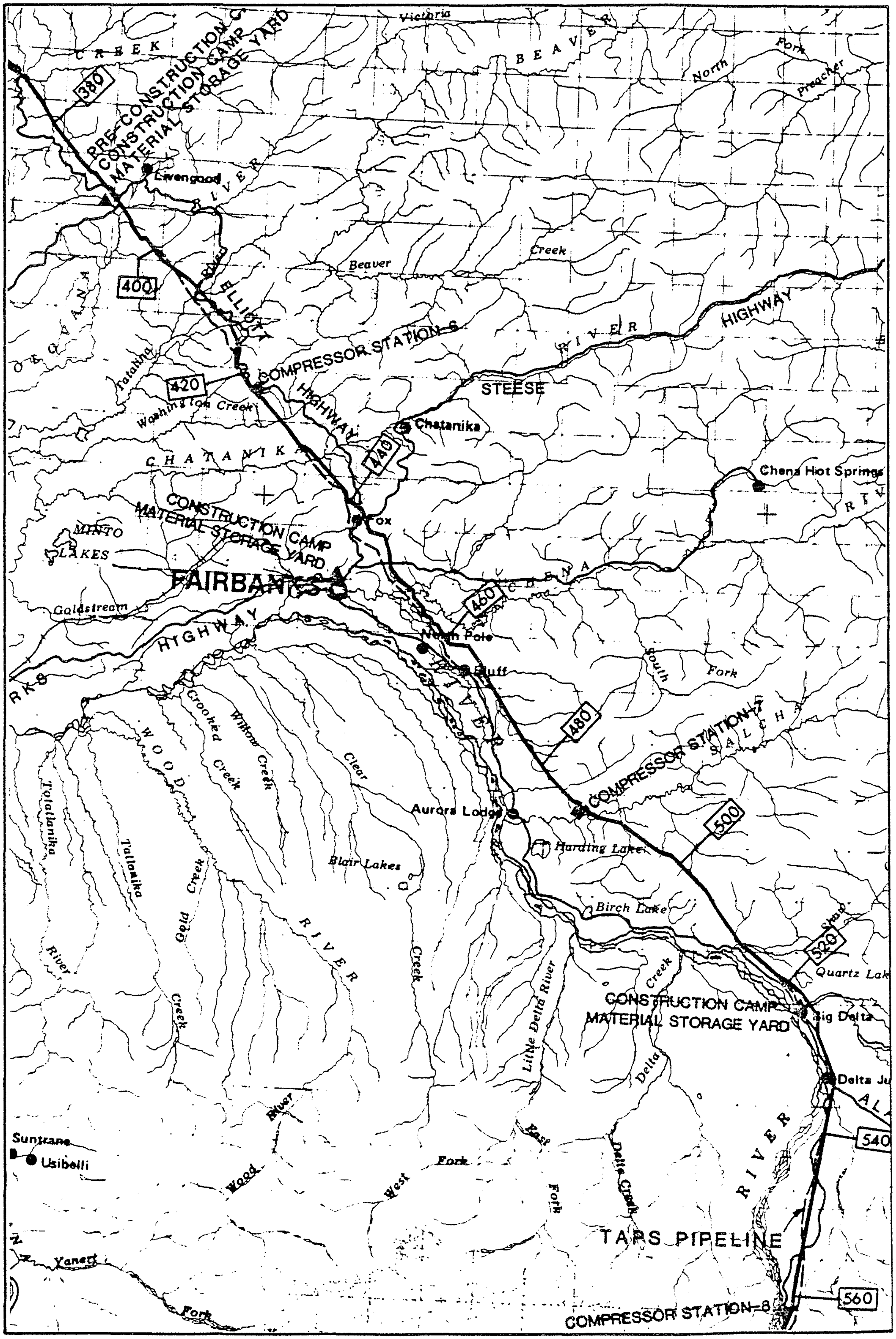


Figure 5 Alignment Map 4

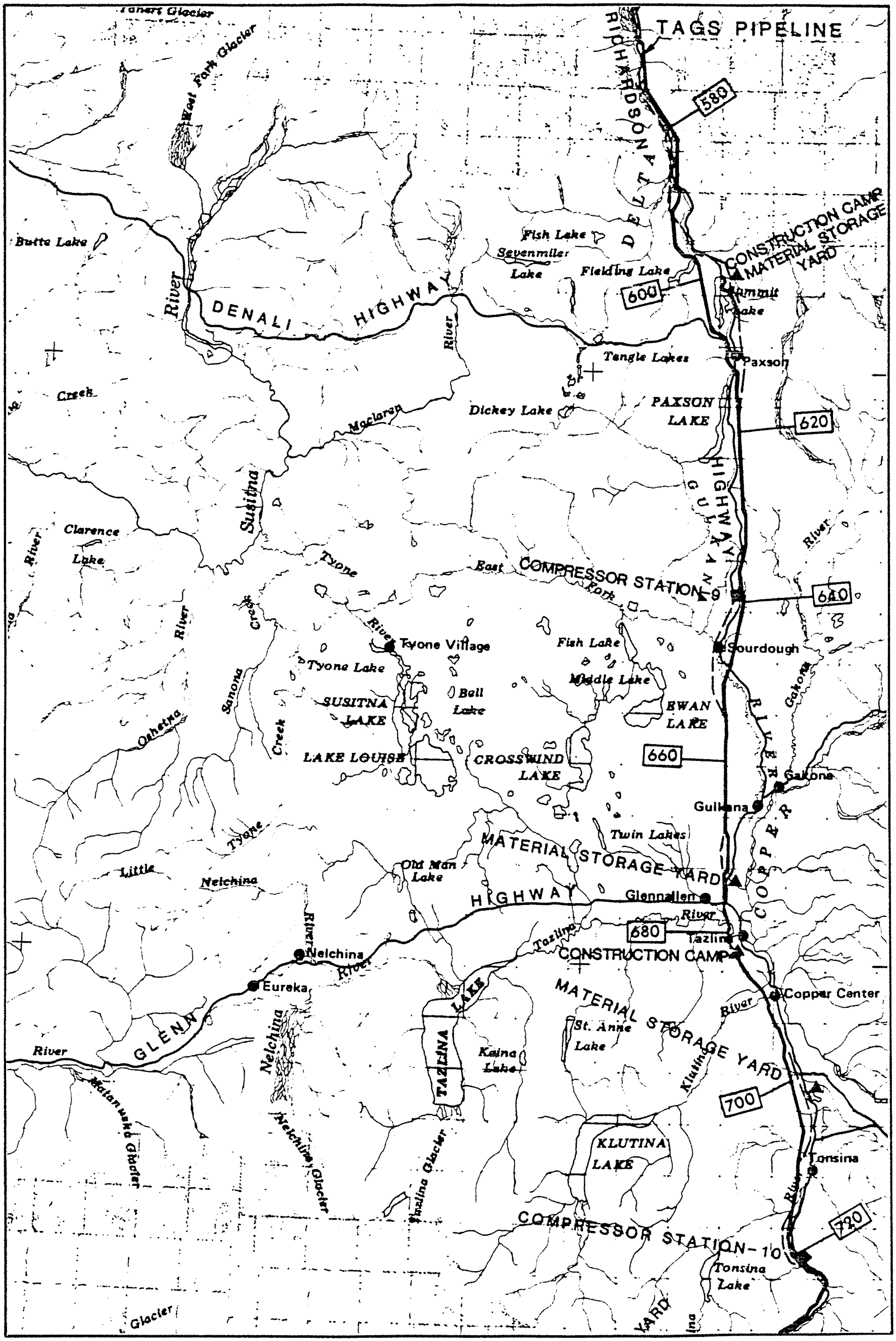


Figure 6 Alignment Map 5

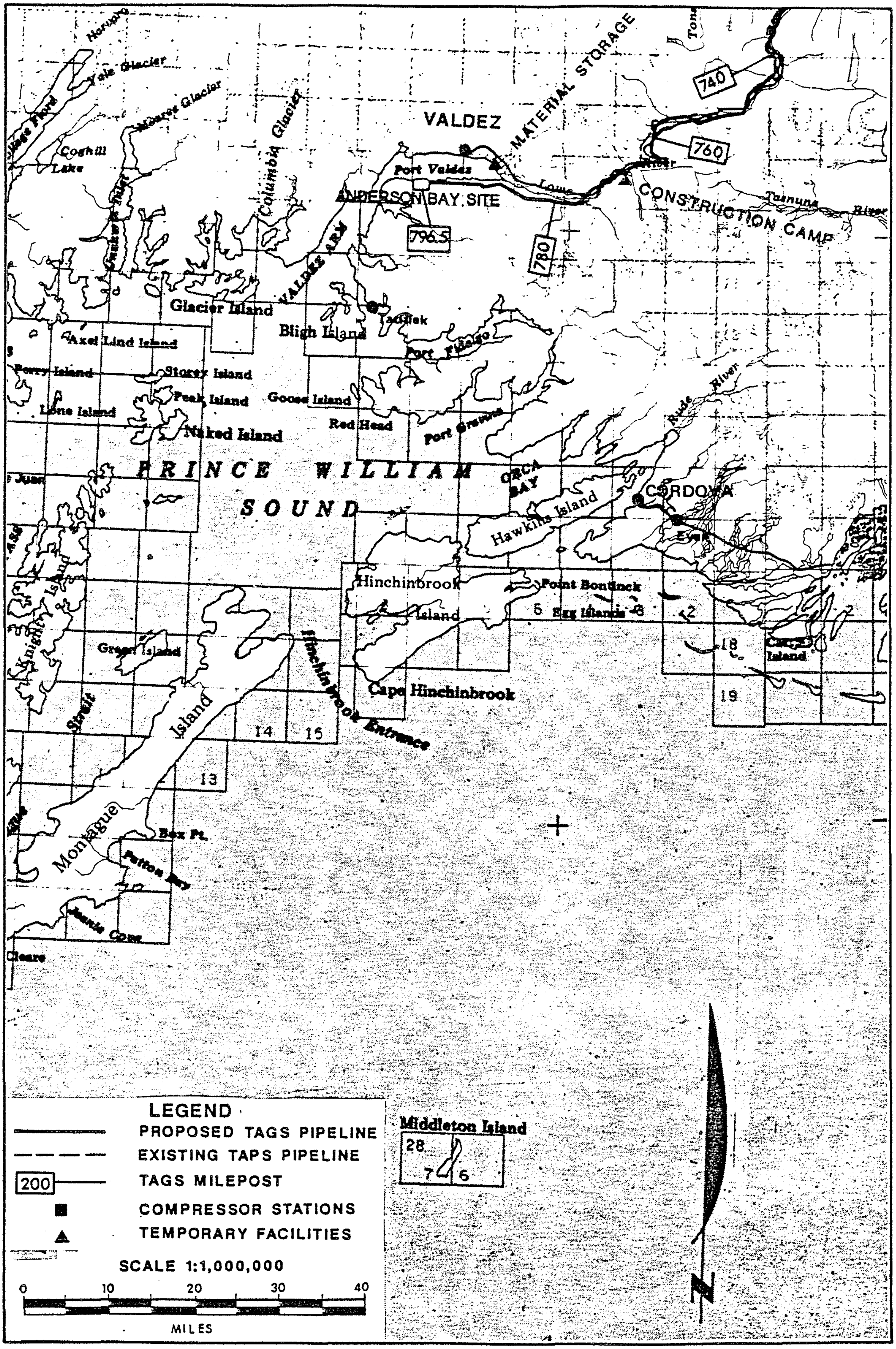


Figure 7 Alignment Map 6

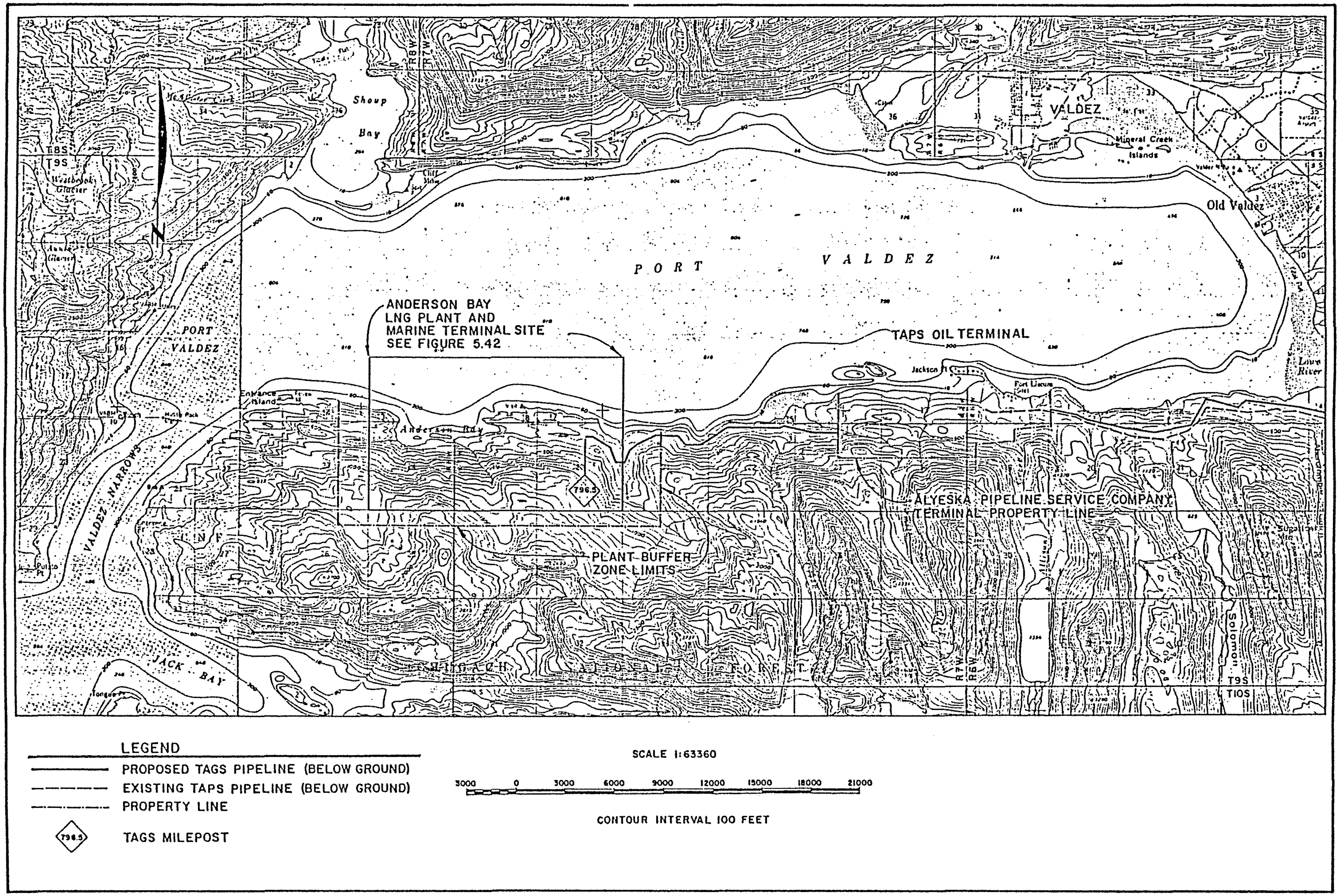


Figure 8 LNG Plant and Terminal Site at Anderson Bay in Port Valdez

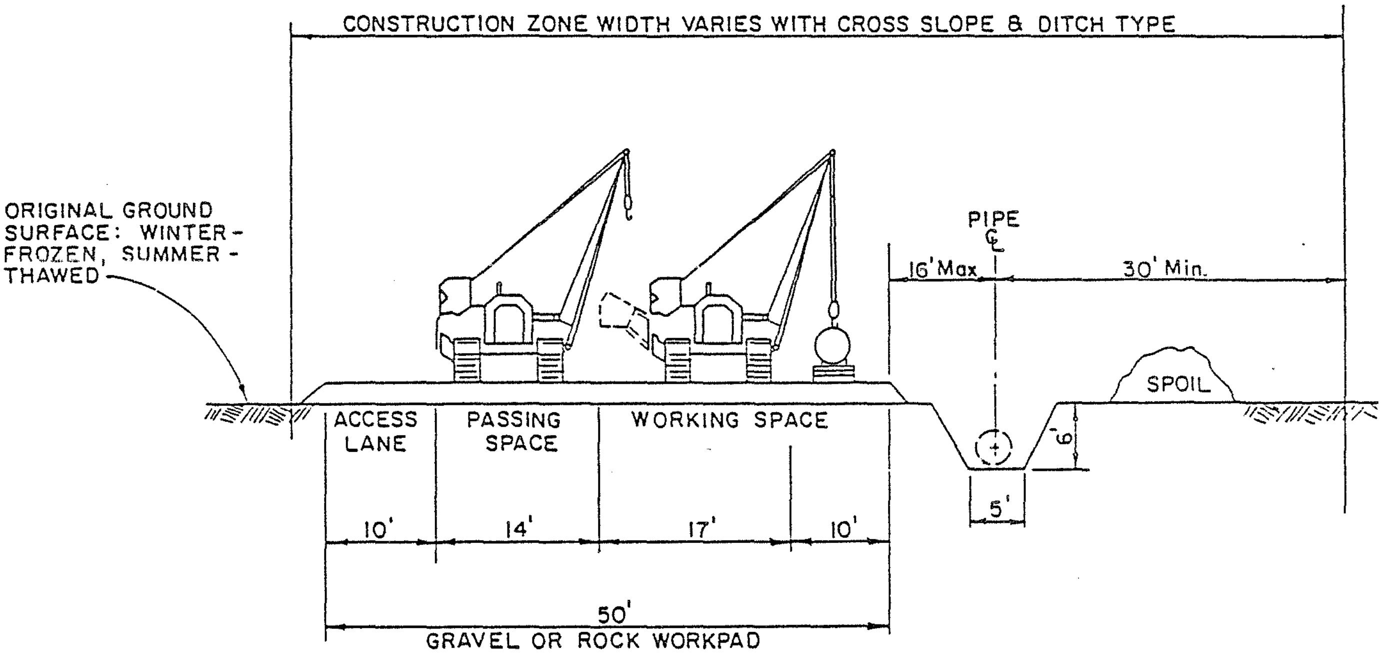


Figure 9 Typical Construction Cross-Section with Gravel or Rock Workpad

Table 1 TAGS Estimated Borrow Material Requirements by Construction Spread

	Construction Section (banked cubic yards x 1000)						
	1	2	3	4	5	6	TOTAL
Workpads	4,200	4,100	3,900	3,600	3,200	2,500	21,500
Access Roads	600	900	60	600	600	300	3,600
Camp Sites/Airfields	400	200	300	100	700	200	1,900
Ditch Backfill	500	500	600	500	700	500	3,300
Compressor Stations	600	300	700	400	200	100	2,300
Other	---	400*	---	---	---	---	400
TOTALS	6,300	6,400	6,100	5,200	5,400	3,600	33,000

* Roadway fill in Atigun Pass special construction area.

