Yukon Pacific LNG Project

May 1993

FERC/EIS-0071D
Yukon Pacific Corporation

Docket Nos. CP88-105-000
CP88-105-001

Draft Environmental Impact Statement

Federal Energy Regulatory Commission

Office of Pipeline and Producer Regulation

WASHINGTON, DC 20426

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D. C. 20426

In Reply Refer To:
OPPR/DEMEA/ECB
Yukon Pacific Company L.P.
Docket No. CP88-105-000

TO THE PARTY ADDRESSED:

The staff of the Federal Energy Regulatory Commission (FERC or Commission) has made available a draft environmental impact statement (DEIS) on the construction and operation of the liquefied natural gas (LNG) liquefaction plant, LNG storage and marine loading facilities, and LNG tanker transport proposed in the above-referenced docket.

The staff prepared the DEIS to satisfy the requirements of the National Environmental Policy Act. The staff concludes that approval of the proposed action, with appropriate mitigating measures as recommended, including receipt of necessary permits and approvals, would have limited adverse environmental impact. The DEIS evaluates alternatives to various components of the proposal.

Yukon Pacific Company L.P. is seeking approval of a specific site at Anderson Bay, Port Valdez, Alaska to export LNG to destinations in Japan, Korea, and Taiwan. The proposed action involves construction of a 2.1 billion cubic feet per day LNG liquefaction plant; four above-ground 800,000-barrel LNG storage tanks; a marine facility to load two tankers within a 12-hour period, and a cargo/personnel ferry docking facility. In addition a fleet of 15 LNG tankers, each having 125,000 cubic meters of cargo capacity would make 275 trips per year. Construction of the project would take 8 years with a peak work force of nearly 4,000 workers in the fifth year.

Public Meeting Schedule

Public meetings to receive comments on the DEIS will be held on:

June 8, 1993 at 7:00 p.m. at the Anchorage Museum of Art and History, at 121 W. 7th Ave., Anchorage, Alaska.

June 10, 1993 at 7:00 p.m. at Valdez City Council Chambers, Fairbanks St., Valdez, Alaska

Interested groups and individuals are encouraged to attend and present oral comments on the environmental impacts described in the DEIS. Anyone who would like to make an oral presentation at the meeting should contact the FERC Project Manager to have their name placed on the speakers' list. Priority will be given to persons representing groups. A second speakers' sign-up list will be available at the public meeting. Transcripts will be made of the meetings.

Specific Comment Request

The staff is specifically requesting comments regarding:

- the alternative locations for the construction work camp and means of transporting workers to and from the Valdez alternate campsite (see section 2.3.1).
- the alternative sites to dispose of excess excavated materials generated through the site preparation process (see section 2.3.2).

Comment Procedures

Written comments are welcome to help identify significant new issues or concerns related to the proposed action. All comments on environmental issues should contain supporting documentation and rationale.

Written comments should be filed on or before July 6, 1993, must reference Docket No. CP88-105-000, and be addressed to:

Secretary
Federal Energy Regulatory Commission
825 North Capitol Street, N.E.
Washington, DC 20426

A copy of the comments should also be sent to the FERC Project Manager identified below.

After these comments are reviewed, any significant new issues are investigated, and modifications are made to the DEIS, a final EIS (FEIS) will then be published by the staff and distributed. The FEIS will contain the staff's responses to timely comments received on the DEIS.

The DEIS has been placed in the public files of the FERC and is available for public inspection in the:

FERC Division of Public Information
Room 3104
941 North Capitol Street, N.E.
Washington, DC 20426

Copies of the DEIS have been mailed to Federal, state, and local agencies, public interest groups, libraries, newspapers, individuals who have requested the DEIS, and other parties to this proceeding. Any person may file a motion to intervene on the basis of the Commission staff's DEIS [see 18 CFR 380.10(a) and 385.214].

Limited copies of the DEIS are available from:

Mr. Chris Zerby, Project Manager (Room 7312)
Federal Energy Regulatory Commission
825 North Capitol Street, N.E.
Washington, DC 20426
(202) 208-0111

Jerry Brossia
State Pipeline Coordinator
411 West 4th Avenue, Suite #2
Anchorage, Alaska 99501
(907) 278-8594

Lois D. Cashell,
Secretary

The Yukon Pacific LNG Project Draft Environmental Impact Statement (DEIS) has been prepared by the staff of the Federal Energy Regulatory Commission (FERC or Commission) to fulfill the requirements of the National Environmental Policy Act. Among its other responsibilities, the FERC has authority under Section 3 of the Natural Gas Act to approve or disapprove the "Place of Export" and the associated facilities.

MAJOR CONCLUSIONS

Yukon Pacific Company L.P. (Yukon Pacific) is seeking approval of a specific export site at Anderson Bay, Port Valdez, Alaska. Yukon Pacific proposes to construct and operate facilities to liquefy natural gas delivered to Port Valdez via pipeline from the north slope; briefly store the liquefied natural gas (LNG); and transfer the LNG at a marine terminal in Anderson Bay to LNG tankers for export to various Asian Pacific Rim countries.

We (the Commission staff) conclude that if our recommended mitigation measures to reduce the anticipated environmental impact are adopted and if the appropriate permits and approvals are obtained, the construction and operation of the proposed facilities would be an environmentally acceptable action. We evaluated several alternatives associated with various aspects of the proposed facility in our efforts to establish those most environmentally preferable in both the short and long term.

PROPOSED ACTION

The Yukon Pacific LNG facility would receive and liquefy 2.1 billion cubic feet per day of conditioned natural gas delivered by pipeline from Prudhoe Bay. The entire plant site would occupy a land area of about 390 acres. Major facilities in the plant would include four LNG process trains consisting of gas pretreatment and liquefaction, four 800,000-barrel aboveground LNG storage tanks, and a marine facility to load two tankers of 125,000 cubic meters capacity within a 12-hour period. A fleet of 15 double-hulled LNG tankers would transport the LNG through U.S. territorial waters to receiving terminals in the Pacific Rim, making about 275 loaded voyages per year.

Construction of the proposed facilities would permanently affect approximately 425 acres of predominantly spruce-hemlock forest and wetland. The site, because of its steep topography, would require extensive recontouring, through excavation and filling, to create bedrock benches on which the facility structures would be constructed. This would result in about 3.3 million cubic yards of excess excavated materials requiring disposal (2.6 million cubic yards of overburden and 0.7 million cubic yards of rock).

The period of construction would be about 8 years, with a peak workforce of 4,000 anticipated in the fifth year. Yukon Pacific proposes to house this workforce at the east end of the construction site, on the banks of Seven Mile Creek, using only marine access for the transportation of all materials, supplies, and personnel. A dam and 3.5-acre reservoir on Seven Mile Creek would supply both potable and construction water needs.

From a resource perspective, impacts are expected to be localized and minor overall. Resident freshwater fish resources are limited in distribution at the site and are not expected to be impacted. Impacts on wildlife are expected to be minor: waterfowl and shorebirds are limited by a lack of suitable habitat; raptors are known to nest in the area, but none at the site itself; large mammals occur in very low numbers in the vicinity of the project and impacts on small mammals and furbearers would be limited to the loss of forest habitat through site clearing and preparation. Site development would result in the loss of about 49 acres of estuarine and palustrine wetlands, for which mitigation has been developed. Estuarine spawning areas at the mouths of Seven Mile and Nancy Creeks would require protection through the avoidance of in-stream or near-stream activities during sensitive periods. Measures to ensure that marine mammals are not present, and therefore not affected by construction, have been recommended. No federally listed or proposed endangered or threatened plant or wildlife species have been reported in the vicinity of the site.

No previously recorded or newly identified cultural resource sites were identified. Subsistence use of fishery and marine mammal resources would be minimally affected from increased shipping in Prince William Sound. The Yukon Pacific LNG Project would significantly increase total employment and population in the City of Valdez during construction and operation of the plant and would stimulate economic activity both in the short and long term.

ALTERNATIVES CONSIDERED

We reviewed the No Action Alternative, which would avoid all of the environmental effects of the project, but which would result in the entire Trans-Alaska Gas System (TAGS) Project, including the pipeline, not being built. This DEIS summarizes the analysis of alternative sites in the TAGS Final Environmental Impact Statement (FEIS) which supported the U.S. Department of Energy's disapproval of all sites other than the proposed Valdez (Anderson Bay) location for the Place of Export (DOE, 1989).

We examined six alternatives to the proposed construction camp at Seven Mile Creek, including other locations within or adjacent to the construction site as well as use of the existing camp site in Valdez, in combination with different modes of transport of workers. Of the onsite alternatives, none offered environmental advantages over the proposed Seven Mile Creek site and therefore did not warrant further consideration. The Valdez camp site alternative, however, offers environmental opportunities which the staff believes are deserving of additional examination. Additional public comment is being sought on access to the construction site.

We also examined six potential sites for the disposal of the rock and overburden materials excavated in excess of fill requirements during site preparation. These included onshore, offshore, and combination disposal options. As part of this review, superior environmental benefits (through the preservation of intertidal wetlands) were identified when Site B' was used not only for the disposal of the excess materials, but also as the site of the proposed construction dock. We have therefore recommended that Yukon Pacific provide a revised site grading and construction plan reflecting this alternative so that it can be further evaluated and presented in the FEIS. We also seek public comment on the discussion of alternative disposal sites leading to this recommendation.

AREAS OF CONCERN

On January 31, 1992 the FERC issued a "Notice of Intent to Prepare an Environmental Impact Statement on the Yukon Pacific LNG Project" (NOI). The NOI was sent to Federal, state, county, and local agencies; newspapers; libraries; and individuals. Public scoping meetings were conducted on May 19, May 21, and May 26, 1992 in Anchorage, Fairbanks, and Valdez, Alaska, respectively.

Issues raised during scoping and through letters included concerns about: the seismic design criteria being applied for the site in view of historic records of seismic activity in the area; the effects of surface and groundwater withdrawals on local flowages, with secondary effects on anadromous fish; disturbance to the marine shoreline habitat during construction and filling; impacts on sport and subsistence hunting and fishing during construction and operations; avoidance and mitigation of wetlands; cumulative effects of LNG operations, tanker operations and existing Oil Terminal and refinery operations, on local air quality; loss of recreation, aesthetics, and usage of Anderson Bay; impact of large influx of construction and permanent workers on local resources; effect of increased ship traffic on the Prince William Sound Vessel Traffic Service Area; and the safety of LNG tankers in addition to the existing crude oil tanker traffic in Prince William Sound.

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ACRONYMS AND ABBREVIATIONS

AAC	Alaska Administrative Code
AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council on Historic Preservation
ADEC	Alaska Department of Environmental Conservation
ADFG	Alaska Department of Fish and Game
ADGC	Alaska Division of Governmental Coordination
ADNR	Alaska Department of Natural Resources
ADSSE	Automated Dependent Surveillance Shipborne Equipment
AHRS	Alaska Heritage Resource Survey
Alyeska	Alyeska Pipeline Service Company
ANGTA	Alaska Natural Gas Transportation Act
ANGTS	Alaska Natural Gas Transportation System
ANILCA	Alaska National Interest Lands Conservation Act
Applied Technology	Applied Technology Corporation
APUC	Alaska Public Utilities Commission
AQCR	Air Quality Control Region
ARPA	Archeological Resources Protection Act
BACT	best available control technology
bcfd	billion cubic feet per day
BLM	Bureau of Land Management
BMPM	Erosion Control Best Management Practices Manual
BOD	biochemical oxygen demand
BTEX	benzene, toluene, ethylbenzene, and xylene
Btus	British thermal units
CAA	Clean Air Act
CBI	Chicago Bridge and Iron
CDP	census designated place
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
COE	U.S. Army Corps of Engineers
Commission	Federal Energy Regulatory Commission
CWA	Clean Water Act
dBA	decibels of the A-weighted scale
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DOE/FE	U.S. Department of Energy, Office of Fossil Energy
DOT	U.S. Department of Transportation
DWT	deadweight ton
EMS	emergency medical services
EPA	U.S. Environmental Protection Agency
ERA	Economic Regulatory Administration
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FERC	Federal Energy Regulatory Commission
FPC	Federal Power Commission

ACRONYMS AND ABBREVIATIONS (cont'd)

FS	U.S. Forest Service
FWS	U.S. Fish and Wildlife Service
g	acceleration due to gravity
gpd	gallons per day
gph	gallons per hour
gpm	gallons per minute
hp	horsepower
HRSG	Heat Recovery Steam Generator
JPO	Joint Pipeline Office
kg	kilogram
kJ/W-hr	kiloJoule/Watt-hour
kW	kiloWatt
Ldn	day-night sound level
Leq(24)	24-hour equivalent sound level
LNG	liquefied natural gas
m	meter
MDE	Maximum Design Earthquake
mg/L	milligrams per liter
MLA	Mineral Leasing Act
MLLW	Mean Low Water Level
mm	millimeter
MR	mixed refrigerant
μmoles/l	micromoles per liter
M_w	moment magnitude
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NFPA 59A	National Fire Protection Association 59A LNG Standards
NGA	Natural Gas Act
NHPA	National Historic Preservation Act
NIST	National Institute of Standards and Technology
NMFS	National Marine Fisheries Service
NO_2	nitrogen dioxide
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRHP	National Register of Historic Places
NSAs	noise-sensitive areas
NSPS	New Source Performance Standards
NSR	New Source Review
NWI	U.S. Fish and Wildlife Service National Wetlands Inventory
O_3	ozone
OBE	Operating Basis Earthquake
OPLAN	Operating Plan
OPPR	Office of Pipeline and Producer Regulation
PAH	polynuclear aromatic hydrocarbon
PERC	Powered Emergency Release Coupler
PM_{10}	particulate matter
ppm	parts per million

ACRONYMS AND ABBREVIATIONS (cont'd)

ppmv	parts per million by volume
ppt	parts per thousand
Preload	Preload Incorporated
PSD	Prevention of Significant Deterioration
psig	pounds per square inch gauge
PWSAP	Prince William Sound Area Plan
Quest	Quest Consultants, Inc.
RCRA	Resource Conservation and Recovery Act
RP	return period
Secretary	Secretary of the Commission
SERVS	Ship Escort Response Vehicle System
SGHMP	Solomon Gulch Hatchery Management Plan
SHPO	State Historic Preservation Officer
SO_2	sulfur dioxide
SPCC Plan	Spill Prevention, Containment, and Control Plan
SSE	Safe Shutdown Earthquake
7Q10	Seven-day, 10-year recurrence
TAGS	TransAlaska Gas System
TAPS	Trans-Alaska Pipeline System
TCU	transportation, communication, and utilities
TDS	total dissolved solids
TPH	total petroleum hydrocarbons
tpy	tons per year
TSS	total suspended solids
TSS	Traffic Separation Scheme
UBC	Uniform Building Code
USGS	U.S. Geological Survey
UV/IR	ultraviolet/infrared
VDCMP	Valdez District Coastal Management Program
VMS	Visual Management System
VOC	volatile organic compounds
VPs	viewing points
VTC	Vessel Traffic Center
VTS Area	Vessel Traffic Service Area
WEWG	Wetland Evaluation Working Group
Yukon Pacific	Yukon Pacific Corporation
Yukon Pacific	Yukon Pacific Company L.P.
ZPA	zero period acceleration

1.0 INTRODUCTION

The Federal Energy Regulatory Commission (FERC or Commission) has prepared this Draft Environmental Impact Statement (DEIS) to assess the environmental effects of a proposal by Yukon Pacific Company L.P. to liquefy and export liquefied natural gas (LNG) from a site at Anderson Bay, Valdez, Alaska to destinations in Japan, South Korea, and Taiwan. On December 3, 1987, Yukon Pacific Corporation filed an application with the Commission in Docket No. CP88-105-000 for an order authorizing a place of export at Anderson Bay. On March 9, 1992, Yukon Pacific Corporation filed an amendment with the Commission in Docket No. CP88-105-001 to substitute its new corporate entity, Yukon Pacific Company L.P. as the applicant in the proceeding (both are referred to in this DEIS as Yukon Pacific). The project consists of the site of export, including the liquefaction plant, the marine terminal, the LNG tankers, and the transit of LNG by ship through U.S. territorial waters and is referred to in this DEIS as the Yukon Pacific LNG Project.

1.1 RELATIONSHIP TO PREVIOUS ACTIONS

On December 5, 1986, Yukon Pacific filed applications with the Bureau of Land Management (BLM) and the U.S. Army Corps of Engineers (COE) to construct a large diameter, buried, chilled gas pipeline between Prudhoe Bay, Alaska and Anderson Bay, Valdez, Alaska for export purposes. This application, including the downstream liquefaction and transportation facilities were known collectively as the TransAlaska Gas System (TAGS) Project.

On December 18, 1986, Yukon Pacific filed a petition with the Commission for a Declaratory Order in Docket No. GP87-16-000 on whether the Commission has jurisdiction over the TAGS Project under Section 3 and/or 7 of the Natural Gas Act (NGA). On May 27, 1987, the Commission issued its Declaratory Order determining in part that the Commission has authority under Section 3 of the NGA to approve or disapprove the place of export for the Yukon Pacific LNG Project, but declined at that time to exercise any discretionary authority it may have under Section 3 to regulate the siting, construction, and operation of the TAGS pipeline from Prudhoe Bay to Anderson Bay.

On December 3, 1987, Yukon Pacific also filed an application with the Economic Regulatory Administration (ERA) of the U.S. Department of Energy (DOE) in Docket No. 87-68-LNG for authority to export up to 14 million metric tons of LNG annually to Japan, South Korea and Taiwan. A Presidential Finding was issued on January 12, 1988, which determined that the effects of the exports of Alaska natural gas on American consumers would comply with Section 12 of the Alaska Natural Gas Transportation Act (ANGTA) in the context of current and protected future energy markets, and that this finding should not hinder the completion of the Alaska Natural Gas Transportation System (ANGTS) which was previously authorized to transport North Slope natural gas to the lower-48 states.