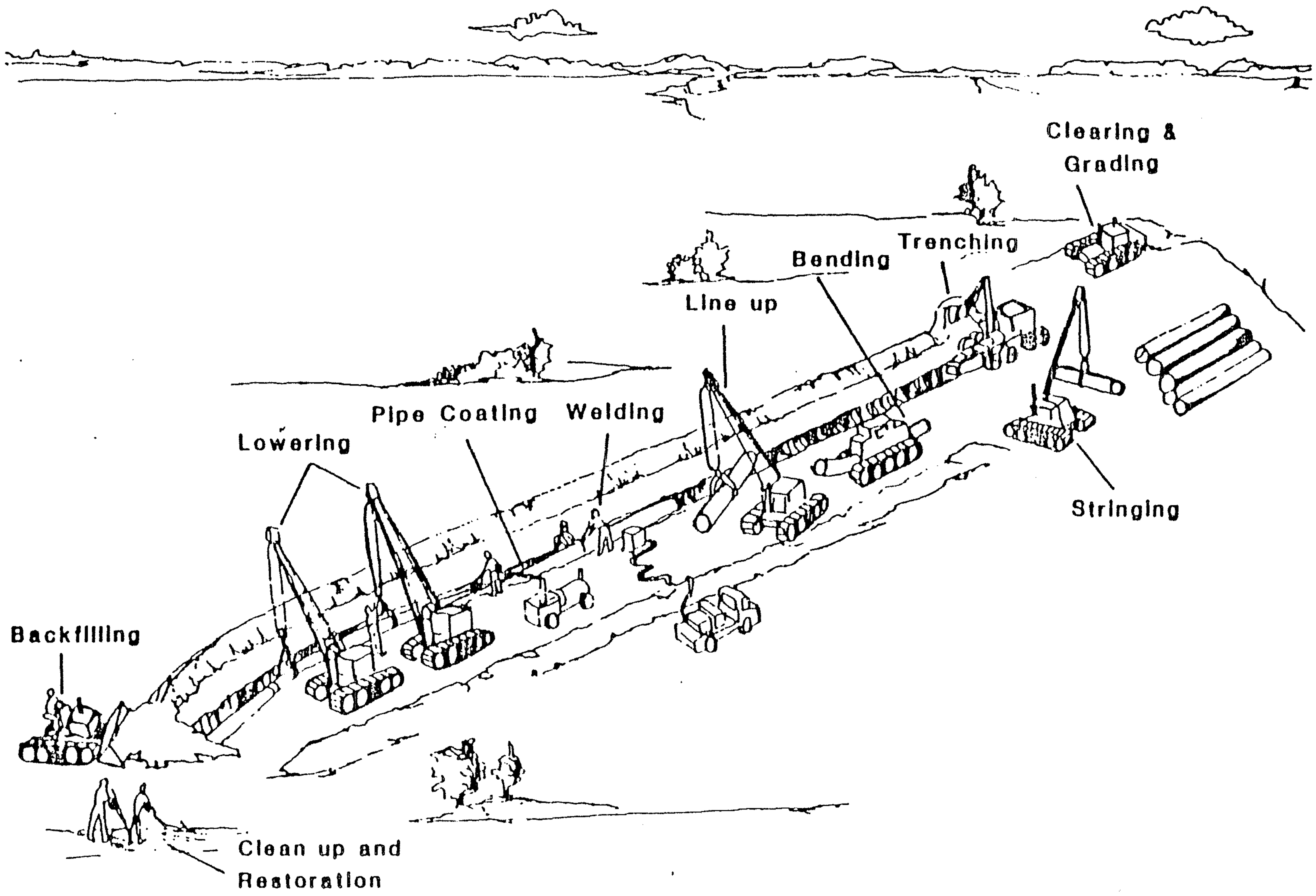
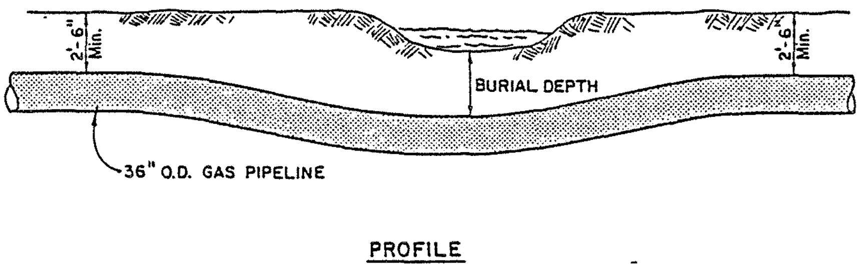
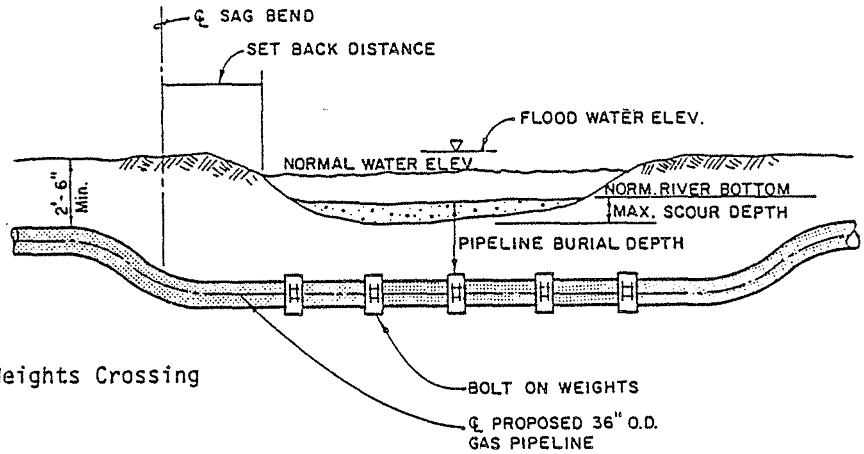


Figure 10 Typical Cross-Country Construction Pipeline Spread (typical, not to scale)
(BLM, 1984)



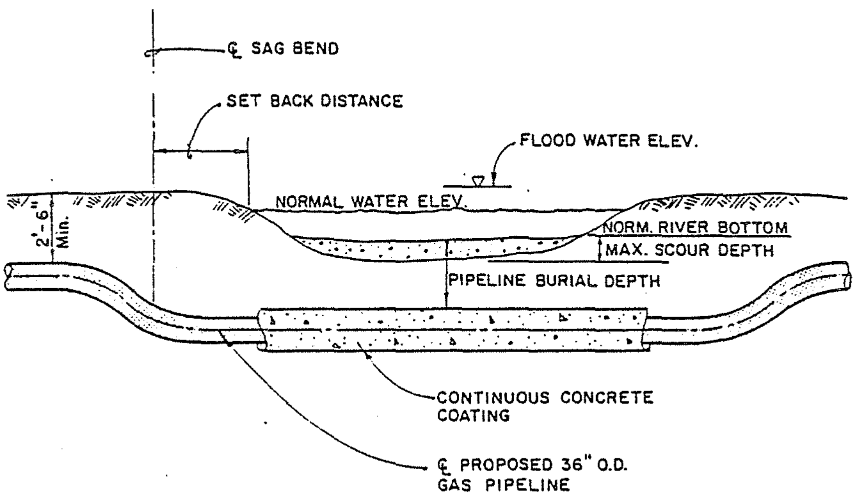
NOTE
PIPELINE BURIAL DEPTH AT STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.

a. Unweighted Stream Crossing



b. Bolt-on Weights Crossing

NOTE
1. PIPELINE BURIAL DEPTH AT RIVER AND STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.
2. BOLT-ON WEIGHTS WILL BE SIZED AND SPACED TO SUFFICIENTLY COUNTER-ACT BUOYANCY FORCES.



c. Concrete Coastal Crossing

NOTE
1. PIPELINE BURIAL AT RIVER AND STREAM CROSSINGS WILL CONSIDER MAXIMUM SCOUR CONDITIONS ALONG WITH MINIMUM REQUIREMENTS OF FEDERAL PIPELINE SAFETY STANDARDS.
2. CONCRETE COATING WILL BE OF SUFFICIENT THICKNESS TO COUNTER-ACT BUOYANCY FORCES.