Since the BLM and the COE were already preparing an EIS on the entire TAGS Project, the BLM requested the FERC on June 5, 1987 to participate in the BLM/COE EIS as a cooperating agency. Although applications were not yet filed with the FERC or the DOE, the FERC agreed to participate as a cooperating agency on July 1, 1987. The DOE also participated as a cooperating agency. A "tiered" process was agreed upon using an initial overview EIS of the entire project from its North Slope gas conditioning facility to tanker transport of the LNG. The EIS examined alternative terminal locations and accompanying pipeline route variations. It was understood that additional detailed environmental work would be required on specific elements of the project when permits and approvals were requested and acquired. In June 1988, the TAGS Final Environmental Impact Statement (FEIS) was issued.

The Department of Energy, Office of Fossil Energy (DOE/FE), successor to the ERA, granted authorization of the export under Section 3 of the NGA in Opinion and Order Number 350, issued November 16, 1989. The DOE Order relied on the TAGS FEIS in assessing the environmental consequences of granting the proposed export. Condition F of the order requires that all aspects of the export be implemented in accordance with all applicable environmental procedures, requirements, and mitigative measures imposed by Federal and state agencies. Further, the order directs "... the FERC to consider the safety and environmental aspects of the export site and facilities, including the liquefaction plant, the marine terminal, the LNG tankers and their routes in Prince William Sound and U.S. territorial waters, prior to approving any export site or facilities" (DOE, pg 37, 1989).

The DOE Order also concluded:

a) "With respect to the place of exportation for the LNG..., all locations other than Port Valdez, Alaska are rejected"1/

b) "Except for the authority under DOE Delegation Order 0204-112 over the export site, including the liquefaction plant, marine terminal, and related transportation of LNG, the Federal Energy Regulatory Commission (FERC) shall exercise no authority over the export project....."

In accordance with the tiered process, the FERC Declaratory Order, and the DOE Order 350, the Commission has prepared this DEIS for the "Place of Export" and associated facilities.2/ The issues addressed are limited to the four issues mandated by the DOE Order and confined to the FERC's jurisdiction described in the Declaratory Order. Issues associated with conditioning plant(s) on the North Slope, the TAGS pipeline, and reconsideration of previously studied locations for the export site or new locations are not addressed in this EIS.

1.2 PURPOSE AND NEED

The Yukon Pacific LNG Project is a major component of the overall TAGS Project. Yukon Pacific asserts that a significant opportunity exists in the mid-1990's to market Alaska North Slope natural gas in the Asian Pacific Rim nations. The TAGS Project would respond to that market in the sale of 14 million tons of LNG annually (equivalent to 660 billion cubic feet of natural gas). The LNG from the TAGS Project would be marketed in Japan, the Republic of South Korea, and Taiwan. Yukon Pacific proposes to sell LNG to all three nations but contends that the need for the TAGS Project could be demonstrated in Japan

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1/ This action was not to be interpreted as approval of the Valdez site. The DOE required that "the FERC conduct its own examination of the health, safety, and environmental impacts associated with Yukon Pacific's use of the Valdez site."

2/ It should be noted that the DOE/FE authorization to export is under appeal by Alaskan Northwest Natural Gas Transportation Company in the U.S. Court of Appeals for the District of Columbia Circuit, and that on May 10, 1991, Circuit Judges Silberman and Williams ordered that the appeals be held in abeyance pending disposition by the FERC of Docket Nos. CP88-105-000 and GP87-16-000.

alone, where forecasted increases in total demand for energy in the year 2000 are more than eight times that provided by the TAGS Project.

1.3 PURPOSE AND SCOPE OF THIS STATEMENT

The FERC is the lead Federal agency for the preparation of this DEIS in compliance with the requirements of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 Code of Federal Regulations [CFR] 1500-1508). The FERC will consider the application for authority to construct and operate a site of export for LNG under Section 3 of the NGA. The assessment of environmental impacts is an important and integral part of the decision. An Order authorizing the construction and operation of a site of export will be granted only after examining the health, safety, and environmental impacts associated with the Anderson Bay site.

This DEIS was prepared by the FERC staff in compliance with NEPA and the Commission's implementing regulations under Chapter I, Title 18, CFR Part 380. The U.S. Coast Guard, the U.S. Department of Transportation (DOT), the COE, the State Pipeline Coordinator's Office, the Alaska Department of Fish and Game (ADFG), and the City of Valdez are cooperating Federal, state, and local agencies for this project. Our principal purposes in preparing this EIS are to: 3/

- Identify and assess potential impact on the natural and human environment that would result from the implementation of the proposed action.

- Assess reasonable alternatives to the proposed action that would avoid or minimize adverse effects on the environment.

- Identify and recommend alternatives and specific mitigation measures to minimize the environmental impact.

- Facilitate public involvement in identifying significant environmental impact.

This DEIS addresses the environmental impact of the proposed LNG facilities on the Anderson Bay site, the marine terminal, the LNG tankers, and transit of LNG by ship through U.S. territorial waters only.

1.4 ALTERNATIVES TO THE PROPOSED ACTION

The Commission can take one of three basic courses of action in processing an application such as this. It may grant the application with or without conditions; postpone action pending further study; or deny the application. Implicit in this determination, is an examination of alternatives to the proposal and of modifying options.

In preparation of this DEIS the Commission has considered alternatives to the proposed action on several levels. These are described in detail in sections 2.2 to 2.4. The DOE previously concluded that the Valdez export site (Anderson Bay) is preferable to all other export sites that were considered in the TAGS EIS and disapproved all sites other than the Valdez site (DOE, 1989). This decision was made after evaluation of the Valdez site and

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3/ Pronouns "we," "us," and "our" refer to the environmental staff of the Office of Pipeline and Producer Regulation.

other alternative sites evaluated during preparation of the TAGS EIS. Accordingly, further consideration of alternative sites is outside the scope of this DEIS. We will however summarize and incorporate by reference the relevant sections of the TAGS FEIS on this issue in this EIS.

During the course of the scoping discussions and in further exchanges with the public and agencies, features of the proposal on the Anderson Bay site raised concern. The most notable of these were the location of the construction work camp and the disposal of excess excavated materials. We evaluated several alternatives to reduce their impact. Yukon Pacific proposes to locate the construction camp along the bank of Seven Mile Creek. We considered other locations including the City of Valdez. Yukon Pacific proposes to dispose of excess rock at locations onsite which would affect wetland and intertidal areas. Alternatives for disposal of excess rock at several other onsite locations and ocean disposal were evaluated. Finally, we considered denial or postponing the action pending further study.

1.5 PUBLIC REVIEW AND COMMENT

The Commission issued a Notice of Intent (NOI) to prepare the EIS for the proposed Yukon Pacific LNG plant on Anderson Bay in Port Valdez, Alaska on January 31, 1992. At this time the FERC requested comments on the environmental issues associated with the construction of Yukon Pacific's proposed LNG Project. Scoping meetings were held in Anchorage, Fairbanks, and Valdez, Alaska on May 19, 21, and 26, 1992, respectively, to solicit input from interested individuals concerning issues to be addressed in the DEIS. The notice of scoping meetings was published in a separate Notification of Public Scoping Meetings on Environmental Issues, issued by the FERC on April 28, 1992.

A mailing list for the NOI was prepared by the FERC identifying individuals and organizations having a potential interest in the project and the development of the DEIS. The mailing list included City of Valdez representatives, state agency representatives, state and local conservation organizations, elected officials (U.S. Representatives, Senators, Governor), and Federal agency representatives. The complete mailing list of the Yukon Pacific LNG Project includes approximately 280 individuals and organizations.

Comments on the proposed project were received in response to the NOI and during the scoping meetings. Issues and concerns raised include:

- Seismic Concerns. Seismic criteria for the site and the design of plant facilities to withstand seismic events. Large, locally produced waves due to seismic slumping impacting tankers at berth.

- Water Resources. Impacts of utilizing potential groundwater and surface supply sources and in-stream flow determinations for surface water supply streams utilized by anadromous fish, including the impact on Seven Mile Creek and beach.

- Marine Habitat. Construction and fill would disturb and cover marine vegetation, estuarine areas, salmon spawning habitat, and nursery habitat utilized by outmigrating salmon fry in Anderson Bay.

- Wildlife. Construction and operations could impact resident and migratory birds and other species and the increased human population could impact sport and subsistence hunting and fishing.

- Wetlands. Delineate wetlands, provide adequate mitigation and compensation for loss of wetlands and estuary/rearing/spawning habitat, and make a thorough evaluation of practicable alternatives to avoid wetlands.

- Air Quality. The combined effect of all LNG plant and tanker emission sources on air quality, the need to describe control technologies to reduce or prevent emissions, the impact of thermal releases on air circulation and weather patterns in the basin.

- Land Use/Recreation. Loss of recreation, aesthetics, and fishing usage in Anderson Bay and compensation for the public for exclusive use of Chugach National forest land.

- Socioeconomic Impact. The impacts caused by the construction and permanent workforce on the City of Valdez and use of public resources, including fish, wildlife, birds, wood gathering, campgrounds, as well as the impact of the project on subsistence resources (including native harvest of sea otters).

- Effects of Increased Shipping. The adequacy of radar and other communication systems to control increased traffic, conflicts with glacial ice, and increased shipping in Prince William Sound could affect sea lion rookeries, fish, and marine mammals. The impact on any alternative LNG tanker anchorage separate from the anchorage Trans-Alaska Pipeline System (TAPS) tankers presently use, in terms of the effect an alternative site's security, safety, and exclusion zones would have on present use of the area.

- Public Safety. Probability and consequences of major LNG spill resulting in a vapor cloud release, consequences of an accident at the Alyeska Pipeline Service Company (Alyeska) Marine Terminal on the LNG tankers impacting the LNG tankers at berth or enroute and vice versa as well as, the nature and costs of environmental restoration required in event of a worst-case LNG disaster.

- Alternatives. The proposed site at Anderson bay had been previously rejected by the Federal Power Commission (FPC) in a 1976 DEIS.

- Cumulative Impact and Indirect Effects. Air and water quality in Port Valdez basin would diminish due to operations of an LNG terminal in addition to Alyeska's Marine Terminal at Jackson Point and other industrial facilities such as the Petro Star Refinery.

- Mitigation. Measures to mitigate project impacts be contained in the EIS.

However, as stated in the January 31, 1992 NOI, issues associated with conditioning plant(s) on the North Slope, the TAGS pipeline, and alternative locations for the export site are outside the scope of this EIS. The above issues were addressed in the TAGS FEIS or DOE Order 350. **WE DO NOT INTEND TO ALLOW THIS EIS TO RESURRECT OLD ISSUES AND WILL NOT ENTERTAIN COMMENTS ON OLD ISSUES. THE COMMENT PERIOD FOR OLD ISSUES IS CLOSED.**

2.0 PROPOSED ACTION AND ALTERNATIVES

2.1 PROJECT DESCRIPTION

The proposed LNG plant and marine terminal would be located at Anderson Bay, approximately 3 miles east of the Valdez narrows on the south shore of Port Valdez. This site is located 3.5 miles west of the existing TAPS oil terminal (Alyeska Marine Terminal) and 5.5 miles west-southwest of the City of Valdez (figure 2.1-1). When completed, the facilities would occupy approximately 390 acres of a 2,500-acre site owned by the State of Alaska. During plant construction, about 426 acres would be located within the construction limits—392 acres on land, and 34 acres in tidal/offshore. The land is moderately steep bedrock generally covered with layers of saturated organic material and overburden, which supports a dense, old-growth forest and scattered wetlands. The site is surrounded by a large buffer zone extending over 3.5 miles from east to west and over 1 mile from north to south1/. The majority of land surrounding the site is within the Chugach National Forest, and the small amount of land contiguous to the site on the east and west sides which is not within the Chugach National Forest, is owned by the State of Alaska.

The proposed project consists of a 2.1 billion cubic feet per day (bcfd) natural gas liquefaction plant, four 800,000 barrel LNG storage tanks, a marine loading facility, and a cargo/personnel ferry dock facility. An artist's concept of the proposed plant is presented on figure 2.1-2. The general arrangement of the LNG plant and marine terminal is presented on figure 2.1-3. Site details are provided on figure 2.1-4, sheets 1 through 3.

In addition to the shore facilities, a fleet of 15 LNG tankers, each having 125,000 cubic meters of cargo capacity, would transport LNG beyond U.S. territorial waters to destinations in Japan, Korea, and Taiwan. Full project development would require about 275 tanker loadings per year.

Figure 2.1-5 presents a simplified process flow diagram showing the various components of the project. For design and discussion purposes, these are subdivided into three broad categories: 1) the LNG plant, which would consist of four LNG process trains for gas pretreatment and liquefaction, and four 800,000-barrel aboveground cryogenic storage tanks (the plant would be designed for the future addition of a fifth process train and storage tank); 2) the marine facilities, which would consist of two LNG tanker berths and loading arms, and a cargo/personnel ferry dock; and 3) the LNG tankers.

2.1.1 LNG Plant

Natural gas that has been conditioned on the North Slope would enter the LNG plant through a 42-inch-diameter pipeline at a rate of up to 2.3 bcfd and a pressure of 1,300 pounds per square inch gauge (psig). After removing about 0.2 bcfd for fuel gas utilization by system

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1/ Yukon Pacific reported in July 1991 that the buffer zone would encompass 2,500 acres. However, in a September 1992 response to a DOT data request, it showed an enlarged buffer zone encompassing approximately 5,500 acres. Explanation of the discrepancy has been requested.

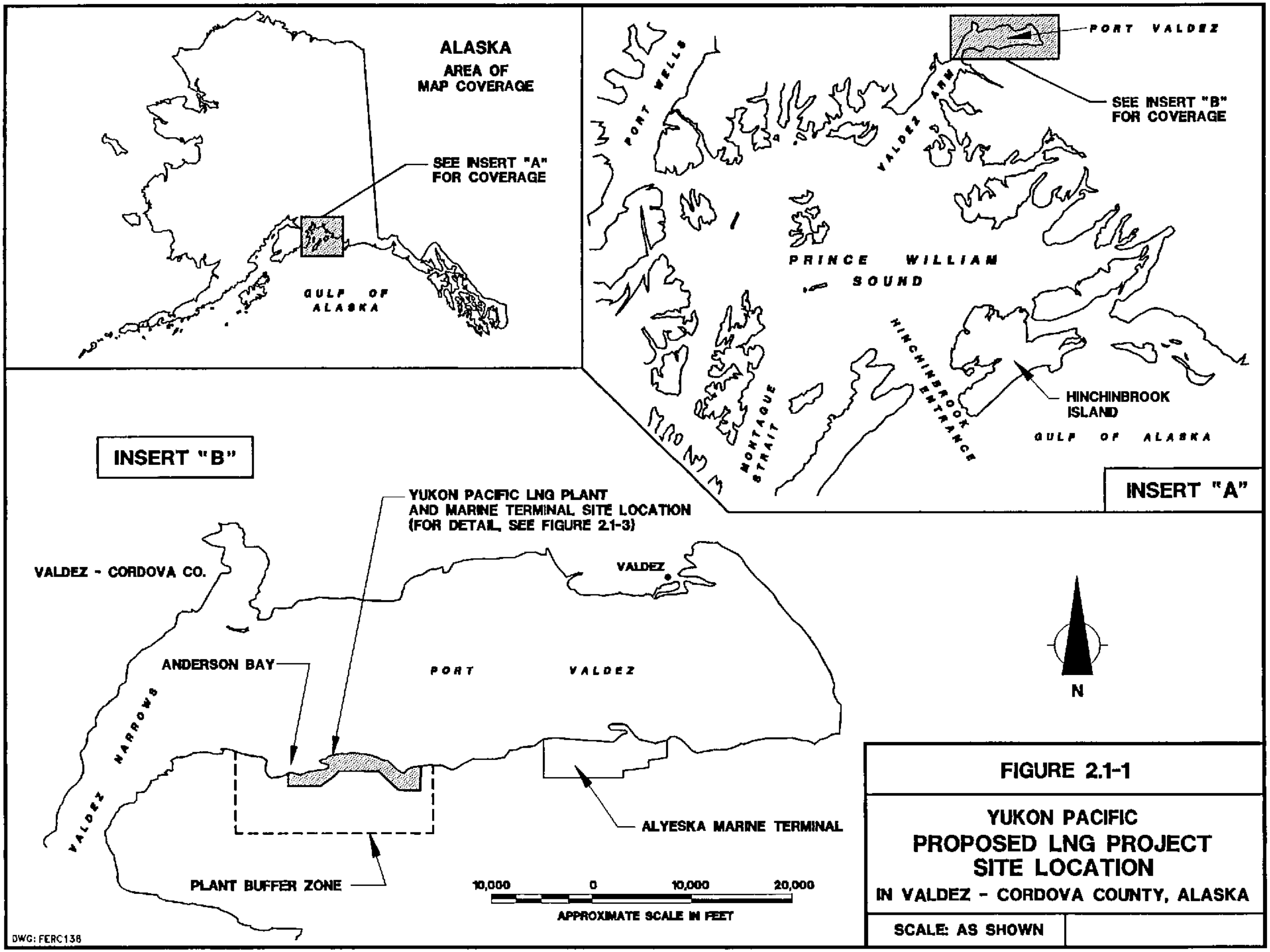
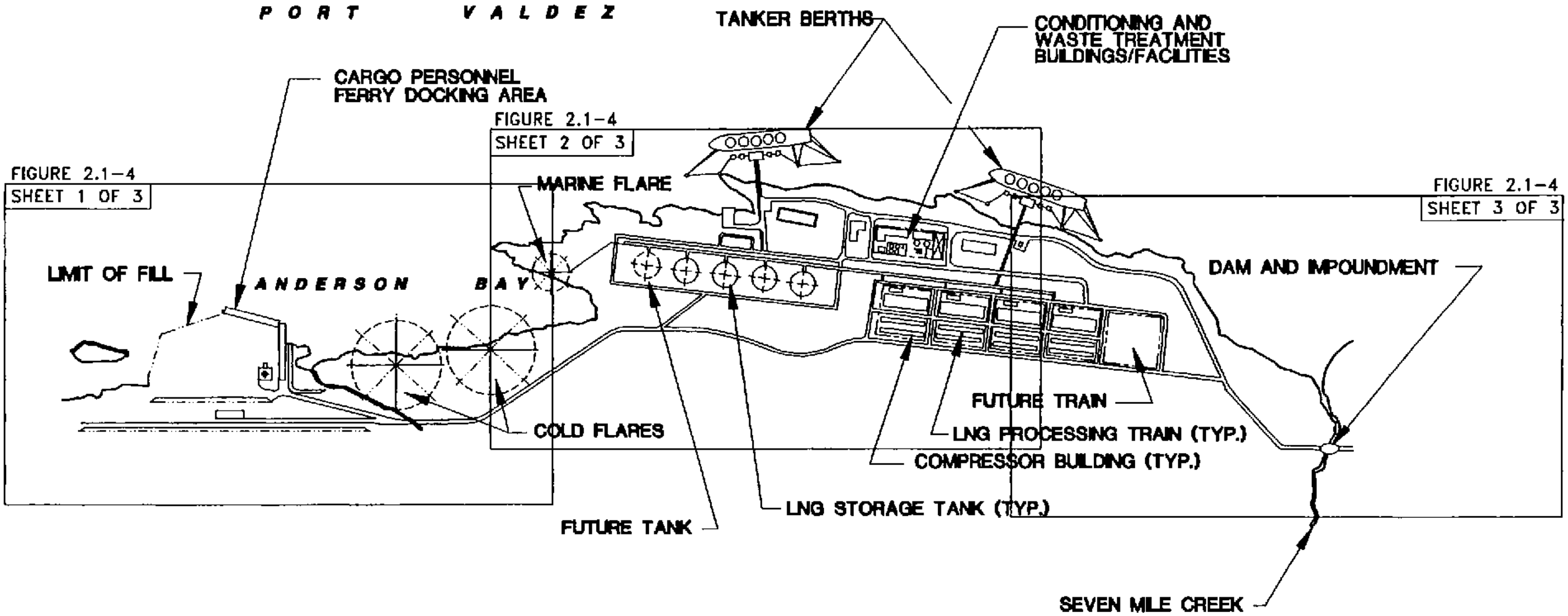


FIGURE 2.1-1

YUKON PACIFIC
PROPOSED LNG PROJECT
SITE LOCATION
IN VALDEZ - CORDOVA COUNTY, ALASKA

FIGURE 2.1-2

VIEW OF PROPOSED LNG PLANT FROM PORT VALDEZ



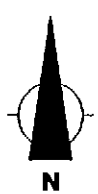


FIGURE 2.1-3

PROPOSED LNG PROJECT OVERALL SITE PLAN

SCALE: AS SHOWN

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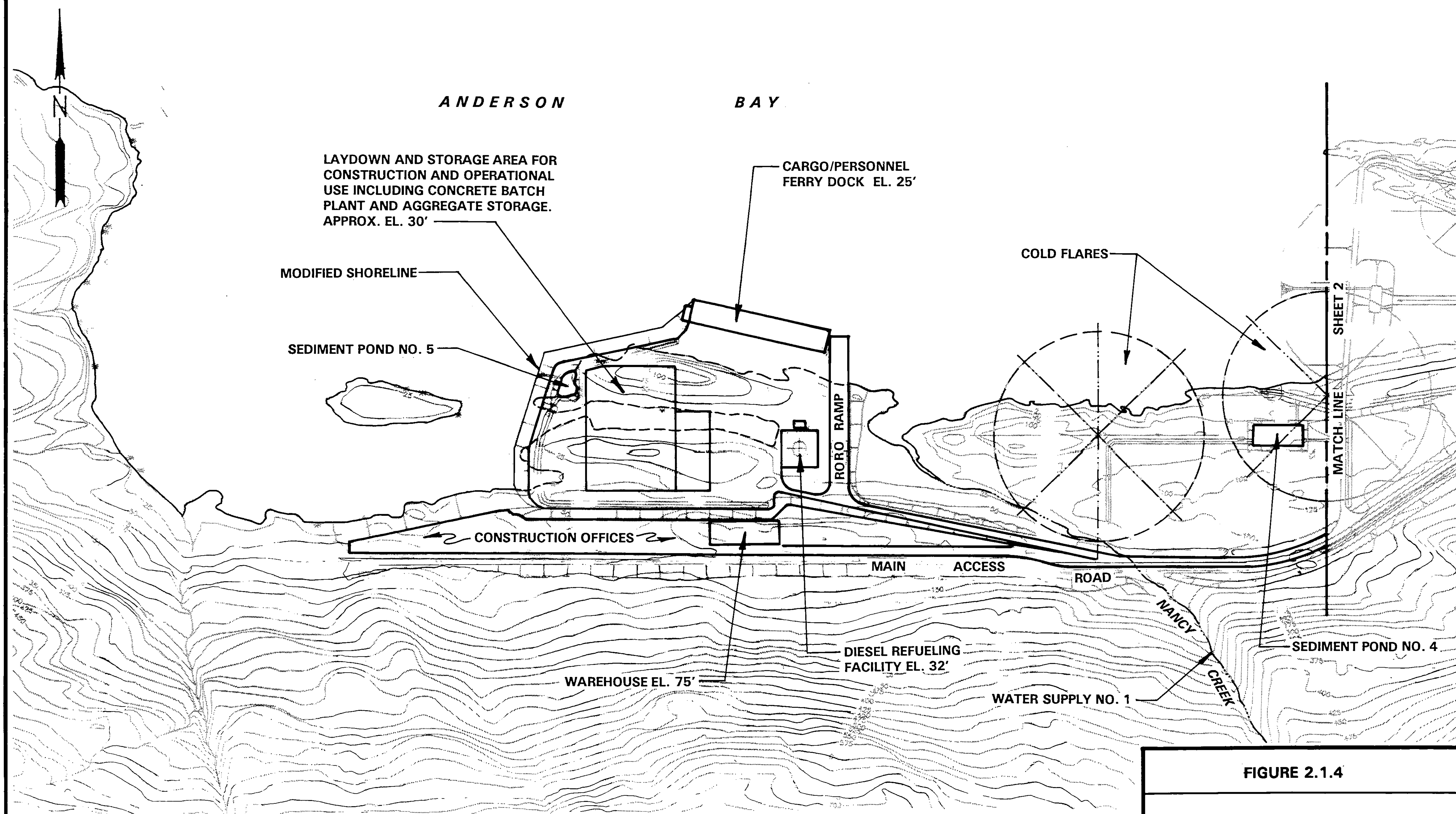


FIGURE 2.1.4

PROPOSED LNG PROJECT SITE DEVELOPMENT PLAN

SCALE: 1" = 400'