Figure 11 Typical River or Stream Crossing

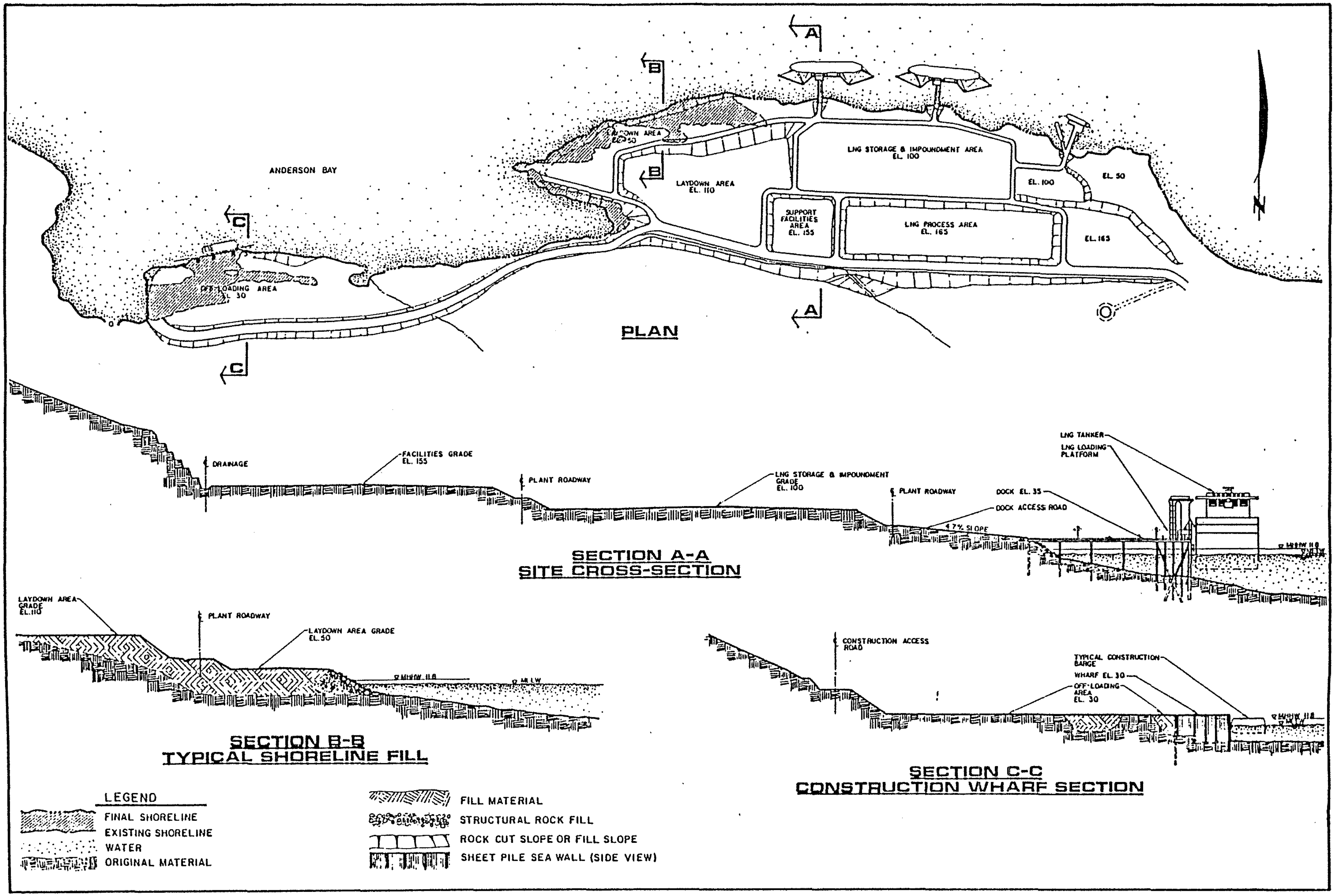


Figure 12 Conceptual Design for Site Development

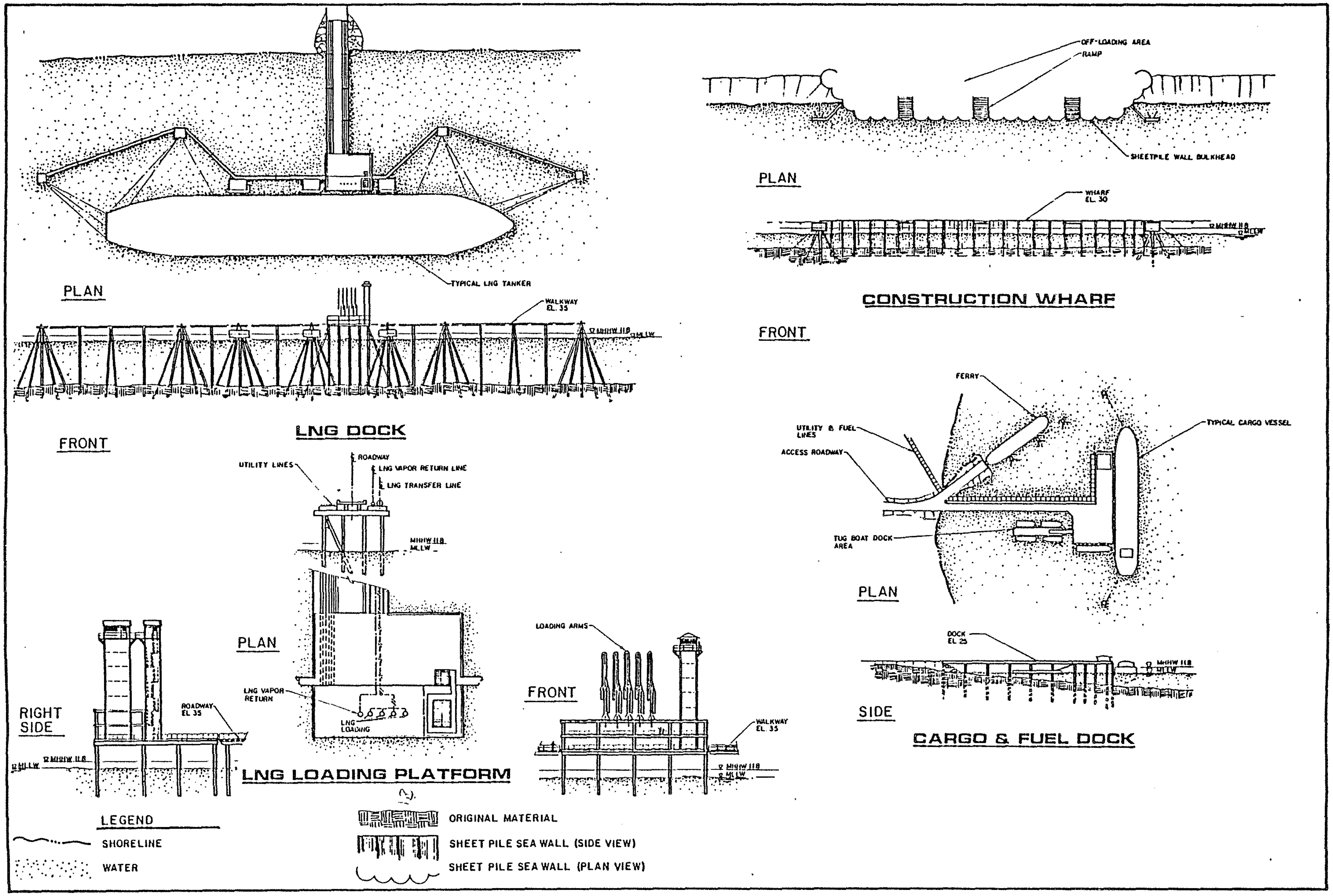


Figure 13 Typical for Terminal Marine Facilities

APPENDIX M

ANILCA SECTION 810 EVALUATION

1.0 PURPOSE OF THE PROPOSED ACTION

In November 1986, the Yukon-Pacific Corporation applied for a Department of the Army permit (Section 10, Section 10 River and Harbor Act 1899 and Section 404, Clean Water Act) and a Bureau of Land Management Federal Grant of Right-of-Way permit (Section 28, Mineral Leasing Act of 1920) to construct a large diameter buried gas pipeline, liquid natural gas plant and tanker loading port facilities, and other related facilities. Prior to issuance of these permits for the proposed work, an evaluation of the effects of the proposed action on subsistence uses and needs, is required under Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA). Because the U.S. Army Corps of Engineers (Corps) and the Bureau of Land Management has determined that the issuance of these permits for the proposed work are major Federal actions which may significantly affect the human environment, an Environmental Impact Statement (EIS) will be prepared prior to a decision to issue or deny the permits, and the ANILCA 810 process shall be incorporated as part of the EIS process and document.

The ANILCA 810 process requires up to four steps. The steps are:

- preparation of an <u>evaluation</u> of the effect of the proposed activities on subsistence uses and needs;

- preparation of a <u>finding</u> of whether or not the proposed activities will significantly restrict subsistence uses;

- if the evaluation results in a finding of significant restriction of subsistence uses, a <u>public hearing proceeded by proper notice</u> must be held in the vicinity of the area involved; and

- if the evaluation results in a finding of significant restriction of subsistence uses, an <u>810 Determination</u> will be prepared.

For further information on the subsistence uses along the TAGS project and environmental consequences, refer to Sections 3.2.17 <u>Subsistence</u>, 4.2.17 <u>Subsistence</u>, and References of the Environmental Impact Statement.

2.0 EVALUATION

DESCRIPTION OF THE PREFERRED ALTERNATIVE

The Yukon-Pacific Corporation (YPC) project is a Trans-Alaska Gas System (TAGS) that will transport natural gas from Prudhoe Bay to Port Valdez, reduce the gas to a liquid state, and ship the liquified natural gas (LNG) to markets in Pacific Rim countries. The project is comprised of three major components: a pipeline, gas compressor stations, and an LNG terminal (Figure 1).