SHEET 1 OF 3

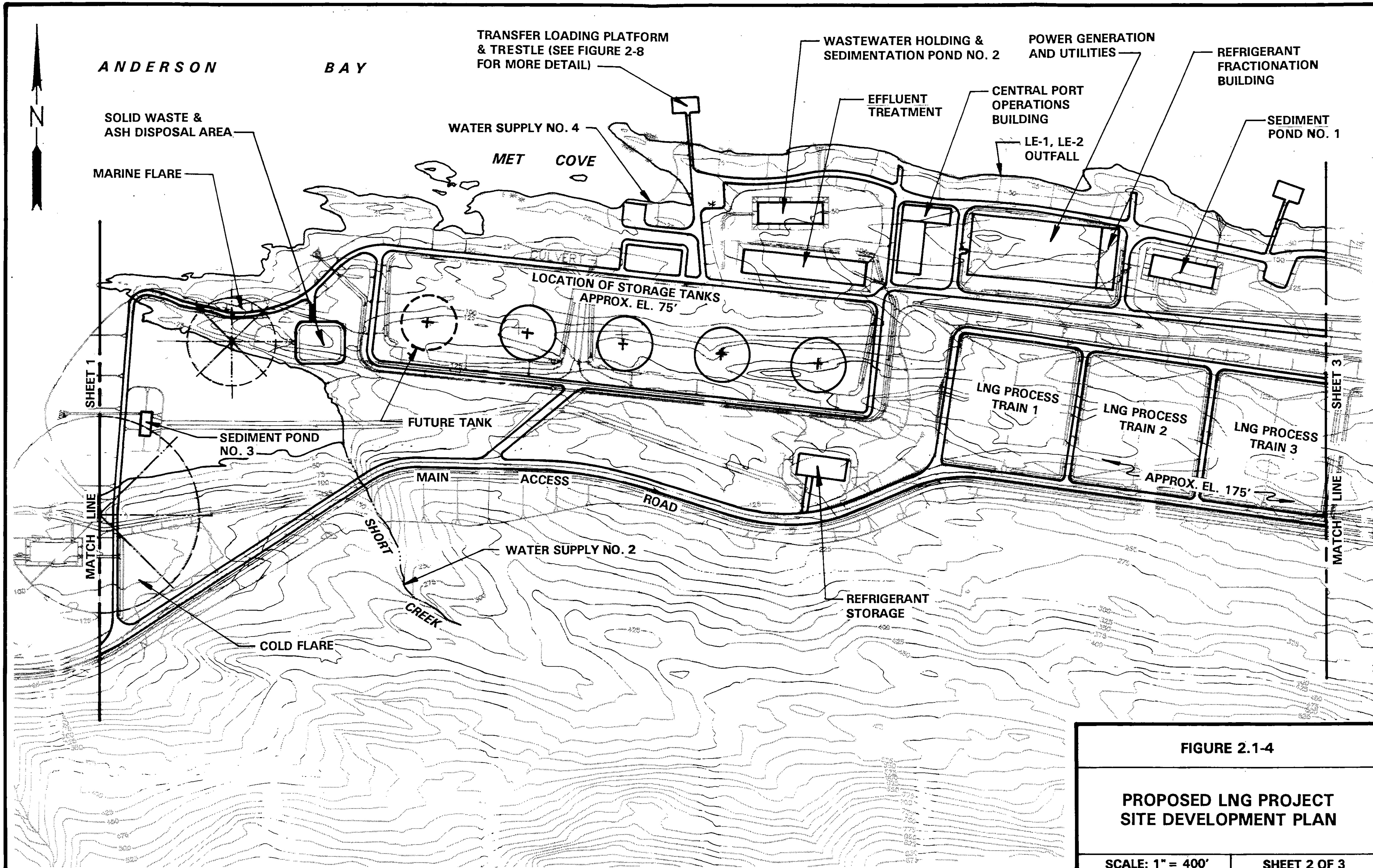


FIGURE 2.1-4

PROPOSED LNG PROJECT SITE DEVELOPMENT PLAN

SCALE: 1" = 400′	SHEET 2 OF 3

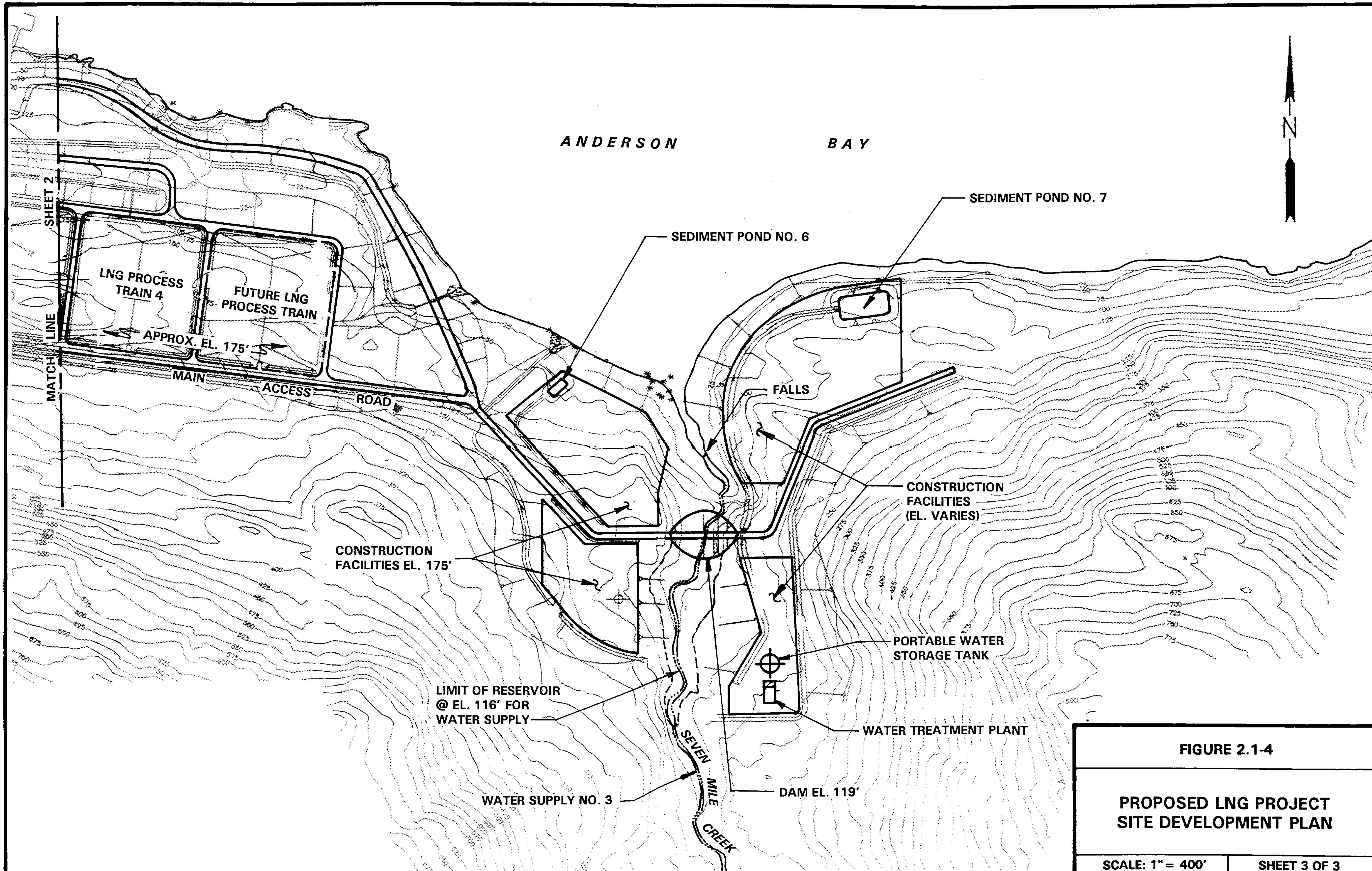


FIGURE 2.1-4

PROPOSED LNG PROJECT SITE DEVELOPMENT PLAN

SCALE: 1" = 400' | SHEET 3 OF 3

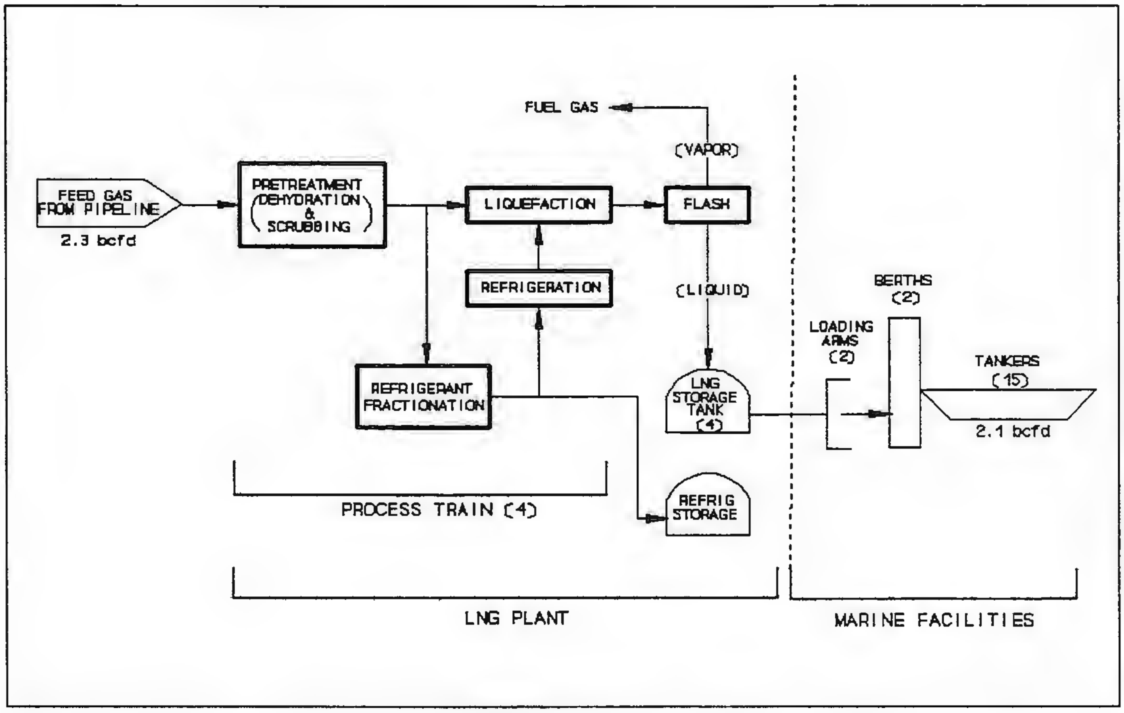


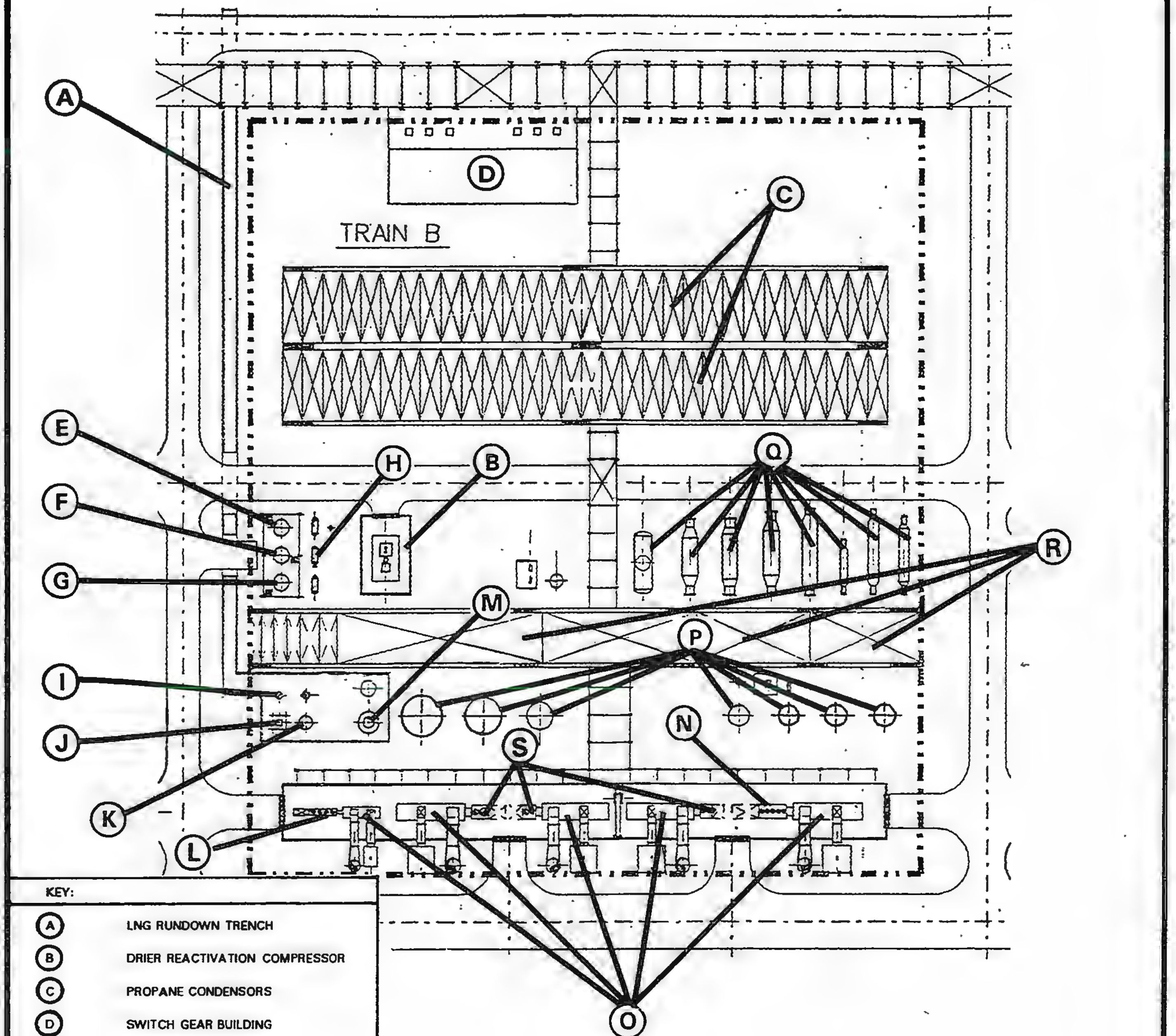
FIGURE 2.1-5 **Process Flow Diagram**

equipment, the feed gas would be split into four 20-inch lines, each going to one of the separate but identical parallel liquefaction trains. The first stage is pretreatment, whereby the feed gas is cleaned to remove undesirable components remaining after initial gas treatment on the North Slope. The estimated composition of the feed gas (units in mole percent) is as follows:

Design Feed Gas Composition

Nitrogen	0.70	n-Butane	0.82
Methane	89.87	i-Pentane	0.02
Ethane	5.94	n-Pentane	0.01
Propane	1.88	n-Hexane	0.01
i-Butane	0.75		

The pretreatment and liquefaction processes would occur in the liquefaction trains located on a bench at elevation 175 feet toward the east end of the site (see figure 2.1-4). Each train would occupy an area 600 feet by 550 feet. The major facilities associated with each train are shown on figure 2.1.1-1.



KEY:

A	LNG RUNDOWN TRENCH
B	DRIER REACTIVATION COMPRESSOR
C	PROPANE CONDENSORS
D	SWITCH GEAR BUILDING
E	MERCURY GUARD VESSEL
F	FEED DRIERS (2)
G	FEED SEPARATOR
H	DRIER REACTIVATION SEPARATOR
I	LNG PRODUCT PUMPS (2)
J	MR/FLASH GAS HEAT EXCHANGER
K	LNG FLASH DRUM
L	FLASH GAS COMPRESSOR
M	MAIN CRYOGENIC HEAT EXCHANGE
N	PROPANE COMPRESSOR
O	TURBINE DRIVERS (4)
P	PROPANE SUCTION DRUMS
Q	PROPANE EVAPORATORS
R	MR COMPRESSOR COOLERS
S	MR COMPRESSORS (3)

FIGURE 2.1.1-1

TYPICAL
LNG MODULE
LIQUEFACTION TRAIN

NOT TO SCALE

2.1.1.1 Pretreatment

The feed gas would first enter a feed separator to remove pipeline liquids, followed by drying in one of two parallel feed driers to reduce water content from an estimated 4 parts per million by volume (ppmv) to 1 ppmv. The driers contain molecular sieves which would be reactivated by a drier reactivation heating and cooling cycle. The molecular sieves would also remove any minor volumes of carbon dioxide, although most or all of this would be removed at a gas conditioning facility located at Prudhoe Bay. The exiting gas is then filtered to remove adsorbent dust before being passed through a Mercury Guard Vessel to adsorb mercury to prevent mercury-induced corrosion in subsequent process steps.

Feed gas impurities removed by these pretreatment processes typically include particulates, dust, iron oxide, lubricant oils, and possibly some petroleum liquid condensates. Effluent from the feed gas separator would be collected at a lift station, combined with other oily wastewater, and pumped to the LNG plant/marine terminal's oil/water separator. This effluent then would receive further treatment at the site's wastewater treatment plant (see section 2.1.1.5).

2.1.1.2 Liquefaction

Pretreated feed gas from the dehydration system would enter the liquefaction system within the process train. The feed gas ultimately would be liquefied using a mixed refrigerant (MR) cycle. The constituents of the MR fluid would be nitrogen, methane, ethane, and propane in appropriate proportions. Multi-stage precooling both for the MR and for the feed gas would be provided by a closed-cycle propane refrigeration system. The feed gas would be precooled in successive propane evaporators prior to entering the MR refrigeration portion of the system. Final refrigeration, resulting in the LNG product, would occur in the main cryogenic heat exchanger. Yukon Pacific's contractor studied four cases to determine the benefits of seawater cooling versus air cooling for the propane and MR cooling requirements and recommended air cooling for the total plant.

The refrigerant in the closed-cycle MR system would be circulated by three centrifugal compressors, each driven by a 37,000-horsepower (hp) gas turbine. The compressors would be operated in series, progressively increasing the pressure. The high pressure refrigerant after precooling by propane evaporators would flow to a liquid/vapor separator. The propane refrigeration system would use a four-stage propane compressor driven by a 37,000-hp gas turbine. The separated streams would provide refrigeration and ultimately liquefaction and subcooling of the feed gas within the main cryogenic heat exchanger.

The LNG exiting the Main Cryogenic Heat Exchanger would be expanded to 18 psig. An LNG flash drum would separate flash gas which would be warmed and compressed by a 6,400-hp gas turbine-driven compressor and sent to the fuel gas system. Finally, the LNG from the LNG flash drum would be pumped to one of the four LNG storage tanks at a design flow rate of 0.55 bcfd.

2.1.1.3 Refrigerant Separation

Refrigerants required in the refrigeration system for the liquefaction portion of the facility consist of nitrogen, methane, ethane, and propane. Nitrogen would be obtained from an onsite air separation plant, while methane would be obtained directly from the feed gas process stream. The other hydrocarbon refrigerants (ethane and propane) would be extracted from the feed gas by a fractionation system. Only one fractionation system would be provided for the entire facility but it would be capable of using treated feed gas from any of the four trains.

Feed gas for the fractionation system would be taken as a slipstream of about 0.235 bcfd. This would enter a feed gas expander suction drum for fluid separation, then would be expanded in a fractionation feed gas expander. The cooled gas would then enter a scrub column where the more volatile components (primarily nitrogen and methane) would be separated from the heavier hydrocarbons. The condensibles from the scrub column would be sent to a deethanizer column where gaseous ethane would be extracted from the top of the column, condensed, and transferred to one of two insulated 26,000-gallon ethane storage tanks. The bottoms from the deethanizer column flow to the depropanizer column where propane would be separated, condensed, and transferred to one of two 430,500-gallon propane storage tanks. The refrigerant storage tanks would be located south of the easternmost LNG storage tank. The extracted refrigerants would amount to about 1 percent of the total slipstream. Ethane would be produced at about 5.7 gallons per minute (gpm) and propane would be produced at about 35.9 gpm.

2.1.1.4 LNG Storage Tanks

The plant would have four insulated, double-walled, suspended roof, aboveground storage tanks, each with a capacity of 800,000 barrels. Spatial provision would be made to accommodate a fifth tank in the future. The tanks would be located centrally onsite between the LNG process trains and the cargo docking facilities on a cut bedrock bench at elevation 75 feet. The site is in Uniform Building Code (UBC) Seismic Zone 4, and Yukon Pacific has adopted a 0.6 g horizontal and 0.4 g vertical acceleration for seismic design. The combined storage capacity of 3,200,000 barrels would provide approximately 5 days of LNG storage at the design liquefaction rate.

After conducting a study of seven different types of LNG storage and impoundment systems, Yukon Pacific's contractor narrowed its preference to four for further consideration:

Type T-1	Conventional metal tank with low wall dike
Type T-2	Conventional metal tank with high wall dike
Type T-4	Double-integrity tank with concrete inner and outer tank wall
Type T-6	Double-integrity tank with metal inner tank wall and concrete outer tank wall

After further evaluation, Yukon Pacific's contractor concluded that:

1. The LNG storage tank and impoundment system should be the double-integrity type; and

2. Final selection between the inner concrete tank and the metal tank (T-4 and T-6) should be made at the time of purchase quotation, considering cost and construction schedule.

Unlike conventional metal storage tanks, both the inner and outer tank walls of a double-integrity tank are capable of containing LNG. Thus the outer wall provides impoundment for any liquid spill or leakage from the primary inner vessel. Type T-4 by Preload Incorporated (Preload) would use prestressed concrete for both inner and outer tank walls, the walls either being precast or cast-in-place. Type T-6 by Chicago Bridge and Iron (CBI) would use a 9 percent nickel steel inner tank and a prestressed concrete outer tank wall.

Subsequently, in an August 10, 1992 letter to Robert Arvedlund of the FERC, Yukon Pacific stated it favors three storage tank configurations—Types T-4 and T-6 selected by its contractor, as well as Type T-2. Typical tank cross-sections for Types T-2, T-4 (precast design), and T-6 are shown on figure 2.1.1-2 and principal design features are compared in table 2.1.1-1.

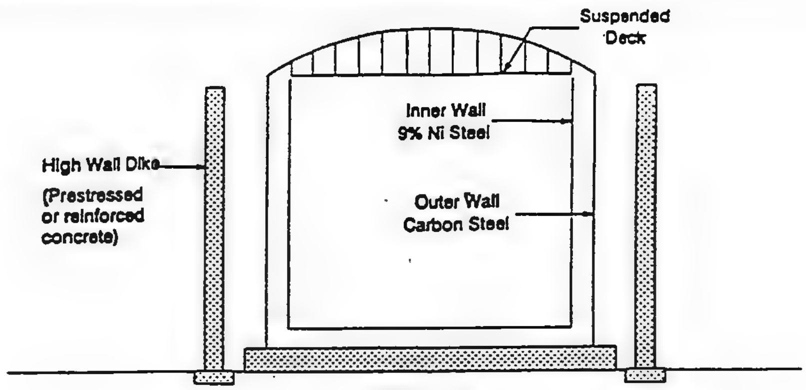
TABLE 2.1.1-1

LNG Storage Tank Design Comparison

	T-2	T-4	T-6
Outer tank diameter	280'	250'7"	285'
Outer tank height	96'	111'6.5"	91'
Inner tank diameter	270'	240'5"	270'
Inner tank height	87'6"	106'1.5"	87'6"
Maximum liquid height	79'9"	101'	79'9"
Anulus insulation	48" perlite 12" fiberglass	44" perlite	48" perlite 12" fiberglass
Deck insulation	24" perlite	26" fiberglass	24" perlite
Floor insulation	20" foamglass	12" foamglass	20" foamglass
Dike wall diameter	310'	same as outer wall	same as outer wall
Dike wall height	90'9"	same as outer wall	same as outer wall

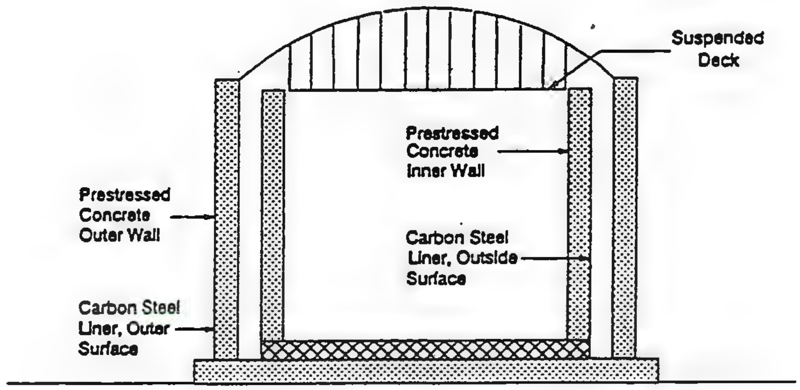
Although Yukon Pacific has not made a decision on the final storage tank design or selected the tank fabricator, it has established preliminary design criteria and process configuration to be used in the final design. The tanks would have a design pressure of 2.0 psig and a normal operating pressure of 0.5 psig. The design vacuum pressure would be 0.05 psig, with replacement pad gas automatically supplied by a 4-inch line from the fuel gas header. The number, size, and spacing of vacuum and pressure relief valves would be determined during final design.

All process piping would enter or exit through the roof of each LNG storage tank; there would be no penetrations of the bottom or side walls of either the inner or outer tank. The 24-inch liquid bottom fill line would terminate at the top of a larger-diameter standpipe. The flashbreak at the top of the standpipe would release vapor from the incoming liquid, and allow the bottom-filled liquid to equilibrate to tank ullage pressure. Each tank would also have a 24-inch top fill line terminating at the center of the tank above an inverted funnel-shaped splash plate. This line would permit tank recirculation, circulation between tanks, thermal relief, and cool down. A 30-inch boiloff line would remove normal tank boiloff and flash gas from liquefaction.



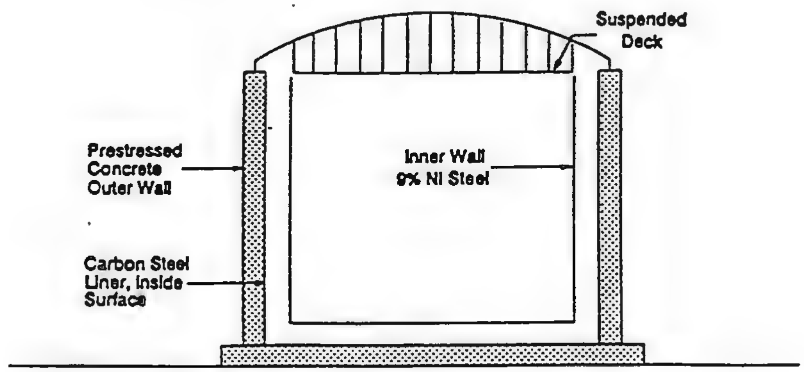
TYPE T-2

CONVENTIONAL METAL TANK, HIGH WALL DIKE



TYPE T-4

DOUBLE INTEGRETY TANK, DOUBLE CONCRETE WALL



TYPE T-6

DOUBLE INTEGRETY TANK, CARBON STEEL ROOF

FIGURE 2.1.1-2

TYPICAL LNG STORAGE TANK CONFIGURATIONS

NOT TO SCALE

Each tank would have four submerged 7,500-gpm centrifugal pumps, located at the bottom of individual columns, to withdraw tank inventory. Pump discharge would be through separate 16-inch lines combining with a 24-inch header. Each tank would also have a single 500-gpm liquid circulating pump. The plant piping configuration would provide various pumping options: a) circulation through marine loading lines, b) recirculation within a storage tank, and c) inter tank liquid transfer.

Storage tank instrumentation would include temperature elements attached to the shell and floor of the inner vessel, in the annular space, and in the vapor space between the tank roof and suspended dock. The number, location, and type of elements would be determined in the final design. Liquid level would be measured by both a differential pressure instrument, and a combined level, density, and temperature traveling probe. Alarm and shutdown features on the level gauges would include low-level alarm, pump shutdown, high-level alarm, and fill valve closure. Linear and rotational inner tank movement indicators would also be provided for each tank.

2.1.1.5 Plant Utility Systems

The main area, located north of the first liquefaction train at 100 feet elevation, would contain the power generation system, steam generation system, water and wastewater treatment systems, and the compressed air and nitrogen plants.

Power Supply

Electricity for the proposed plant would be provided by seven 8,840-kiloWatt (kW) gas turbine generators. One unit would generate most of the plant steam by cooling the turbine exhaust gases in a heat recovery steam generator (HRSG). Two of the units would also be able to use diesel oil as an alternative fuel to provide operation in the event of a fuel gas supply interruption.

Water Supply

Water supply for both construction and operation would be obtained from a combination of sources depending upon the use and relative quantities available from each source. Primary sources proposed include stored surface waters from onsite streams and waters barged in from offsite. A desalination plant would be used as a secondary source of water for industrial operations and potable uses, but would not be used for construction water.

Water requirements for plant operations would be obtained from Seven Mile Creek. Yukon Pacific has proposed to construct a 40-foot-high, gravity dam approximately 400 feet upstream from the waterfall at the mouth of this stream to pool and store water for use during construction and operation. While the exact location of the dam would be determined after a detailed geologic survey, Yukon Pacific has developed a conceptual design for the water impoundment and withdrawal. The dam would result in the creation of a small reservoir of approximately 3.5 acres.

Water required for operations, both potable and industrial, would be obtained from the same source. Total water requirements for operations are estimated at about 75 gpm average and 200 gpm peak, with little seasonal variation. Potable water derived from surface water sources would be treated at a Trident package water treatment plant located in the main utility area.

Liquid and Solid Wastes

Much of the liquid and solid wastes generated on the site would be handled by the Waste Treatment Plant and Incinerator. These would be designed to:

- receive, treat, and dispose of all the oils and grease removed from the plant's oily wastewater system;
- receive and treat all of the sewage from the plant's sanitary sewage collection system and to dispose of all of the sewage treatment sludge produced from the effluent of the biological waste treatment plant;
- receive and incinerate all waste oils (e.g., spent crankcase and hydraulic oils) generated during construction and to receive and incinerate all spent lubricating and other oils generated during permanent plant operations;
- receive and incinerate all general construction material and shipping material that cannot be disposed of in open pit burning;
- receive and incinerate all garbage and filters generated onsite during construction and permanent plant operations; and
- receive and incinerate all heavy hydrocarbon waste streams generated in the process.

<u>Wastewater Treatment System</u> - Wastewater from LNG plant facilities would be comprised of potentially oily wastewater from washdown and marine facilities, and sanitary wastewater from personnel facilities. Oily wastewater could contain significant amounts of oil and grease, grit, and other settleable solids, as well as various suspended solids composed of organics and inorganics. Proposed treatment for such wastewater is a two-stage process. Initially, a pretreatment oil/water separator would be used to remove floatable oils and greases and readily settleable solids. This separator is designed to produce an effluent with less than 10 parts per million (ppm) oil. Pretreated oily wastewater would then be combined with domestic wastewater for biological secondary treatment to remove organics, some trace metals, and remaining settleable and suspended solids.

Domestic wastewater from personnel facilities is anticipated to be of standard sewage strength. Collection systems would be relatively short and well controlled; no excessive infiltration or inflow sources of wastewater are anticipated. Secondary treatment would be accomplished using a packaged aerobic treatment unit. The system would include a complete mixed aeration tank for biological treatment followed by a settling tank (clarifier) for solids removal. Solids would be recycled into the aeration process to provide a fresh supply of bacteria for the aerobic treatment.

Yukon Pacific has also proposed to supply fresh water during operation of the plant by use of a desalination process when necessary. The desalination process would withdraw from Port Valdez approximately 803 gpm average and 2,510 gpm maximum to produce between

75 and 200 gpm of fresh water. Desalination operations would produce a discharge of between 657 gpm (average) and 1,503 gpm (maximum). Yukon Pacific has indicated that the effluent from desalination operations would be about 100° F, and be independent of the temperature of water obtained from Port Valdez.

Solid Waste and Ash Disposal - Much of the solid wastes generated on the site would be handled by an onsite incinerator. Both the preheat burner and the main combustion burner of the incinerator would be designed to burn either fuel gas, diesel oil, or waste lubricating oil and hydraulic fluids. During the construction phase of the project, diesel oil, waste lubricating oils, and hydraulic fluids from vehicles would be used as incinerator fuels. Once the plant is in operation, waste lubricating oil and hydraulic fluid from vehicles and stationary equipment or fuel gas would be used as incinerator fuels. No substances with hazardous characteristics would be incinerated. General construction and shipping waste materials and all garbage generated onsite during construction would also be incinerated.

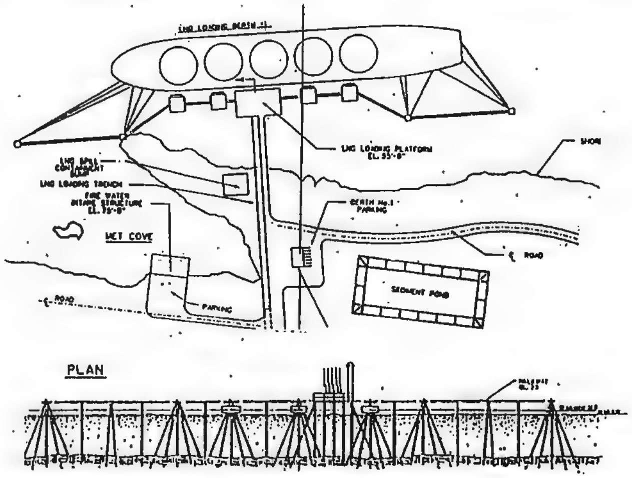
Solid effluents produced during normal operations would also include spent molecular sieve from the feed driers and spent sulfur impregnated activated carbon from the mercury guard vessels within the process trains. The life of the molecular sieve should exceed 3 years. Spent molecular sieve is not expected to be hazardous and would either be landfilled onsite or shipped offsite for regeneration. The life of the sulfur-impregnated activated carbon, a function of the mercury content of the feed gas, would probably exceed 3 years. If feasible, the activated carbon would be regenerated at an offsite facility. If this is not feasible, the activated carbon would be landfilled. Ash from the incinerator and incinerator scrubber would be disposed in a permitted landfill located on the plant site. The onsite landfill location has not yet been identified by Yukon Pacific.

2.1.2 Marine Facilities

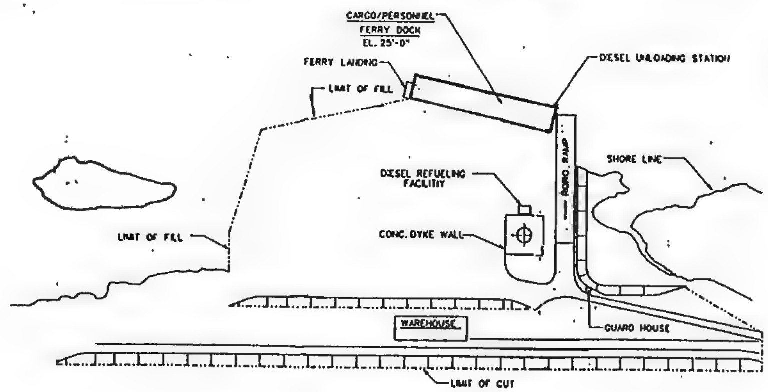
The permanent marine facilities would consist of an LNG loading system, two LNG tanker berths, a cargo vessel docking area with a ferry landing for site access, and berths for tugs and work boats. Figure 2.1.2-1 illustrates the major components of the permanent marine facilities.

LNG Loading System

The LNG loading system would use the internal LNG pumps to transfer LNG from the storage tanks to LNG tankers berthed at the marine terminal. Transfer piping would be sized to load an LNG tanker in a 12-hour period (approximately 44,000 gpm). LNG would be transferred to each dock using two parallel 24-inch cryogenic insulated pipelines supported by trestles. During non-loading periods, LNG would be circulated through one line and returned to storage through the other line to maintain the piping at cryogenic temperatures. The loading operation at each berth would use four 16-inch articulated marine loading arms for loading LNG onto the tankers and one 16-inch vapor-return arm which would take LNG vapors back to either the plant's fuel gas system or the feed gas system for reliquefaction. Shutoff valves would be located in the 24-inch loading lines both onshore and at the docks. Additionally, each articulated arm would contain a hydraulically operated Powered Emergency Release Coupler (PERC) consisting of double ball shutoff valves and an emergency release coupler. The PERC would be used only for emergency situations and not for routine connections. During normal operations, the loading arm connection would either use bolted flanges or a hydraulically operated quick connect/disconnect coupler.

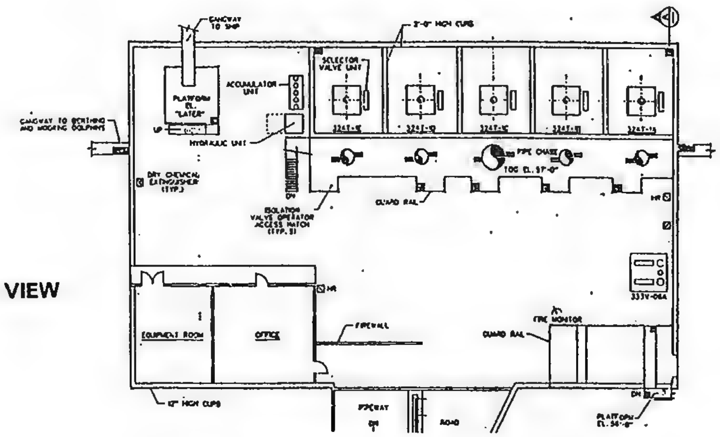


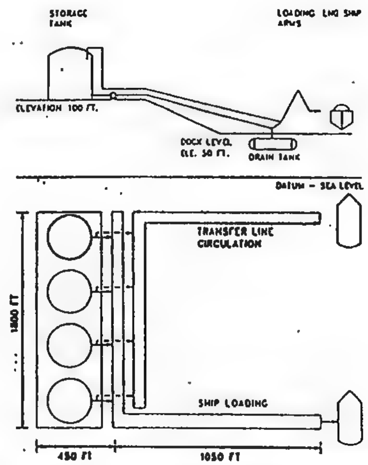
LNG DOCK



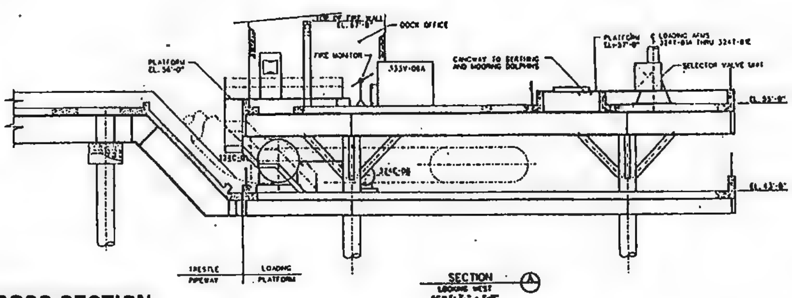
CARGO DOCK

PLAN VIEW





LNG LOADING ARRANGEMENT



CROSS-SECTION

LNG LOADING PLATFORM

FIGURE 2.1.2-1

TYPICAL MARINE TERMINAL FACILITIES

NOT TO SCALE

Each LNG loading platform would be constructed in two levels. The upper deck would be 120 feet long and 72 feet wide at an elevation of 55 feet above Mean Low Water Level (MLLW). The product and utility piping would be located on a lower deck at an elevation of approximately 43 feet above MLLW, with risers to the upper deck at appropriate locations. A hydraulically operated gangway would provide shore-to-ship access. The platforms would be connected to shore by a causeway, built on piles, carrying roadway and piping (see figure 2.1.2-1).

LNG Tanker Berths

The two LNG tanker berths would be approximately parallel to shore in 55 feet of water. The tanker berths would be designed to handle tankers in the 125,000 to 135,000 cubic meter size range and suitable for the next generation of up to 165,000 cubic meter capacity. The LNG berths have been designed to provide safe mooring for the LNG tankers and would be designed to withstand severe environmental conditions (110 mile per hour winds and maximum waves and currents). Each berthing facility would consist of four breasting dolphins, a transfer platform for the four marine loading arms and one vapor return arm, and four mooring dolphins located outboard to the vessel. Both the mooring and breasting dolphins would be accessible by catwalks. The outer mooring dolphins of each LNG berth would be equipped with small boat landings (see figure 2.1.2-1).

Cargo/Personnel Ferry Vessel Docking Area

There are no construction or operational access roads proposed for the LNG plant and associated marine facilities. Consequently, all transportation of personnel, supplies, and materials for construction, plant operation, or emergency access or egress would be by air and/or waterborne traffic. A cargo/personnel ferry dock would be located on the west end of the site to accommodate all marine transports (see figure 2.1-4). A temporary dock would be built initially for construction equipment, materials, and supplies. The permanent dock at the same site would support plant operations, including the receipt of diesel oil, consumables, potable water, and other supplies for plant operation and maintenance. The cargo dock would have a fuel station for supplying small craft and floating equipment. The unloading of bulk liquids would occur between supply vessels and a permanent manifold near the face of the dock. Since both areas are potential spill areas, they would be curbed and drained to the oil/water separator sump.

The cargo/personnel ferry dock would be used by ferries, freighters, and bulk carriers with drafts up to 20 feet. There would be a 600-foot-long wharf and 100-foot-wide roll-on/roll-off ramp. The cargo dock would have a 100-foot-wide apron consisting of a heavy duty compacted crushed stone pavement during construction, which would be paved prior to operation. Elevations of the wharf, ramp, and ferry dock are 30 feet, 15 feet, and 15 feet above MLLW, respectively.

The cargo/personnel ferry dock would provide permanent moorings for the service vessels and small craft employed by the plant. Also third-party owned tugs and launches could be temporarily moored at the cargo dock as required for plant operation. The ferry docking area would also have a passenger terminal building with waiting rooms for passengers leaving and entering the plant, check-in facilities, luggage handling facilities, and security and control functions. The cargo/personnel ferry dock would be located on a 23-acre site consisting primarily of fill over an intertidal marine area located near the midpoint of the Anderson Bay shoreline. The level site would be used during both construction and operation for a variety of uses, including staging, equipment, and supply storage.

2.1.3 LNG Tankers

At the design terminal throughput of 14 million tons of LNG per year (29.3 million cubic meters), a fleet of 15 tankers of 125,000 cubic meters capacity would make about 275 loaded voyages per year to receiving terminals in the Pacific Rim once LNG production was at full capacity. LNG tankers returning from Pacific Rim Countries in ballast would enter Prince William Sound through Hinchinbrook Entrance. Yukon Pacific would require all LNG tankers to change all ballast water during the 36-hour period prior to entering Prince William Sound. Tankers would proceed north through the sound into Valdez Arm, then pass through Valdez Narrows to the marine terminal at Anderson Bay. LNG tankers entering the Prince William Sound Vessel Traffic Service Area (VTS Area) would follow the Coast Guard regulations in 33 CFR 161.301 through 161.387. Major requirements of the VTS Area include:

- a Traffic Separation Scheme (TSS) having one-way traffic lanes with a separation zone;
- a vessel movement reporting system;
- a one-way traffic area in Valdez Narrows; and
- radar surveillance in Valdez Arm, Valdez Narrows, and Port Valdez.

Further, tank vessels greater than 20,000 DWT operating in the VTS Area must have:

- two separate marine radar systems for surface navigation;
- an operating LORAN-C receiver;
- an operating rate of turn indicator; and
- two operating radiotelephones, one battery powered, capable of operating at the designated VTS Area frequency.

No later than August 1, 1993, tank vessels greater than 20,000 DWT must also have an operating Automated Dependent Surveillance Shipborne Equipment (ADSSE) that meets the requirements of 33 CFR 161.376(a)(5). The ADSSE will automatically provide the Vessel Traffic Center (VTC) in Valdez with position information on tank vessels at greater distances than now available, allowing for more timely and reliable traffic decisions.

In addition, the Coast Guard issued notices of proposed rule-making concerning escort vessels for single hull tankers on July 7, 1992, and concerning pilotage requirements in Prince William Sound on October 26, 1992, and March 26, 1993.

The Coast Guard has stated that it does not anticipate VTS problems with the increased LNG tanker traffic, but has recommended additional restrictions governing LNG tankers in the VTS Area and is likely to develop a Captain of the Port Plan specific to LNG tanker operations. Section 4.15.4, Marine Safety, presents a more detailed discussion of the VTS Area and Coast Guard requirements.

As the LNG tanker approaches Anderson Bay, the vessel and accompanying tugs would make a 180° turn to starboard prior to berthing at the marine terminal. This would enable the LNG tanker to berth on its port side with its bow toward the sea. After securing the tanker with berthing and mooring lines, the loading and vapor return arms would be connected to the tanker cargo manifold and cargo transfer would commence. Typically, cargo loading would require 12 hours, with a tanker turnaround time of about 18 hours.

While the project design is based on a fleet of 15 LNG tankers with a nominal cargo capacity of 125,000 cubic meters, Yukon Pacific would design the marine facilities to accommodate the next generation of LNG tankers with capacities of 165,000 cubic meters. Use of larger capacity LNG tankers could correspondingly reduce the size of the fleet and annual number of tanker transits. While Yukon Pacific has neither identified shipyard(s) that would construct the LNG nor determined the type of LNG cargo containment, the nominal 125,000 cubic meter tanker is fairly representative of the present LNG carrier fleet in service—between 120,000 and 137,000 cubic meters.

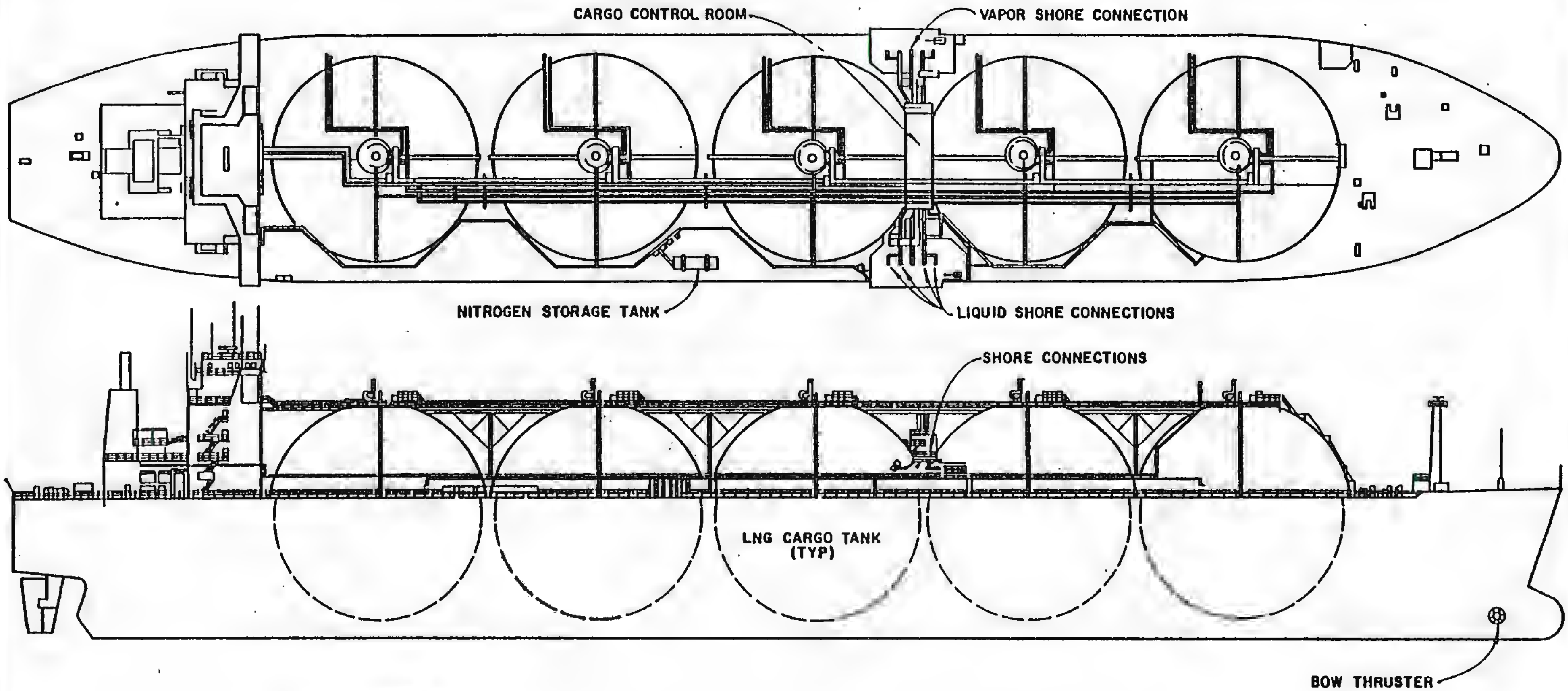
Three basic tank designs have been developed for LNG cargo containment—spherical, prismatic free-standing, and membrane. The earliest form of LNG containment is the prismatic free-standing tank. It consists of an aluminum alloy or 9 percent nickel steel, self-supporting tank that is supported and restrained by the hull structure. Insulation consists of reinforced polyurethane foam on the bottom and the sides, with fiberglass on the top. The spherical tank design uses an unstiffered, spherical, aluminum alloy tank that is supported at its equator by a vertical cylindrical skirt, with the bottom of the skirt integrally welded to the ship's structure. This free-standing tank is insulated with multi-layer close-cell polyurethane panels.