A 36-inch (outside diameter), buried, chilled gas pipeline from Prudhoe Bay to Anderson Bay in Port Valdez will be located in an established utility and transportation corridor, approximately parallel to the existing Alyeska Trans-Alaska Pipeline System route and a segment of the authorized but unconstructed Alaska Natural Gas Transportation System Route. The pipeline right-of-way (ROW) will generally have a width of 120 feet and extend approximately 796.5 miles. Total area disturbed by pipeline construction is estimated at 14,473 acres; during the operation of the pipeline, the disturbed area will be reduced to 5,114 acres (Table 1).

Ten gas compressor stations will be located along the route to control the pressure and temperature of the gas flowing through the pipeline. Each station will occupy approximately 20 acres. Construction camps will generally be located at the compressor station sites.

A 300 acre LNG plant and marine terminal will be located at Anderson Bay on the south side of Port Valdez, three miles west of the TAPS oil terminal. Facilities include four 800,000 barrel LNG tanks. The marine terminal dock will extend 500 feet out from shore and include two loading berths for the 1,000 foot LNG tankers.

Associated facilities and estimates of construction disturbance include access roads (430 acres), air strips (144 acres), temporary camp storage yards (730 acres), construction materials and access roads to sites (5,800 acres), and spoil storage (700 acres).

Construction of the TAGS project will take place over a five year period, with construction of the LNG plant/marine terminal requiring five years, and construction of the pipeline and compressor stations taking place during years three, four, and five (Figure 2). Pipeline construction will progress in the following sequence: material acquisition and stockpiling; camp construction; ROW preparation (clearing and grading); ditching; pipe stringing, bending and welding; pipe lowering-in and tie-in; ditch backfilling; and clean-up and restoration. The pipeline will be constructed simultaneously over six construction spreads; construction for each spread will require roughly 34 months to complete. On a given spread, camp and ROW/workpad preparation will occur throughout the year over years 3 and 4; pipe ditching and laying will occur primarily over the winter-spring months of years 3, 4, and 5 (except in the southernmost spread); and clean-up and restoration will occur during the summer and fall months of year 5.

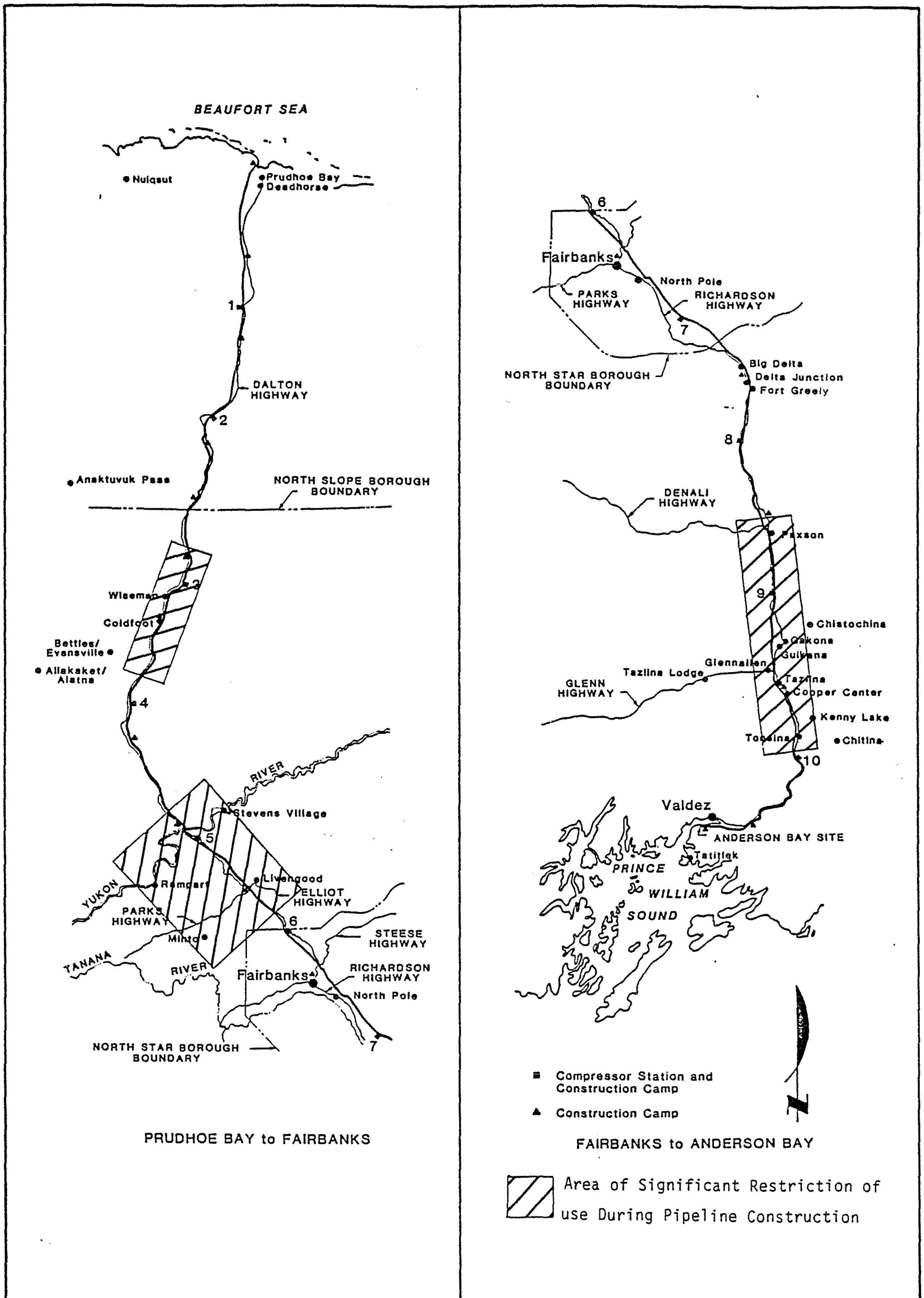


Figure 1 Location of Communities within 50 Miles of the Proposed TAGS Project

Table 1
Estimate of Disturbed Area for TAGS

	Construction	Operation
	Acres	
Pipeline	14, 473	5,114
Ten Compressor Stations	278	200
Access Roads	430	430
Temporary Camps Storage Yards	730	255
Air Strips	144	0
River Crossing Extra Work Space	55	20
Spoil	700	80
Construction Material Sites and Access Roads	5,800	1,740
LNG Facility	300	280
Total Area Disturbed	22,910	8,119

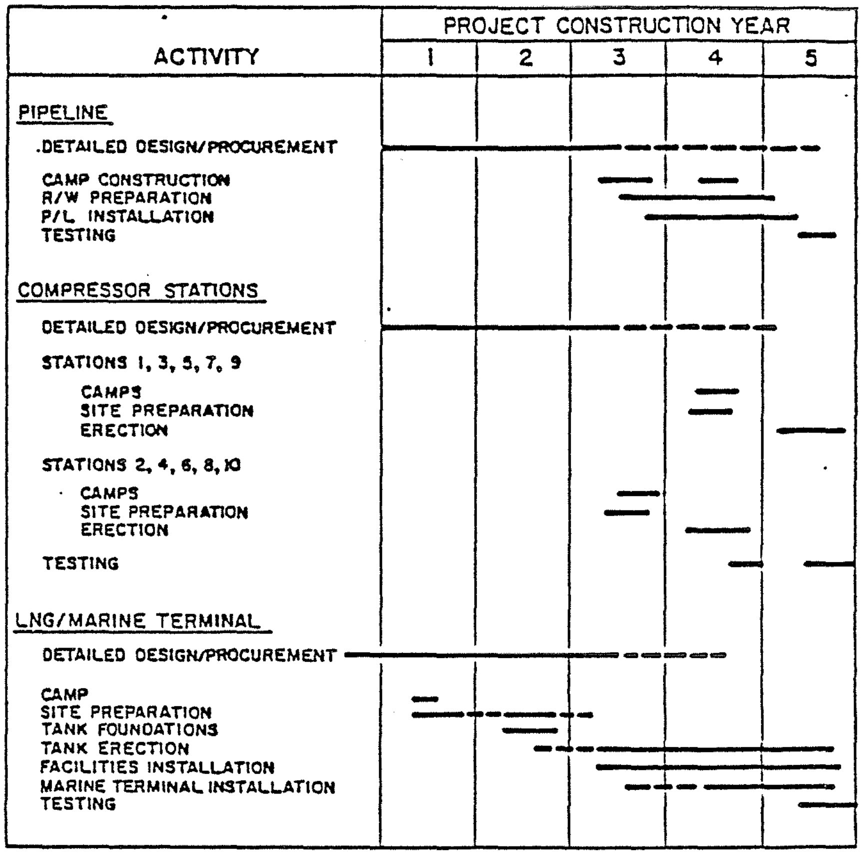


Figure 2
TAGS Overall Construction Schedule

CURRENT SUBSISTENCE ACTIVITIES IN THE AFFECTED AREA

The indigenous people of Alaska have pursued subsistence as a way of life for generations; subsistence contributes to the economy, social structure and cultural traditions, nutrition, and identity of those who participate in it. The foundation of their sociocultural systems is the utilization of the natural environment and its biological resources. Subsistence foods constitute a significant portion of the diet of Native Alaskan communities, particularly in smaller villages where imported foods are not readily available or expensive. Subsistence resources represent income; the combination of subsistence and employment contribute to the overall village economy.

Subsistence harvest patterns are seasonal, responding to biological cycles, proximity of resources, environmental conditions, and ease of travel and access. These patterns have a historical basis, and have been modified with the establishment of permanent settlements. Each community relies on specific subsistence resources to varying degrees, depending on their abundance, seasonal distribution and proximity to the village.