In the membrane containment system, the ship's hull constitutes the outer tank wall, with an inner tank membrane separated by insulation. Two forms of membrane are commonly used—the Technigaz membrane using stainless steel, and the Gaz-Transport membrane using Invar. (Greater detail on cargo tank containment systems is provided in Yukon Pacific's July 26, 1991 data response, Volume IX, FERC question 17, available at the Commission's offices in Washington, DC and the Joint Pipeline Office (JPO) in Anchorage, AK.)

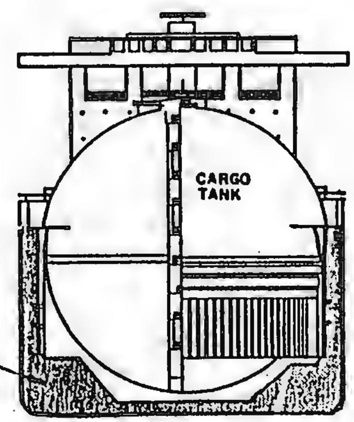
Regardless of the containment system used, LNG tankers are of the double-hulled design. A double bottom and double sides are provided for the full length of the cargo area and arranged as ballast tanks, independent of the cargo tanks. The double-hulled design provides greatly increased reliability of cargo containment in the event of grounding and collisions. Further, the segregated ballast tanks prevent ballast water from mixing with any residue in the cargo tanks.

Typical characteristics of an LNG tanker for a 125,000 cubic meter tanker (a General Dynamic's spherical design) and a 165,000 cubic meter tanker are presented in figures 2.1.3-1 and 2.1.3-2 and table 2.1.3-1.

Typically, the LNG tankers would be powered by steam turbines, using either a single or a twin screw. The boilers would have dual fuel capability, burning both cargo boiloff gas and



NOTE
TANKER CHARACTERISTICS WILL VARY WITH SPECIFIC MANUFACTURERS AND TANKER TYPES.



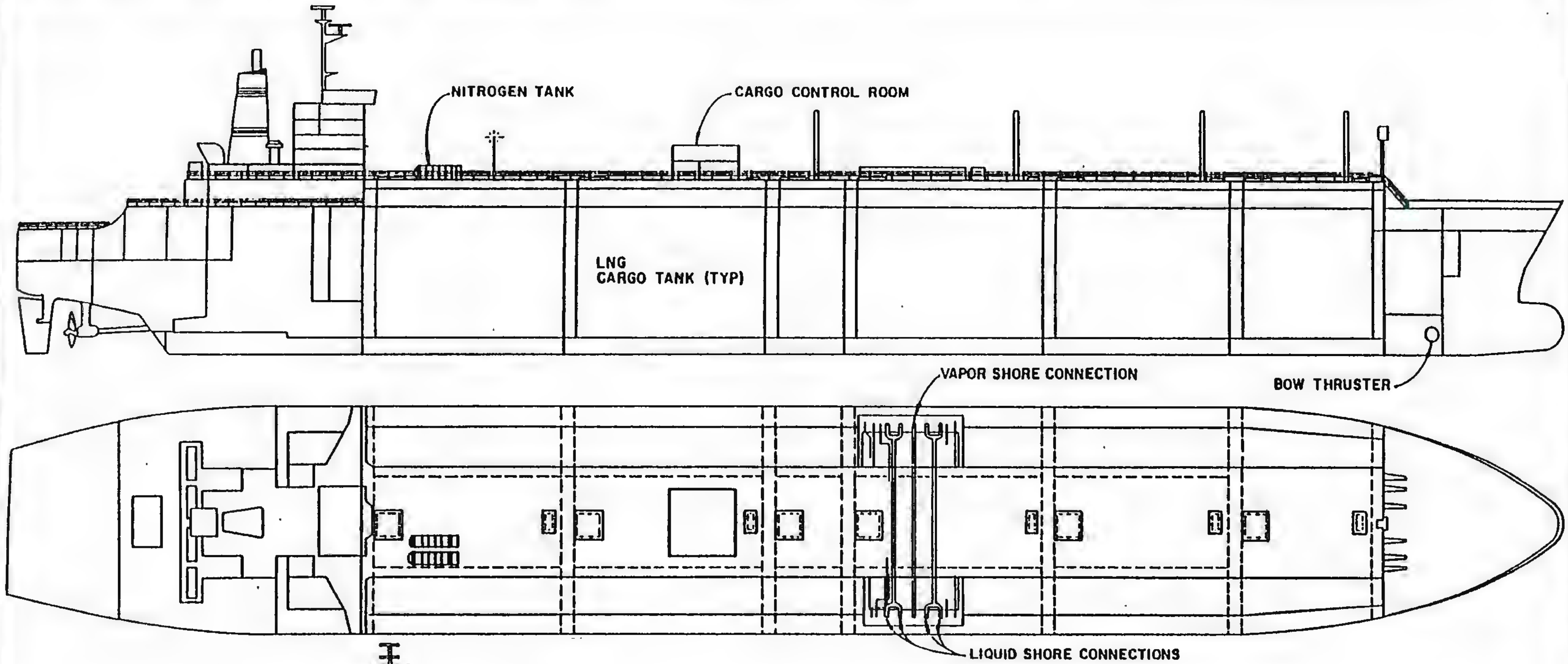
TANKER CHARACTERISTICS

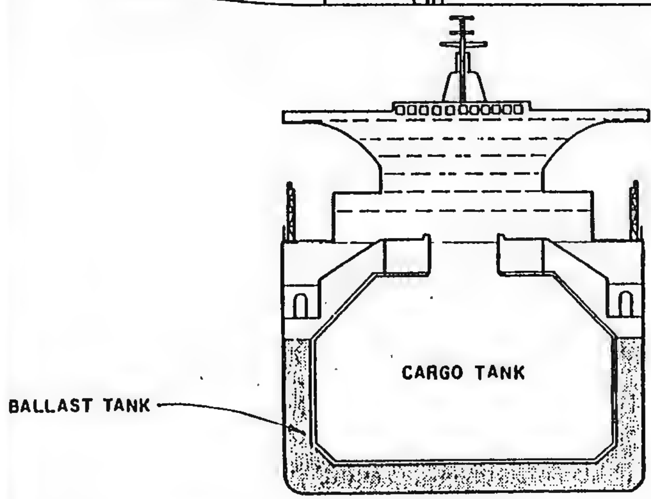
LNG CAPACITY	$125{,}000\ m^3$	$165{,}000\ m^3$
LENGTH OVERALL	950 FT.	1,000 FT.
BEAM	145 FT.	150 FT.
HULL DEPTH	82 FT.	100 FT.
DRAFT, LOADED	38 FT.	40 FT.
DISPLACEMENT, LOADED	95,000 LONG TONS	122,000 LONG TONS

FIGURE 2.1.3-1

TYPICAL SPHERICAL DESIGN FOR AN LNG TANKER

NOT TO SCALE





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

NOTE

TANKER CHARACTERISTICS WILL VARY WITH SPECIFIC MANUFACTURERS AND TANKER TYPES.

FIGURE 2.1.3-2

TYPICAL MEMBRANE DESIGN FOR AN LNG TANKER

NOT TO SCALE

TABLE 2.1.3-1

Typical LNG Tanker Characteristics

	Unit	125,000 m^3	165,000 m^3
Length overall	ft	950	1,002
Breadth	ft	143	150
Depth	ft	82	100
Design draft	ft	38	40
Full load displacement	long tons	95,000	122,000
Shaft horsepower	hp	43,000	55,000
Number of propellers		1	2
Service speed	knots	20.4	18.5
Fuel oil	long tons	6,650	8,200
Bow thruster	hp	2,200	2,500

bunker fuel oil. Although tankers would normally burn only bunker fuel in port, while at sea both boiloff gas and bunker fuel oil would be burned. Cargo boiloff gas would not be vented to the atmosphere under normal conditions.

The LNG tankers would have a redundant, independent steering control system to maintain rudder movement in the event of a steering system failure. To improve maneuverability at low speeds such as during docking maneuvers, the tankers would have a bow thruster, consisting of a controllable pitch propeller driven by electric motors.

Navigation systems would include 3 centimeter and 10 centimeter radars, an automatic radar plotting aid, radio direction finder, LORAN-C position locating system, gyro compass system, echo depth sounder systems, doppler log system, collision avoidance/satellite navigation system, and an ADSSE.

Typically, LNG tankers use three independent fire fighting systems. A fire water system using seawater via dual centrifugal pumps is intended to extinguish Type A fires. This system supplies water to multiple fire monitors on the deck and stations throughout the ship. A carbon dioxide system would protect the machinery space, ballast pump room, emergency diesel generator, point room, and forward pump room. A dry power system would be used to extinguish LNG fires.

The LNG tankers would be constructed and operated in accordance with national and international regulatory requirements. The regulations include the International Maritime Organization's Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, the 1974 International Convention for the Safety of Life at Sea, and 46 CFR Part 154, which contain the U.S. regulations for implementing the International Gas Code. Foreign flag LNG tankers would be required to possess a valid International Maritime Organization Certificate of Fitness and a Coast Guard Certificate of Compliance.

2.1.4 Construction Plan and Schedule

Detailed design and construction of the LNG plant and marine terminal at Anderson Bay would be completed over an 8-year period using a phased construction strategy, with an incremental construction, startup, and production over a period of several years. Yukon Pacific's current scenario would complete one liquefaction train per year over 4 years, with the first train startup in the fifth year of construction. Other major components—LNG tanks, docks, etc.—would also occur in sequence. A general schedule outlining the overall construction program is provided on figure 2.1.4-1. The critical path schedule consists of site preparation, LNG tank foundation installation, and tank construction.

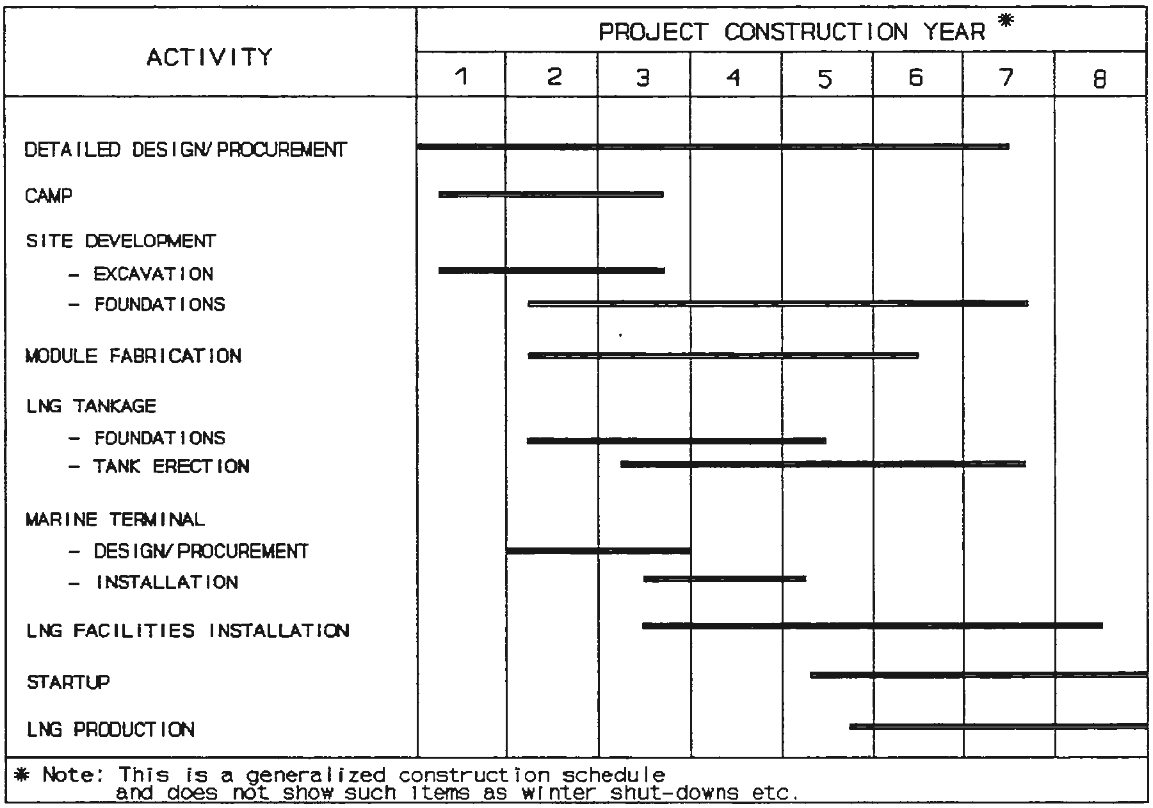


FIGURE 2.1.4-1 **LNG Plant and Marine Terminal Construction Schedule**

2.1.4.1 Construction Workforce and Related Support Facilities

Personnel for initial project mobilization would be housed in the camp facilities in Valdez which are situated near the airport (see figure 2.1.4-2). The Valdez facilities would be used during the whole project by a small number ranging between 150 to 250 personnel. These would include intransit personnel, permanent employees for procurement and personnel processing, busing, and ferrying. Some senior management people may live in the City of Valdez with their families, but this number should not exceed 30 to 40 families.

Floating camps would be established at the Anderson Bay job site during initial site preparation and excavation. The construction camp would be established on the banks of Seven Mile Creek (figure 2.1.4-3) and would be sized to accommodate a maximum workforce

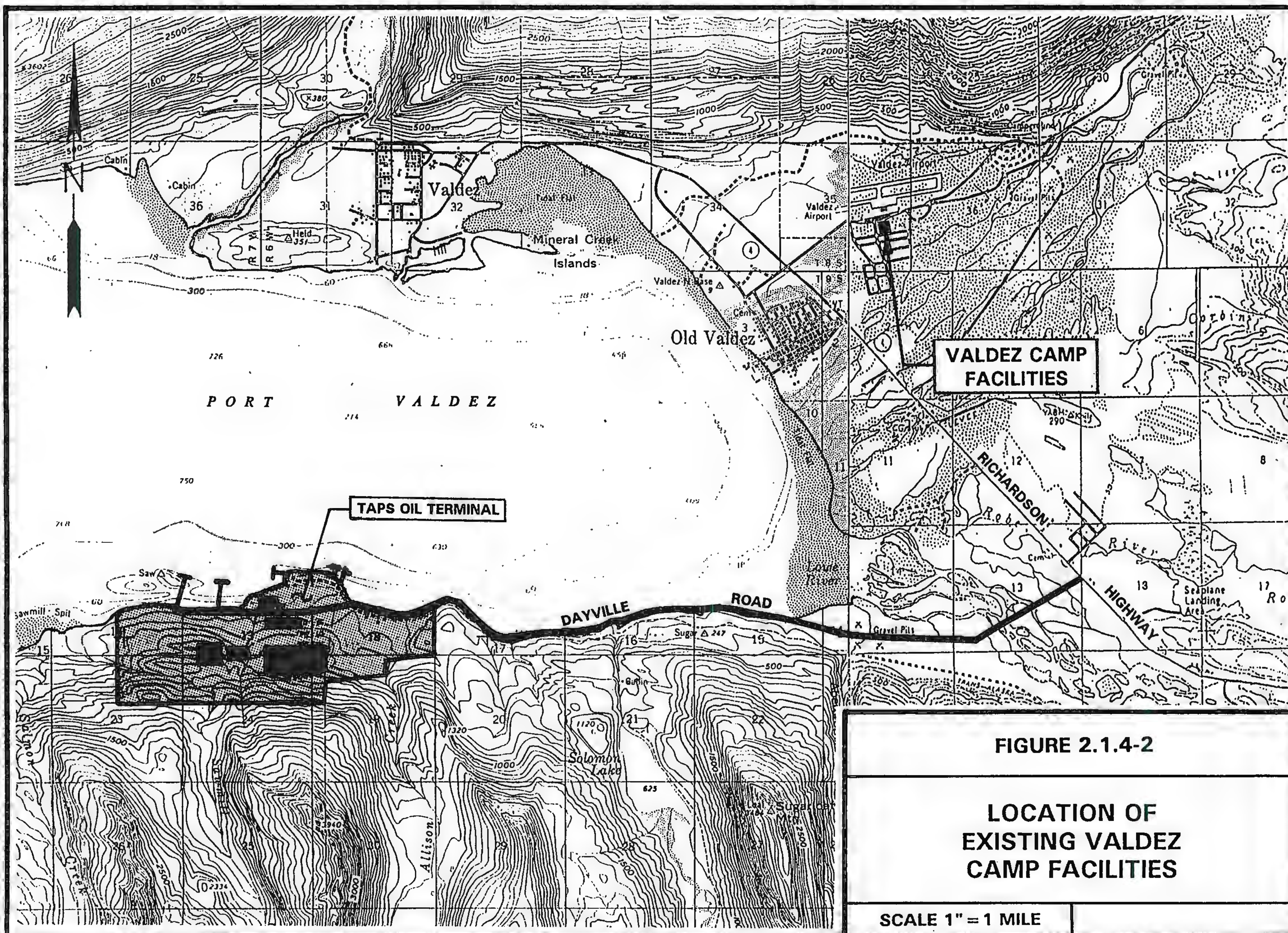


FIGURE 2.1.4-2

LOCATION OF EXISTING VALDEZ CAMP FACILITIES

SCALE 1" = 1 MILE

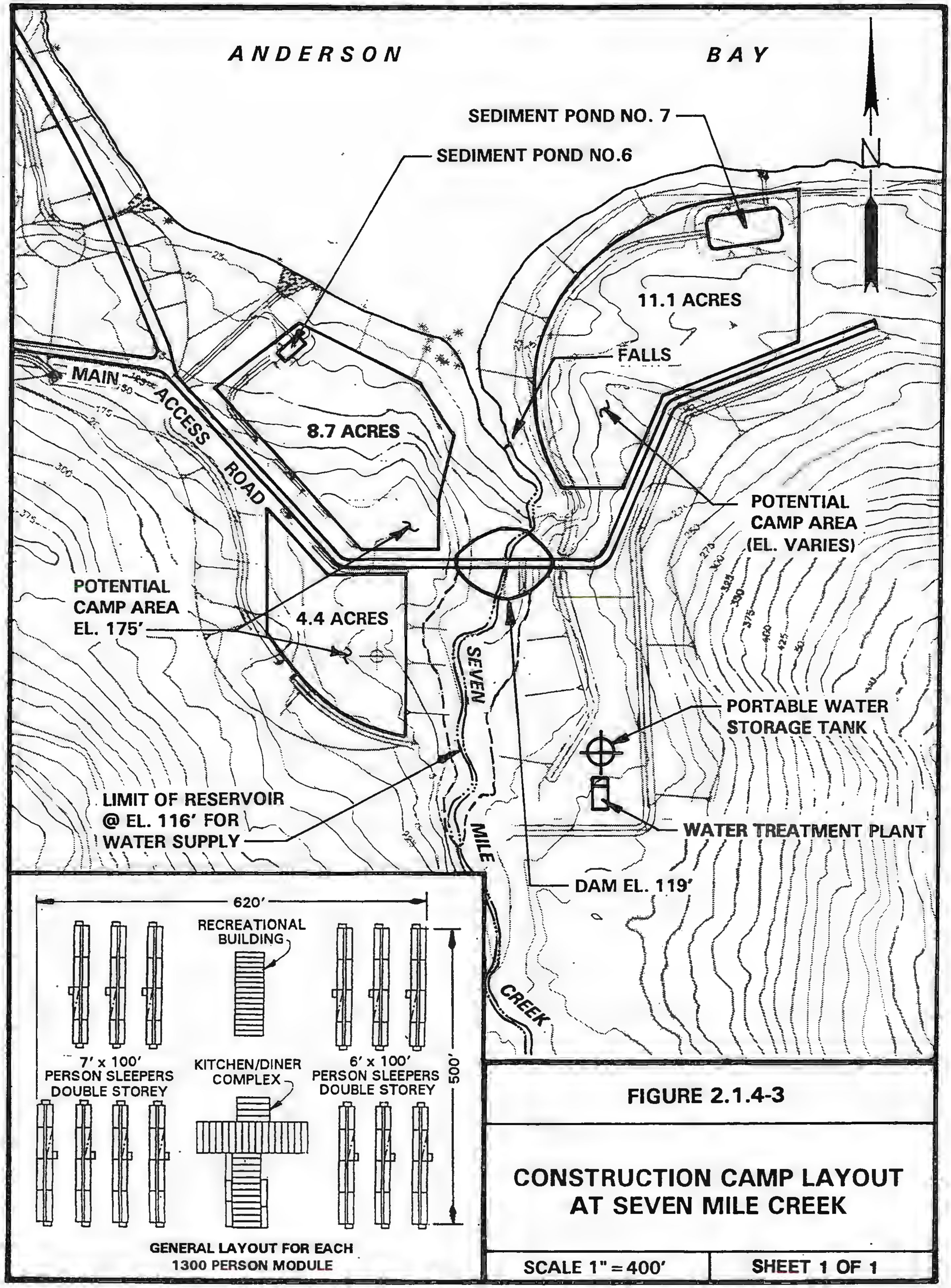


FIGURE 2.1.4-3

CONSTRUCTION CAMP LAYOUT AT SEVEN MILE CREEK

SCALE 1" = 400' | SHEET 1 OF 1

of 4,000 individuals. It would be developed in three modules, each with the capacity to house 1,300 people. Each complex would consist of a kitchen, mess hall, recreation complex, and thirteen 2-story, 100-person dormitories. These would be put in place over three consecutive summers in response to increasing manpower requirements.

Each complex would require a cleared and leveled area of 620 feet by 500 feet (approximately 7 acres) for a total of 21 acres for the buildings alone. The total land requirement is approximately 30 acres. Liquid propane gas would be used for heating and cooking (2,200 gallons per day [gpd] per complex). Electricity usage is estimated at 10,000 kW/day per complex. The water supply would come from Seven Mile Creek as described in section 2.1.1.5 and would be processed through a packaged water treatment plant before delivery to an 800,000-gallon potable water holding tank. Sewage and liquid wastes would be collected from the camp for delivery to the waste treatment plant described in section 2.1.1.5. Solid waste (garbage) generated at the camp would be incinerated onsite in the waste incinerator described in section 2.1.1.5.

The project field administration office would be located on a bench overlooking the cargo/personnel ferry dock area at elevation 75 feet MLLW. Additional construction offices would be located on specific jobsites to place management in proximity to the work. These complexes would contain parking areas, laydown areas, tool cribs, warehouses, and lunch rooms. The construction offices would be located at the LNG train, power generation plant, marine terminal, LNG storage tanks, and offsite. Potable water would be supplied to the field offices in bottles.

2.1.4.2 Temporary Marine Facilities and Traffic

The cargo dock would be a permanent structure that initially would serve construction and later would be used for operation. During construction, the cargo dock would receive shipments of construction materials brought in by barge, module carriers, small freighter, and bulk carriers. It would have a roll-on/roll-off ramp for unloading large prefabricated modules and a ferry landing.

Some temporary dock facilities would also be built to support construction of the LNG facility. These would include a personnel and small boat dock in the construction camp area and temporary moorings for fuel and water barges. The personnel and small boat dock would consist of a 100 foot by 50 foot steel or concrete pontoon 10 to 15 feet deep with fender strips and mooring hardware with an access bridge to shore. The floating dock as currently proposed would be temporary, and would be removed upon completion of construction.

The use of large prefabricated modules is an option to reduce the total number of loads into Anderson Bay. This would result in a single shipment of 10 to 15 ocean-going barges which would all arrive at about the same time. In addition, one to two ocean-going barges per month during the construction season would be required for the first several years. Materials movement to the site from Valdez would average two trips per day, hauling six tractor trailer units or equivalent. Peak requirements could be six trips per day.

2.1.4.3 Permanent Plant and Marine Site Development

Site development activities would begin as early as possible in the first construction year and be carried out in three consecutive summer seasons. Site excavation would involve:

removal of overburden soils down to bedrock and placement of these soils in planned fill and 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 (figure 2.1-4). Overburden removal would be done using shovels, loaders, and haul trucks. Rock excavation would be done using conventional drilling and blasting techniques. Rock would be moved and placed by bulldozers, loaders, haul trucks, and compactors. Blasting of rock would commence upon project mobilization and would be planned initially twice a day—once at lunch period, and sometime between the first and second shifts, weather permitting.

The amount of underwater blasting would be limited to what is necessary at the cargo/personnel ferry dock and the LNG tanker berthing docks, and cannot be determined exactly until detailed bathymetry of the areas is completed. In any event, blasting would be designed to meet Federal Regulations Part 1926, Safety and Health Regulations for Construction Sub Part "U". The proposed schedule restricts underwater blasting to the period October 1 through April 15 or in accordance with ADFG guidelines to avoid impacts on marine resources. The TAGS Right-of-Way Lease Stipulation Number 2.11 requires the preparation of a blasting plan and approval by the Alaska Department of Natural Resources (ADNR) for blasting in streams, rivers, or lakes.

The layout of the site shown on figure 2.1-4 reflects a need to locate all critical facilities on bedrock while at the same time, optimizing cut/fill requirements to minimize spoil quantities. Site excavation quantities would be approximately 9.7 million cubic yards. Approximately 5.9 million cubic yards of this would be used for onsite fill, including earthwork for the construction wharf and off-loading area in Anderson Bay. Approximately 3.8 million cubic yards of excavated material, about 19 percent rock, would not be needed and would require disposal. This is discussed further in section 2.3.2. The site development concept uses terracing (benching) to maximize the functional area of a site which is relatively steep.

The highest bench would be occupied by the LNG process trains at an approximate elevation of 175 feet MLLW. Another major bench would be located to the west where the LNG storage tanks would be placed at a base elevation of approximately 75 feet MLLW. Secondary benches would be graded for other facilities such as the:

- power plant and operations support area and utility storage area (100 feet MLLW);
- harbormaster, helipad, and wastewater retention area (50 feet MLLW); and
- construction wharf and off-loading area (31 feet MLLW).

Once site development for the LNG tank area is well underway, the LNG tanks subcontractor would mobilize to begin construction of the ring foundations for the first LNG tank. This would be as early as possible in the second construction season; with tank installation the following year. Using a phased construction strategy it is Yukon Pacific's intention to complete one train per year for 4 years with the first train startup occurring in the fifth year. At the end of the eighth year of construction, all four trains would be completed and producing.

LNG process trains, completed in modules offsite, would be shipped via barge to Alaska, unloaded at the construction dock facility in Anderson Bay, and moved into place by way of the onsite access roadway. These would be delivered and installed in sequence and the remaining yard pipe would be installed and tested. All systems would go through a transfer of custody and control procedure prior to final commissioning and operations. The installation of the remaining LNG shoreside facilities would be handled by a subcontractor, who would mobilize to the site in the third quarter of the third construction year.

The design and construction of all marine terminal facilities would be handled by a specialty subcontractor, who would begin construction of the two LNG mooring and loading berths late in the third construction year, continuing until completion in the midsummer of the fifth construction year.

The cargo dock would be constructed of precast concrete caissons filled with granular material, that can be floated into place and sunk in position. The final design of the dock would depend on the construction equipment available and the preference of the installation contractor.

2.1.4.4 Concrete Batch Plant

The proposed location for the concrete batch plant is at the construction dock because of the proximity to the unloading area. Water run-off from the batch plant would be contained in the sediment ponds, then either pumped back to the water tank or allowed to drain to a permitted outfall. Waste concrete would be used as miscellaneous fill in the construction operations or removed from the site in dumpsters to an approved landfill area.

The batch plant would require a 400,000-gallon water storage tank which would be supplied from the Seven Mile Creek reservoir by submersible pump. At peak, the plant would use 80,000 gpd with an average use of 10,000 gpd. During the summer months, the storage tank would supply 40 days at the average rate and 5 days at the maximum batch plant production. The tank might require occasional topping off from the sandbag catchments from Nancy or Short Creek. Water barges would be used to supplement the water supply during periods of limited stream flows. The use of a small skid-mounted desalination system is also being reviewed.

There are insufficient quantities of high quality aggregates to meet construction needs at the Anderson Bay site. Therefore, concrete aggregates would be barged to the construction dock, then transported directly to the batch plant or placed in the aggregate stockpile area at the dock. Aggregate supply would come from local sources; the deposits would be excavated using backhoes and front end loaders. Trucks would transport the material to barges which would ship the aggregate loose on the barge, or trucks would drive onto transport vessels and drive off at the cargo dock.

Estimates of required aggregate types indicate that up to 250,000 cubic yards of concrete aggregate and 700,000 cubic yards of special aggregates would be required from offsite sources. These would be purchased from private suppliers in the Valdez area and barged to Anderson Bay where they would be stockpiled. Space limitations would limit the stockpiles to less than 25,000 cubic yards.

2.1.4.5 Fuels

Power for the temporary construction facilities would be supplied by diesel generators at various locations throughout the jobsite. Fuel would be provided from small above grade storage tanks and each location would be contained with berms. Fuel would be dispensed from the permanent diesel storage facility adjacent to the cargo/personnel ferry dock and transported in fuel tankers around the site to refuel each piece of equipment and each generator.

Fuel barges would be unloaded at the cargo dock using flexible hoses between the supply vessel and a permanent manifold near the face of the dock. During transfers, the offloading vessel would be surrounded by a floating oil boom to contain any accidental spillage.

Gasoline would be transported to the site by tanker truck on the roll-on/roll-off ramp. The use of gasoline would be limited to that required for small power tools and some vehicles. The gasoline tank farm would be located near the diesel tank in elevated tanks surrounded by a berm.

2.1.5 Safety Controls

The proposed facilities would be designed, constructed, operated, and maintained in accordance with DOT Federal Safety Standards for Liquefied Natural Gas Facilities, 49 CFR Part 193. The facilities would also meet the National Fire Protection Association 59A LNG Standards (NFPA 59A). The marine cargo transfer system and any other appurtenances located between the LNG tanker and the last valve immediately before an LNG storage tank would comply with the Coast Guard regulations for Liquefied Natural Gas Waterfront Facilities, 33 CFR Part 127 and Executive Order 10173. Table 2.1.5-1 summarizes the Siting Requirements found in Subpart B of Part 193, and Yukon Pacific's action to comply.

In recognition of the importance of design and operational safety for a major LNG export facility, the Commission staff had two studies undertaken on key safety aspects of the facility: 1) a seismic design review, and 2) a cryogenic design and technical review. To accomplish the first task, the Commission entered into an Interagency Agreement with the National Institute of Standards and Technology (NIST) in January 1992. The NIST and its predecessor, the National Bureau of Standards, had previously conducted similar reviews for the Commission on LNG terminals in high seismic areas. For the present review, the NIST conducted a technical conference in Anchorage on May 20, 1992 and conducted site inspections on May 21 and 22. The results of the seismic investigation appear in the report in appendix A and are summarized in section 4.2, Seismicity.

For the second task, the Commission staff worked jointly with its consultant, Cryogenic Engineering, to commence a cryogenic design and technical review. A cryogenic design data request was sent to Yukon Pacific on February 1, 1990 and partial responses received on July 26, 1991, and March 31, 1992. A technical conference was convened in May 1992 in Valdez, followed by a site visit. Section 4.15, Analysis of Public Safety, summarizes the study and presents the conclusions and recommendations. The preliminary cryogenic report is in appendix B.

TABLE 2.1.5-1

Actions Taken to Comply with 49 CFR Part 193 Siting Criteria

Criteria	Action
193.2057 Thermal radiation protection: This criterion is designed to ensure that certain public land uses and structures outside the LNG facility boundaries are protected in the event of an LNG fire.	The calculated "thermal exclusion zones" for each container and transfer system do not impinge on any of the excluded land uses.
193.2059 Flammable Vapor-gas dispersion protection: Similar to the thermal radiation protection requirements described above, this criterion aims to protect from a flammable gas cloud resulting from an LNG spill.	Outdoor usage plan to be developed to control excluded uses within the calculated "dispersion exclusion zones."
193.2061 Seismic investigation and design forces.	Seismic design criteria, developed by both deterministic and probabilistic methods to meet or exceed the codes in 49 CFR 193, under review.
193.2063 Flooding: This criterion addresses risks from flooding on an LNG site based upon the worst occurrence in a 100-year period, taking into account the volume and velocity of the floodwater, tsunamis (tidal waves), potential failure of dams, predictable land developments which would affect runoff accumulations of water, and tidal action.	Seawall and energy dissipation devices recommended to control wave runup.
193.2065 Soil Characteristics: This criterion addresses the load bearing capacity of the site (static loading caused by the facility and its contents, and dynamic loading caused by the movement of contents during operation).	Through the use of bedrock and engineered rock fill, the site preparation design criteria assure compliance with this paragraph's requirements.
193.2067 Wind Forces: This criterion requires that all facilities be designed to withstand a 200 mile per hour wind force without the loss of structural integrity.	Ongoing review in conjunction with seismic study.
193.2069 Other Severe Weather and Natural Conditions: The intention of this criterion is to determine the worst effect of other weather and natural conditions which may predictably occur at the site and to ensure that the design is appropriate to withstand those conditions.	Snow and avalanche were identified and accommodated in the plant design. Ongoing review in conjunction with seismic study.
193.2071 Adjacent Activities: This criterion states that an LNG facility must not be located where present or projected offsite activities would be reasonably expected to adversely affect the operation of any of the facility's safety control systems or cause the failure of the facility.	The LNG site is surrounded by either the Chugach National Forest or by state land reserved for the plant as buffer zone.
193.2073 Separation of Activities: This criterion specifies separation distances between individual facilities and between facilities and the site boundary to permit movement of personnel, maintenance equipment, and emergency equipment.	These have been incorporated into the site layout.

Spill Containment

The LNG impoundment systems would be designed to comply with the DOT regulations in 49 CFR 193.2149 through .2185 which require that each LNG container and each LNG transfer system have an impoundment capable of containing the quantity of LNG that could be released by a credible accident. Each impounding system would be sized to contain the volume of LNG that could be released in 10 minutes from the single pipe rupture that would produce the highest release rate, plus the volume of LNG that could drain from the pipe (and associated containers) following an emergency shutdown.

At the present stage of design, spill containment systems for the proposed facility are conceptual with final configurations to be developed as the design progresses. Containers in the proposed facility requiring such impoundment include: liquefaction system main cryogenic heat exchangers, LNG flash drums, LNG storage tanks, and loading arm drain tanks on each loading dock. LNG transfer systems necessitating impoundment include: lines from the liquefaction trains to the LNG storage tanks, LNG loading lines from the storage tanks to the docks, and LNG ship loading arms. Details on impoundment dimensions and sizing criteria are discussed in section 4.15, Analysis of Public Safety. (Also see figure 4.15.3-1).