The area affected by the proposed TAGS project includes 18 communities that participate in subsistence activities. For the purposes of discussing subsistence activities in the EIS, the route has been divided into five subregions: 1) the North Slope Borough, 2) the Northern Corridor communities, 3) the Fairbanks-Delta Junction communities, the 4) Glennallen-Copper Center communities, 5) and Valdez-Tatitlek (Table 2).

North Slope Borough

The portion of the route within the North Slope Borough lies approximately between mileposts 0 and 160. Three North Slope Borough communities use this area of the route for subsistence activities: Nuiqsut, Kaktovik, and Anaktuvuk Pass.

Marine mammals are important North Slope Borough subsistence resources and include seal (ringed, bearded, and spotted), walrus, polar bear, Beluga and Bowhead whale. Terrestrial mammals hunted for subsistence include caribou, moose, brown/grizzly bear, Dall sheep, and rabbits. Hunting for seabirds, waterfowl and gathering bird eggs occurs during the late spring, summer and early fall. A variety of fish contribute to the subsistence diet including salmon, char, cisco, grayling, and varieties of marine fish. Fish are taken year around, both in coastal waters by boat and at traditional fish camp sites on rivers and the coast. Various plant resources for food and other needs, such as berries, roots, seeds, fuel wood and construction materials make up the last category of subsistence resources.

None of these communities are located in the immediate vicinity of the TAGS route. In addition, their subsistence use areas are relatively broad, and the TAGS route is located on the periphery of these areas.

Table 2 Communities Participating in Subsistence Uses

Area/Community
North Slope Borough
Nuiqsut
Kaktovik
Anaktuvik Pass
Northern Corridor
Nolan/Wiseman
Livengood
Bettles/Evansville
Allakaket/Alatna
Stevens Village
Rampart
Minto
Fairbanks/Delta
College
Fairbanks
North Pole
Delta Junction
Glennallen-Copper Center
Paxson/Sourdough
Gakona
Gulkana
Glennallen
Copper Center
Upper Tonsina
Valdez-Tatitlek
Valdez
Tatitlek

Northern Corridor Communities

The Northern Corridor area runs from milepost 160 to 420, and is used for subsistence activities by seven communities: Nolan/Wiseman, Bettles/Evansville, Allakaket/Alatna, Livengood, Stevens Village, Rampart, and, to a lesser extent, Minto. Several of these communities are traditionally Northern Athabascan; the others are the result of mining activities or highway and Trans-Alaska Pipeline System maintenance activities.

Five major types of subsistence resources are utilized by Northern Corridor communities along the proposed route: hunting for moose, caribou, bear, Dall sheep, rabbits, and a variety of waterfowl; fishing for salmon, char, cisco, grayling, and other varieties of fish; trapping various furbearers, including beaver, martin, fox, wolf, wolverine, marmot, and others; and collecting various plant resources for food and other needs, including berries, roots, seeds, fuel wood and construction materials. Of these activities, moose hunting and fishing exhibit the highest percentages of house participation and are considered the most significant subsistence activities.

Several of the communities are located adjacent to or near the TAGS route, notably Nolan/Wiseman and Livengood, with Stevens Village and Rampart located respectively upstream and downstream of the Yukon River crossing. Other area communities potentially affected by the TAGS project are not easily accessible from the Utility Corridor and have subsistence use areas that are relatively broad, with the TAGS route located on the periphery of these areas.

Fairbanks-Delta Junction Communities

Unlike the areas to the north, the Fairbanks-Delta Junction communities are more urban in their orientation, with greater participation in wage employment and the cash economy. They are not as economically or culturally tied to pursuit of subsistence activities, and are not considered rural subsistence areas by the State Boards of Fisheries and Game. Some residents participate in subsistence-like activities (hunting, fishing and wood harvesting) and personal use fisheries. This portion of the TAGS route contains 3 major communities: Fairbanks, North Pole, and Delta Junction (smaller communities such as Fox and Big Delta are included).

Glennallen-Copper Center Communities

Located between TAGS mileposts 560 and 760, this subregion contains six communities: Paxson/Sourdough, Gakona, Gulkana, Glennallen, Copper Center, and Upper Tonsina. These communities are located adjacent to or in the vicinity of the TAGS route. Similar to the Northern Corridor subregion, this area is a mix of traditional Athabascan communities, regional service centers and highway/pipeline maintenance camps. Subsistence patterns are further influenced by readily available road access. In addition to subsistence activities, several of the rivers in the subregion support popular personal use fisheries.

Fish harvests are the most important subsistence activity in the subregion, with sockeye salmon constituting the majority of the harvest (ADF&G 1985). Salmon are harvested from June through September, using fish wheels, dip nets and rod and reel. Grayling, trout and burbot are also harvested. Access to subsistence sites is by road and boat.

Moose are highly valued subsistence resources. They are hunted during fall months, with hunting access provided by highway vehicles, offroad vehicles, airplanes and boats. Due to ease of highway access, there has been significant competition for moose between subsistence and sport hunters. Over the past few years, subsistence hunting regulations have been changed to help ensure an adequate subsistence harvest.

Caribou have been a historically important subsistence resource. However, since population declines in both the Nelchina and Mentasta caribou herds over the last two decades, hunting has been restricted to allow for an increase in herd size. Recent changes in subsistence hunting regulations have resulted in a fall caribou subsistence hunt. Access to hunting areas is similar to that of moose.

Other activities include harvesting berries and native vegetation. Wood harvesting, for firewood and construction, is popular in this area; a subsistence permit is required to harvest wood on federal lands.

The Copper river is the location of a very popular personal use dipnet fishery for sockeye salmon; nearly 7000 permits were issued for this fishery in 1983. Many non-residents participate in the fishery; approximately 35% of the permits issued in 1983 went to Anchorage residents. Currently, the most popular location for dipnetting is just outside of Chitina, to the east of the TAGS route.

Valdez-Tatitlek

The area between milepost 760 and the proposed LNG terminal at Anderson Bay (MP 796.5) is sparsely populated and contains only two communities: Valdez and Tatitlek. Valdez has a wage employment and cash economy; it is not considered a rural subsistence area by the State Boards of Fisheries and Game, and subsistence by residents is limited to activities like wood harvesting. Tatitlek is a traditional Chugach Eskimo community that is oriented towards coastal subsistence activities.

While no detailed subsistence surveys of Tatitlek have been completed, resource availability and harvest patterns are similar to those of the Cordova/Eyak area. A wide variety of subsistence resources are available throughout the year, unlike interior locations. Harvest activities of residents tend to be oriented to use of relatively nearby marine and coastal areas . Access to resources is primarily by boat. Major subsistence resources include fish, invertebrates,marine mammals, deer, and waterfowl and bird eggs.

IMPACTS ON HABITAT AND FISH AND WILDLIFE IMPORTANT TO SUBSISTENCE

Construction and operation of the project can affect fish and wildlife resources used for subsistence activities in three ways, resulting in their reduced availability for subsistence harvest. First, mortality could occur from project construction or accidental events such as an oil spill. Fish would be most at risk due to the potential for siltation or fuel spills into a watercourse. Second, fish and wildlife might avoid the project area due to construction activities or, in the case of poorly placed drainage and fish passage structures, be unable to physically migrate through the project area. Animals that can avoid the area during construction activities, such as moose and caribou, are likely to do so. Finally, construction and operation of project related facilities could result in habitat loss and a reduced level of utilization of the project area by fish and wildlife. The potential for impacts to fish and wildlife resources used for subsistence purposes varies along the TAGS route.

North Slope Borough

In the North Slope Borough, some subsistence resources like marine mammals would not be affected by the project. Some fish resources would be affected by mortality, obstructions to migration, and loss of critical habitat, primarily along the Sagavanirktok River. However, there are other important areas used by village residents for fishing, and impacts to fish would be minimized through proper design and construction procedures proposed for the TAGS project. Impacts to moose, sheep and caribou are potentially more significant on a short-term basis. Avoidance of construction areas and induced changes to distribution or migration patterns would cause temporary hardship to individuals who utilize areas along the route for the subsistence harvest of moose and caribou, requiring increased harvest effort elsewhere. Loss of riparian habitat could reduce the availability of moose. Because the area along the TAGS route is not a primary subsistence use area of Kaktovik, Nuiqsut, and Anaktuvuk Pass, impacts to fish and wildlife in this area would not be significant in terms of subsistence.

Northern Corridor

Along the Northern Corridor, caribou, moose and fish would also be sensitive to TAGS-related impacts. Communities close to the TAGS route would be more likely to be significantly affected, such as Nolan/Wiseman and Livengood. Fish and wildlife avoidance of the construction area would temporarily require a greater level of harvest effort in areas more remote from construction activities. The cumulative effect of avoidance impacts (when added to other subsistence use impacts discussed below) would contribute to temporary but significant restriction of use in this area. The communities of Allakaket/Alatna, Bettles/Evansville, Rampart, and Stevens Village use many areas other than the TAGS route for subsistence activities and would experience minor impact to fish and wildlife used for subsistence purposes.

Fairbanks-Delta Communities

Because there is significant development that already affects fish and wildlife in this area, and there is negligible subsistence use, impacts to fish and wildlife would not affect subsistence use.

Glennallen-Copper Center Communities

The type of impacts in the Glennallen/Copper Center Corridor would be similar to those in the Northern Corridor, with fish, moose, and caribou being the most sensitive subsistence species. Because there would be no pipeline crossings of streams important to subsistence or personal use fisheries there would be minimal direct impacts to fisheries, except in the unlikely event of a catastrophic fuel spill. Some avoidance of the construction area by moose and caribou would occur. The TAGS project would add to the cumulative habitat disruption and avoidance by moose and caribou resulting from existing development in the area, and would contribute to temporary but significant restriction of subsistence use in this area. Nearly all the communities in the area are adjacent to the TAGS route and would be affected, including Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities.

Valdez-Tatitlek

Like the Fairbanks area, subsistence hunting and fishing by Valdez residents is negligible and effects on subsistence from fish and wildlife impacts would not be significant. Tatitlek is reliant on coastal and marine subsistence species, and primary harvest areas are located outside Valdez Arm (City of Valdez 1986). Marine mammals used for subsistence may be sensitive to increased levels of tanker traffic; other subsistence fish and wildlife species are unlikely to be affected.

IMPACTS ON SUBSISTENCE USES AND NEEDS

Adverse impacts to fish and wildlife used for subsistence purposes and resulting loss of harvest would require some increased effort for adequate subsistence harvest, and create adverse economic and social impacts. In addition, interference with harvesting activities and access to resources, increased competition from sport hunting, fishing, and trapping, and adverse impacts from project employment would also result in relocation of and/or increased harvest effort, economic impacts, and social impacts. These topics are discussed below.

Interference and Access Impacts

TAGS project construction and operation has the potential to interfere with subsistence activities. The primary causes of interference are restriction of access to traditional subsistence use areas and restrictions on hunting and fishing in the vicinity of the TAGS project. Construction activities and placement of facilities, roads and borrow pits would eliminate or restrict some access to areas traditionally used for subsistence activities throughout the project area. During TAPS construction and operation, Glennallen area residents have mentioned restricted access to wood harvesting areas as a concern. During construction, workpad construction and pipeline ditching and laying activities will last for periods of up to eleven months (although the pipeline ditch would not likely be open for more than 30 days in any given location); construction camps, access roads and borrow pits could be operational for the period of construction. Therefore, the potential for these impacts would be temporary, and limited to the duration of construction activities in a given area. Regulations regarding hunting and trespass in the vicinity of the completed TAGS line can also have the effect of restricting subsistence use of traditional sites.

Communities located adjacent to the TAGS route, such as those in the Northern Corridor (Nolan/Wiseman and Livengood) and Glennallen/Copper Center area (Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities) are more sensitive to interference and access impacts. They harvest resources and/or require access in the immediate vicinity of the route, compared to those which are further away or have broad subsistence use areas. Access and interference impacts in these areas adds to the cumulative restriction of subsistence uses.

Increased Sport Hunting, Fishing, and Trapping Competition

Increased levels of sport hunting, fishing and trapping would be associated with construction and operation of the TAGS project. The project will introduce large numbers of direct and indirect employees into the project area and likely result in improved access into many places with fish and wildlife resources. This workforce and its dependents would participate in sport hunting, fishing, and trapping activities. Left unregulated, such participation would compete with subsistence users for fish and wildlife resources and threaten maintaining the populations of fish and wildlife used for subsistence purposes. Sport hunting, fishing and trapping activities by employees will be concentrated around the locations of construction camps.

Due to the availability of public access for sport hunting, fishing and trapping, and subsistence reliance on the area in the immediate vicinity of the TAGS project, the Northern Corridor and (Nolan/Wiseman) and Glennallen/Copper Center area (Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities) would be more vulnerable to increased competition from sport hunting, fishing, and trapping than those which are further away or have broad subsistence use areas. Even though a five mile corridor along the Dalton Highway is subject to hunting restrictions, sport hunting would still compete with subsistence hunting outside the corridor, and sport fishing is not similarly restricted. Fish (salmon, grayling, burbot, and whitefish), moose and caribou are important dietary components to communities of these areas, and are also popular sport hunting and fishing species. Small and medium size furbearers are trapped to provide materials for local handicrafts, and pelts which are an important source of cash for some families. Increased competition from sport hunting, fishing and trapping would result in some increased effort for adequate subsistence harvest, and economic and social impacts.

The duration of competitive impacts would result in some significant restriction of subsistence use, but would be limited to the period of construction. During operation, the workforce could continue to compete with subsistence users on a smaller scale.

Impacts From Employment

Project employment opportunities are very important to local residents, and wage income will offset loss of subsistence resources to some degree. However, employment also presents some disadvantages to participating in the traditional subsistence way of life. Subsistence harvest patterns follow the seasonal availability of resources; and are also flexible to take advantage of unexpected harvest opportunities as they arise. Full-time employment does not provide the flexibility to participate in subsistence activities as they arise, particularly those that cannot be scheduled in advance.

The communities most likely to be sensitive to employment-created subsistence impacts are those that are predominantly Native, and which have a social structure and personal identity that revolves around participation in subsistence activities. These include the North Slope communities, Evansville, Allakaket/Alatna, Stevens Village, Rampart, Minto, Copper Center and Tatitlek. The effects of an employment-induced reduction in subsistence participation are primarily social. Because the majority of local employment opportunities will be during project construction, impacts from employment will generally be temporary and are not considered significant restrictions of subsistence use.

Relocation/Increased Harvest Effort

An indirect impact of the TAGS project, resulting from the primary impacts described above, is increased harvest effort required to offset loss of subsistence resources in the vicinity of the project. Any reduction in harvest levels attributable to the project would result in increased effort to make up the loss in other areas unaffected by the project (relocation). In addition to the time involved with extra travel, an increased harvest effort usually requires additional outlays of cash for fuel and supplies.

Communities located adjacent to the TAGS route, such as those in the Northern Corridor (Nolan/Wiseman and Livengood) and Glennallen/Copper Center area (Paxson/Sourdough, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities), are more sensitive to impacts from relocated or increased effort than those which are further away or have broad subsistence use areas. In these areas, relocation and increased effort impacts lead to the cummulative restriction of subsistence uses. Because of greatly reduced levels of activity and construction facility closure/rehabilitation after construction, relocation and increased effort impacts will be minimal during project operation.

Economic Impacts

A second indirect subsistence impact of TAGS construction and operation is adverse economic impact on communities that are oriented towards a subsistence way of life. This impact would be partially offset by any local hire/employment opportunities. Economic impacts result from increased outlays of cash to replace reductions in subsistence harvests and to support increased harvest efforts to make up for reductions in resources. Where a reduction of harvest in traditional use areas occurs, a resulting increase in or relocation of harvest effort may require additional cash outlays for supplies such as food and fuel for boats and snowmobiles. In addition, harvest replacement with expensive store-bought foods may be necessary , and cash used for these purposes may be diverted from other needs, such as heating fuel, clothing and equipment.

In communities where employment opportunities are few, additional cash outlays are a hardship, since no ready sources of cash are available. This would be partially offset by local hire employment opportunities provided by the project. Communities with limited employment opportunities and located adjacent to the TAGS route, such as Native communities in the Northern Corridor and Glennallen/Copper Center area, are more sensitive to competition impacts than those which are further away or have broad subsistence use areas. The level of economic impacts will be minimal after completion of construction activities, which are the major source of fish and wildlife, interference/access, and relocation/increased effort impacts.

Social Impacts

The social impacts from the loss of participation in subsistence activities include loss of cultural identity and status in the affected community, dietary impacts, and aggravation of social problems such as depression and substance abuse. As indicated earlier, the foundation of the sociocultural systems of many rural communities is the subsistence utilization of the natural environment and its fish, wildlife, and vegetation resources. A reduction in the ability to participate in subsistence activities would result in community and individual identity loss through being unable to provide and distribute subsistence resources at traditional levels. Subsistence foods are a physically and psychologically important source of nutrition to Alaskan Natives. A significant reduction in such foods, and their replacement with a limited range of store-bought foods can also lead to dietary problems and a loss in sense of "well being".

The communities that are most likely to be sensitive to social impacts from reduced subsistence activities are those that are predominantly Native and which have a social structure and personal identity that revolves around participation in subsistence activities. These include the North Slope communities, Evansville, Allakaket/Alatna, Stevens Village, Rampart, Minto, Copper Center and Tatitlek. Proximity to the TAGS route, severity of harvest opportunity reduction, and limited alternatives for relocation of effort will also aggravate social impacts. Duration of social impacts are likely to be limited to the period of project construction.

ALTERNATIVES

Suitable alteratives to the proposed action are limited to routes between Prudhoe Bay, where the gas resource lies, and an ice free LNG terminal site at tidewater. Various alternative routings and facility sites from previously proposed oil and natural gas pipeline systems in Alaska were considered and screened by YPC, along with some additional sites not previously considered. Through this screening process, two primary pipeline corridors and seven terminal sites were evaluated in detail (refer to Section 1.0 for further detail). Alternative evaluation included cost, engineering, safety, social and environmental factors. Three alternatives are considered as part of the EIS: 1) the preferred alternative of Prudhoe Bay to Anderson Bay, 2) Prudhoe Bay to the Boulder Point site on Cook Inlet, and 3) no action. There are no other reasonable and feasible alternatives that would reduce or eliminate the proposed action from lands needed for subsistence purposes. Mitigation measures are discussed in Section 2.8 of the Environmental Impact Statement.

Prudhoe-Bay to Boulder Point Alternative

From the perspective of subsistence, the Prudhoe Bay-Boulder Point Alterative would be similar to the preferred alternative. The route would be identical from Prudhoe Bay to a point just north of Fairbanks, where it would diverge south across the Minto Flats and past Nenana along the Parks Highway. These latter two areas would be of equal or greater sensitivity to subsistence impacts compared to the Glennallen-Copper Center Corridor. In the Upper Cook Inlet communities, while not considered to be a rural subsistence area by the State of Alaska, subsistence-like activities occur and would be subject to competition and interference/access impacts. Therefore, this alternative would provide no advantages in reducing subsistence impacts over the preferred alternative.

No Action Alternative

Under the No Action Alternative, the TAGS project would not be constructed and operated, and there would be no impacts to subsistence uses and resources. However, the Nation and the State of Alaska would lose the benefits of developing and marketing the natural gas resources of the Prudhoe Bay area.

3.0 SECTION 810 FINDING

The Section 810 Findings for each of the three alternatives are presented below.

Preferred Alternative

Construction of preferred alternative of the TAGS project would result in some restriction of subsistence uses along the route. In limited areas, discussed below, these restrictions will be significant. The duration of restrictions, particularly those that are significant, will be short-term and limited to the 34 month pipeline construction period. Significant restrictions are not associated with construction of other project facilities, nor with operation of the project.

In the North Slope Borough, restriction of subsistence uses associated with construction and operation of the project would not be significant. This due to the fact that the affected communities are not located in the immediate vicinity of the TAGS route, that they have relatively broad subsistence uses areas, and that the TAGS project is located on the periphery of these use areas; and that public access for competing sport hunting, fishing and trapping is restricted.

Because the Fairbanks-Delta Area is not considered to be a rural subsistence use area by the State and the participation in subsistence is lower in that area, there would be negligible impacts except in the unlikely event of a catastrophic fuel spill event. There would be no significant restriction of subsistence uses.

Similarly, restriction of subsistence uses in the Valdez-Tatitlek area would not be significant. Like Fairbanks, Valdez has negligible participation in subsistence activities. Tatitlek subsistence activities are oriented towards coastal resources and utilize broad areas removed from the Anderson Bay terminal. Impacts would be limited to potential disturbance of marine mammal movement due to increased levels of tanker traffic.

However, in the Northern Corridor and Glennallen-Copper Center Communities, there would be some short term but significant restriction of subsistence uses. The duration of significant restriction of subsistence use would be limited to the 34 month pipeline construction period. Communities significantly affected are those adjacent to or in the immediate vicinity of the TAGS route, and include Nolan/Wiseman, Livengood, Sourdough/Paxson, Gulkana, Glennallen, Copper Center, and the Upper Tonsina communities. The justification for the finding of significant restriction of subsistence uses is based on the level of several specific environmental consequences and their cumulative effects on the these two areas. These affects are described below in order of importance:

- these areas currently have unrestricted public access to fish and wildlife resources, and subsistence uses, particularly moose and fish harvesting, would be subject to increased participation in competitive sport hunting, fishing, and trapping by direct and indirect project employees;

- project construction would result in some restrictions of access to subsistence use areas and interference with subsistence activities during the period of construction;

- moose, an important subsistence resource, would likely avoid the area of construction activities during the period of construction;

- these communities utilize the area in the vicinity of the pipeline route for subsistence uses and have relatively smaller use areas compared to other affected communities.

The combination of these effects would result in a temporary but significant restriction of subsistence uses. There will be no significant restrictions of use in the Northern Corridor and Glennallen-Copper Center Communities resulting operation of the project.

<u>Prudhoe-Bay to Boulder Point Alternative</u>

Construction of Prudhoe Bay to Boulder Point alternative of the TAGS project would result in some restriction of subsistence uses along the route. In limited areas, the Northern Corridor and the Nenana Corridor communities, these restrictions will be significant. The duration of restrictions, particularly those that are significant, will be short-term and limited to the 34 month pipeline construction period. Significant restrictions are not associated with construction of other project facilities, nor with operation of the project.

Like the Preferred alternative, this alternative includes the North Slope Borough, and for the reasons discussed above, some restrictions of subsistence use would occur during pipeline construction but would not be significant.

The Upper Cook Inlet and Anchorage-Kenai communities are not classified as rural subsistence use areas by the State Boards of Fisheries and Game, although subsistence-like activities occur. Temporary restrictions to these activities would occur during construction of the pipeline, but would not be significant.

In the Northern Corridor and Nenana Corridor communities,there would be some short term but significant restriction of subsistence uses. The duration of significant restriction of subsistence use would be limited to the 34 month pipeline construction period. Communities significantly affected are those adjacent to or in the immediate vicinity of the TAGS route, and include Nolan/Wiseman, Livengood, Minto, Nenana, Anderson/Clear, and Healy/Sultrana. The justification for the finding of significant restriction of subsistence uses is based on the level of several specific environmental consequences and their cumulative effects on the these two areas. These affects are described below in order of importance:

- these areas currently have unrestricted public access to fish and wildlife resources, and subsistence uses, particularly moose and fish harvesting, would be subject to increased participation in competitive sport hunting, fishing, and trapping by direct and indirect project employees;

- project construction would result in some restrictions of access to subsistence use areas and interference with subsistence activities during the period of construction;

- moose, an important subsistence resource, would likely avoid the area of construction activities during the period of construction;

- these communities utilize the area in the vicinity of the pipeline route for subsistence uses and have relatively smaller use areas compared to other affected communities.

The combination of these effects would result in a temporary but significant restriction of subsistence uses. There will be no significant restrictions of use in the Northern Corridor and Nenana Corridor Communities resulting operation of the project.

No Action Alternative

The No Project alternative would have no affects on subsistence uses. Therefore, this alternative would not result in any significant restrictions of subsistence use.

LEGEND

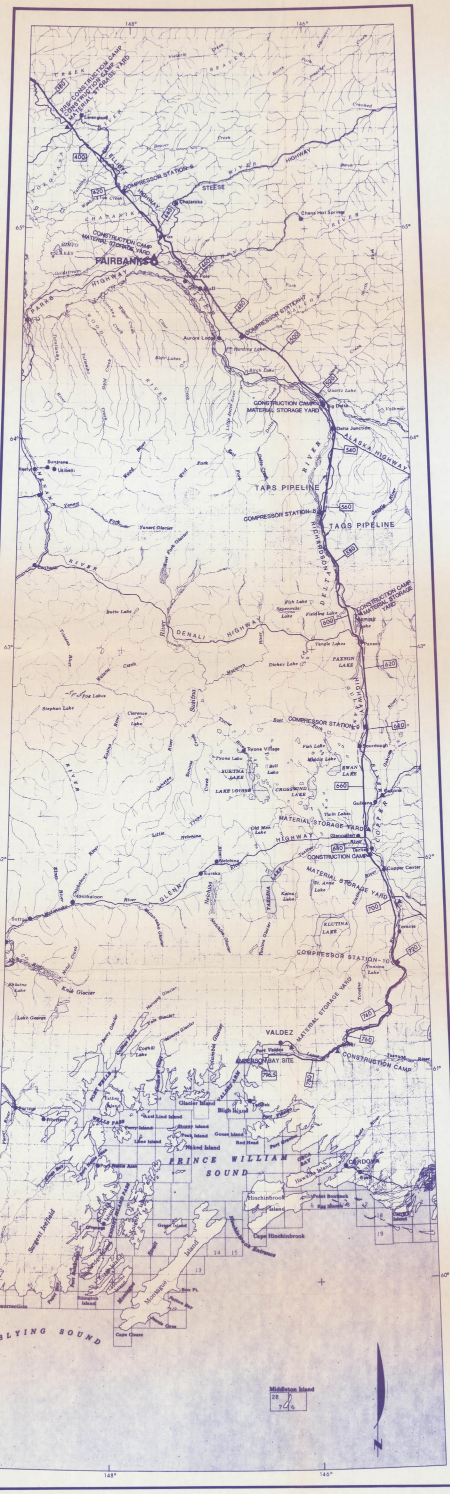
- PROPOSED TAGS PIPELINE
- EXISTING TAPS PIPELINE
- 200 TAGS MILEPOST
- COMPRESSOR STATIONS
- TEMPORARY FACILITIES

SCALE 1:1,000,000

0 10 20 30 40 MILES

ALIGNMENT MAP 1
PRUDHOE BAY to FAIRBANKS

FEB. 16, 1987



LEGEND

- PROPOSED TAGS PIPELINE
- ALTERNATIVE TAGS PIPELINE
- EXISTING TAPS PIPELINE
- 200 TAGS MILEPOST
- COMPRESSOR STATIONS
- TEMPORARY FACILITIES

SCALE 1:1,000,000

0 10 20 30 40 MILES

ALIGNMENT MAP 2
FAIRBANKS to ANDERSON BAY

FEB. 16, 1987

LEGEND

- PROPOSED TAGS PIPELINE
- ALTERNATIVE TAGS PIPELINE
- EXISTING TAPS PIPELINE
- 200 TAGS MILEPOST
- COMPRESSOR STATIONS
- ALTERNATIVE COMPRESSOR STATIONS
- TEMPORARY FACILITIES

SCALE 1:1,000,000

0 10 20 30 40 MILES

ALIGNMENT MAP 3
COOK INLET -
BOULDER POINT ALTERNATIVE