The Type T-2 LNG storage tank configuration would use a high dike wall constructed of 2-foot-thick reinforced concrete. The impoundment would form a 15-foot annular space between the outer tank wall and provide a containment volume of 137 percent of the tank contents. The high wall design is considered a Class 2 impoundment. Type T-4 and T-6 configurations would be constructed with an integral concrete outer wall which would serve as a Class 1 impoundment capable of holding 110 percent of the tank contents.

Hazard Detection System

The hazard detection system would consist of combustible gas, ultraviolet/infrared (UV/IR), smoke (ionization), high temperature, and low temperature units. Precise numbers and locations would be determined in the final design. Hazard detectors would be installed to provide operating personnel with early indication of releases of flammable fluids and fires; to indicate the general location of the release or fire; to initiate automatic shutdown of equipment in the affected portion of the facility; and to initiate automatic discharge of selected fire control systems. Each hazard detector would actuate visible and audible alarms in the Main Control Room and in the Fire Station. In most cases, automatic shutdown and/or automatic discharge of fire control systems would occur only if two or more hazard detectors in a given area are in alarm mode simultaneously.

Combustible gas detector installation would include the following locations:

- air inlets to all pressurized buildings;
- inside all enclosed buildings;
- air inlets to all fired heaters and gas turbines;
- each flammable liquid pump;
- each flammable gas compressor;
- inside each gas turbine enclosure;

- refrigerant storage area;
- near LNG ship loading arms;
- liquefaction trains;
- fin-fan coolers/condensers; and
- fractionation area.

Low temperature detectors would be a minimum of two point-type detectors or one continuous strip-type detector. Low temperature detectors would have a factory set point of -40°F with a field adjustment to -50°F, and be located in each of the following areas:

- each LNG impounding area and spill drainage trench;
- LNG flash drum, product pumps, and main liquefaction heat exchanger for each train; and
- below LNG loading arms on both docks.

Smoke detectors (ionization) would be installed inside all buildings within the plant complex.

UV/IR fire detectors would be installed in pairs in the following areas:

- each LNG storage tank;
- LNG loading arms on each dock;
- refrigerant storage area;
- liquefaction trains;
- LNG impounding areas;
- fractionation area;
- diesel firewater pumps;
- diesel fuel storage tanks;
- natural gas and refrigerant compressors/turbines;
- fin-fan coolers/condensers; and
- compressor lube oil skids.

High temperature detectors would have a set point of +248°F.

Hazard Control Systems

Several different types of chemical agents would be available for fighting fires within the facility. The type of agent that would be used in a specific situation would depend on the characteristics of a particular event and on the relative effectiveness of the various agents on that particular type of fires.

Low-expansion foam is effective for extinguishing fires of ordinary liquid hydrocarbons. Semi-fixed low-expansion foam systems would be installed on all diesel storage tanks with capacities greater than 200 barrels. Portable devices for producing and dispersing low-expansion foam also would be available.

High-expansion foam would be applied to unignited pools of LNG to reduce downwind travel of the flammable vapor cloud. When applied to a pool of burning LNG, high-expansion foam would be used to decrease the size of the flame and thus reduce the amount of radiated heat. Installation of fixed location foam generators would include the following areas:

- beneath the LNG loading arms on both LNG loading docks;
- curbed area around the Main Cryogenic Heat Exchanger and the LNG Flash Drum in each train;
- LNG drainage trench beneath each LNG storage tank piping run to main transfer line impoundment; and
- two LNG impounding areas (onshore) for holding dock spills.

The number of generators to be installed in each location would be determined during detailed design. The overall design intent is to provide sufficient generators to produce a 6-foot-thick blanket of foam over the protected area within 2 minutes. Portable high-expansion foam generators would be available to apply foam to other impounding areas. The foam concentrate would be suitable for use with both fresh water and seawater. The nominal expansion rate of the foam would be from 400:1 to 600:1.

Gaseous extinguishing/inerting agents would be used for extinguishing fires in enclosed spaces to limit the access of oxygen to the fuel and to inhibit the combustion process. Approved gaseous extinguishing systems would be installed in all gas turbine enclosures, in certain control room areas, and in other enclosures housing critical electrical/electronic equipment.

Dry chemical powders would be used for extinguishing LNG fires and fires of other hydrocarbons. Potassium bicarbonate dry chemical agent would be used on hydrocarbon fires. Monoammonium phosphate would be used in dry chemical extinguishers intended for fighting Class A fires (wood, paper, cloth). Skid-mounted, fixed dry chemical extinguishers would be installed on both LNG docks. These fixed systems would supply dry chemical to close-coupled and remote hose reels. All other plant areas would be protected by portable or mobile dry chemical extinguishers.

Portable hand dry chemical extinguishers of 20 or 30 pound capacity would be distributed throughout the process and storage areas, on both docks, and in all other locations where flammable gases or liquids are stored or processed. Wheeled dry chemical units of 150 or 350 pound capacity would be located beneath the east-west pipe racks in each liquefaction train (five per train), in the fractionation area (two), and in all buildings that house gas turbines and/or flammable gas compressors (one wheeled unit per two turbines or turbine/compressor sets).

Hand portable fire extinguishers containing an approved gaseous extinguishing/inerting agent would be installed in all buildings or rooms that house electrical or electronic equipment.

Mobile and portable fire fighting equipment would include the following:

- two fire trucks (water only);
- one fire truck (high-expansion foam);
- one fire truck (water and low-expansion foam);
- six portable high-expansion foam generators; and
- one 3,000 pound, skid-mounted, dry power unit on wheels with hose reels and one monitor.

These equipment units would be located at the Fire Station. Portable and mobile foam producing equipment and the water fire trucks would be capable of being connected to hydrants on the fire distribution system.

Firewater System

Firewater supply and distribution systems would be provided for extinguishing Class A fires; cooling tanks, structures, and equipment exposed to excessive heat radiation from fires; producing low- and high-expansion foam; and dispersing flammable vapors. The design of the firewater supply and distribution system would provide for simultaneous supply of all fixed fire protection systems, including monitor nozzles, at their design flow and pressure involved in the maximum single incident expected in the plant, plus an allowance of 1,000 gpm for hand hose streams for a period of not less than 2 hours. Jockey pumps are to maintain 150 psig system pressure.

Firewater would be supplied from two independent pumping sources. A 570,000-gallon Fire/Utility Water Tank would be provided to supply fresh (desalinated) water through the fresh firewater pumping station primarily for pressurizing the firewater system and for initial fire fighting capability. A seawater pumping station would be designed to supply the entire plant distribution loop with seawater if demand exceeds the capacity of the fresh water system. Seawater would be pumped from the Firewater Intake Structure into the distribution loop by two electric motor-driven submerged seawater fire pumps (11,500 gpm each) with two additional diesel engine-driven spare pumps.

The firewater distribution network would be a wet underground main with hydrants and monitors strategically located throughout the facility. Sectional isolating valves of the post-indicating type would be incorporated into the firewater mains to ensure system integrity and to permit isolating the system in the event of a break or for making repairs or modifications.

Automatically operated fixed water spray systems would be installed for the protection of selected tanks, pumps, vessels, columns, heat exchangers, and piping. All process vessels that would contain significant amounts of liquefied gas would be water sprayed. All fin-fan coolers/condensers that contain flammable fluids or are located above pipe racks carrying flammable fluids would be water sprayed. Lubrication oil skids located below compressors would have a combination water spray/low-expansion foam system. All pumps that handle combustible liquids that are above their flash points would be protected by fixed water spray systems.

The firewater loop in the LNG storage tank area would supply water for fixed water spray systems on the storage tanks, for monitors and hydrants, and for producing high-expansion foam. Each LNG storage tank would be protected by a fixed water spray system on exposed portions of the tank. (The concrete walls would shield much of each storage tank from heat radiation emitted by fires in adjacent tanks.)

The refrigerant storage area would be equipped with an automatically operated water spray system designed to absorb heat developed by fires and to suppress flames in order to protect piping, refrigerant storage tanks, and surrounding equipment.

The firewater systems at each of the two docks would include a firewater distribution system (normally dry); three hydrants (with hose racks) at strategic locations at the loading platforms; two firewater monitors at the inner breasting dolphins; one firewater monitor at the intersection of the loading platform and trestle; and two elevated, pre-aimed, remote on-off firewater monitors to protect the loading arms. Additionally, a fixed water spray system would be provided on the gangway, LNG Drain Drum, LNG piping, and critical valves. A fixed water spray system also would be provided on the outside of the Dock Operations Building.

Fail Safe Shutdown

There are multiple automatic and manual shutdown systems for all components of the LNG and marine operations. The emergency shutdown system (per train basis) is activated by any of the following: main heat exchanger trip, master trip, any compressor trip, loss of power or air, and a variety of other mechanical triggers.

The loading pumps for each tank are stopped automatically in the event of: emergency shutdown activation, motor overload, low tank pressure or level, dock emergency shutdown activation, and other actions.

The emergency shutdown system (per dock basis) is activated manually from either the main control room or from local hand switches, as well as power failure, instrument air failure, or the PERC activation on the loading arms. In a dock shutdown, all loading pumps stop, loading valves close, the loading arm drains and purges, and the vapor recovery arm valve closes. If the PERC is activated first, it will cause both the dock emergency shutdown and the storage tank emergency shutdown to be activated, as well as full alarms to allow personnel warning.

There are no plans to develop overland access for the regular movement of personnel, equipment, or materials into or out of the Anderson Bay site; however, the pipeline right-of-way would be available as a "summer emergency only" egress route from the terminal if an event were to occur that would require evacuation of personnel from the southern area of the

LNG facility and access to waterborne transportation were restricted by that event. The emergency egress route would be maintained as an unimproved private trail, graded, and kept free of brush.

2.1.6 Future Plans and Abandonment

The project has an expected life of 30 years based on the availability of natural gas. If additional supplies become available, the life of the facility could be extended. The termination procedures to be implemented would be subject to appropriate existing Federal, state, and local regulations in effect at that time.

2.1.7 Permits, Approvals, and Regulatory Requirements

As lead Federal agency for the Yukon Pacific LNG Project, the Commission is required under NEPA to ensure compliance with Section 7 of the Endangered Species Act (ESA) and with Section 106 of the National Historic Preservation Act (NHPA). Section 7 of the ESA, as amended, states that any project authorized, funded, or conducted by any Federal agency (e.g., the Commission) should not "...jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined...to be critical..."[16 USC § 1536(a)(2)(1988)]. The Commission is required to consult with the U.S. Fish and Wildlife Service (FWS) and the National Marine Fisheries Service (NMFS) to determine whether any federally listed or proposed endangered or threatened species or their designated critical habitat occur in the vicinity of the proposed project. If, upon review of existing data, the Commission determines that these species or habitats may be affected by the proposed project, the Commission is required to prepare a Biological Assessment (see appendix C) to identify the nature and extent of adverse impact, and to recommend mitigation measures that would avoid the habitat and/or species or that would reduce potential impact to acceptable levels.

Section 106 of the NHPA requires the FERC to take into account the effects of its undertakings on any prehistoric or historic sites, districts, or objects listed on or eligible for listing on the National Register of Historic Places (NRHP), and to afford the Advisory Council on Historic Preservation (ACHP) an opportunity to comment on the undertakings. The Commission has requested the applicant, as a non-Federal party, to assist it in meeting obligations under Section 106 by preparing the necessary information and analyses as implemented by the ACHP procedures in 36 CFR Part 800. In accordance with the ACHP procedures, the FERC, as the lead agency, is required to consult with the appropriate State Historic Preservation Officer (SHPO) regarding the NRHP eligibility of cultural resources and the potential effects of the proposed undertaking on those NRHP-listed or -eligible cultural resources.

In addition to the FERC's requirement for a Place of Export authorization under Section 3 of the NGA, other Federal and state government agencies have permit or approval authority, and responsibility for determining compliance with their requirements over portions of the proposed project (see table 2.1.7-1). Some individual state and/or local permits may not be required to construct this proposed project due to the Federal pre-emption status of the FERC certificate of public convenience. At the Federal level, required permits and approval authority outside of the FERC's jurisdiction include compliance with regulations of the Clean Water Act (CWA), the Rivers and Harbors Act, the Clean Air Act (CAA), the Mineral Leasing Act (MLA), the Archeological Resources Protection Act (ARPA), and the Native

TABLE 2.1.7-1

Permit and Approvals

Agency	Permit	Remark
FEDERAL		
U.S. Environmental Protection Agency (EPA)	National Pollutant Discharge Elimination System (NPDES) Permit (Clean Water Act, Section 402) FWPCA	During construction and/or operations, NPDES permit required for point source discharge of waste waters (e.g., from sewage treatment system) into waters of the United States.
	Clean Water Act, Section 402 Stormwater Permit for Construction	For construction sites larger than 5 acres, a permit is required for discharge of collected runoff from the site.
	Clean Water Act, Section 402 Stormwater Permit for Industrial Facilities	During operations, industrial facilities require permit for discharge of collected runoff from the site.
	Waste Generator Identification Number	Notification must be given to the EPA as to what RCRA wastes will be generated in order to be entered into Manifest System. This allows generator (Yukon Pacific) to generate, store for ≤ 90 days and ship offsite, RCRA classified wastes.
Federal Communications Commission (FCC)	Radio and Wire Communications and Construction Permit (47 U.S.C. 154-303)	To construct and operate communication system.
Federal Energy Regulatory Commission (FERC)	Authorization of Place of Export under Natural Gas Act Section 3; 18 CFR Part 153.6	Approval of Anderson Bay site as place from which U.S. natural gas may be exported to destinations out of the U.S.
U.S. Department of the Army Corps of Engineers (COE)	Section 404 (Clean Water Act)	Permit for placement of dredge or fill material into waters of the United States.
	Section 10 (Rivers and Harbors Act)	Permit for placement of structures in, or affecting, navigable waters.
U.S. Coast Guard	33 CFR Part 127 requires Yukon Pacific to file a letter of intent	Captain of the Port issues letter of recommendation to operator and develops OPLAN.
	Permission to establish Aids to Navigation required under 33 CFR Part 66	If Yukon Pacific wishes to establish any navigational aids associated with either the tanker terminal or the cargo cock, Coast Guard must be notified and give permission.

TABLE 2.1.7-1 (cont'd)

Agency	Permit	Remark
STATE a/		
Alaska Department of Fish and Game (ADFG)	Fish Habitat Permit AS 16.05.870	Permit required before undertaking any activity in a stream supporting anadromous fish.
	Fish Habitat Permit AS 16.05.840	Permit required if efficient passage facilities of resident fish either upstream or downstream are required.
Alaska Department of Natural Resources (ADNR)	Right-of-Way Lease (AS 38.55) and Notice to Proceed	Yukon Pacific has a conditional lease which will be made unconditional only after all studies, reports etc. are submitted.
	Water Rights Permit and Certificate of Water Appropriation (AS 46.15)	For withdrawal of waters from site streams.
	Purchase of Materials (AS 38.05)	If materials (e.g., gravel or clay) are required from an area outside of the lease, a material sale permit is required.
	Burning Permit (AS 41.15)	To dispose of slash or stumps from clearing by open burning requires a state permit.
	Tidelands Lease (AS 38.05)	For use of shoreline in grading and erection of structures.
Alaska Department of Environmental Conservation (ADEC)	Prevention of Significant Deterioration (PSD) Permit AS 46.03, 140 & 150; 18 AAC 50.300	Permit required for exhaust of any incineration or fossil fuel burning equipment both during construction and operations.
	Open Burning Permit 18 AAC 15.020 -.100	During site clearing/preparation, the burning of slash by open fire requires a permit from the state.
Alaska Coastal Policy Council	Coastal Zone Management Act Consistency Determination	Determination as to consistency with state coastal policies regarding development.
LOCAL		
City of Valdez	Chapter 30 Zoning Permit	
	Building Permit	For construction of all land facilities, authorizing inspection to ensure Building Codes are observed.

a/ The State of Alaska uses a multiple agency coordinated system for reviewing and processing all resource-related permits, leases, and other authorizations which are required for coastal projects through the office of the Governor.

American Graves Protection and Repatriation Act (NAGPRA). While each of these statutes has been taken into account in the preparation of this document, actual permitting will not occur until a later phase of project development when detailed design and equipment selection has occurred.

Federal requirements of the CWA include compliance under Sections 401, 402, and 404. The U.S. Environmental Protection Agency (EPA) determines if a National Pollutant Discharge Elimination System (NPDES) permit would be needed for construction and/or operational discharges.

The Section 404 permitting process is administered by the COE for all stream and wetland crossings. Section 10 of the Rivers and Harbors Act is also administered by the COE; individual Section 10 permits would be required for all construction activities that occur in navigable waterways. The COE has responsibility for determining compliance with all regulatory requirements associated with Section 10 and Section 404 of the CWA.

Ambient air quality is protected by Federal regulations under the CAA. These regulations include compliance under the New Source Performance Standards (NSPS) and the new requirements for the Prevention of Significant Deterioration (PSD). The Federal permitting process for the CAA has been delegated to individual state agencies. Although applications are reviewed by both the states and the EPA, the State of Alaska would determine the need for NSPS or a PSD permit.

2.2 ALTERNATIVE SITE LOCATIONS

In Order 350, the DOE concluded that the Valdez export site (Anderson Bay) is preferable to all other export sites that were considered in the TAGS FEIS issued in June 1988 and disapproved all sites other than the Anderson Bay site (DOE, 1989). Accordingly, as discussed in section 1.5, the Commission is not considering any other site. During scoping, several commentors asked that the process leading to selection of the Anderson Bay site be clarified in the EIS.

The selection of Anderson Bay as the preferred terminal location was the culmination of a series of studies spanning a period of more than 15 years. In 1976, the FPC issued a FEIS in FPC Docket CP75-96 on the then-proposed El Paso Alaska System (FPC, 1976). This project was to carry natural gas from Prudhoe Bay to a site at Gravina Point in Prince William Sound where it would be converted to LNG and transported from Alaska by ship to Point Conception, California. As part of studies leading up to issuance of a FEIS in 1976, 11 potential LNG sites in Prince William Sound, including Anderson Bay, were evaluated against the following 10 criteria:

- topographic conditions
- foundation suitability
- seismic considerations
- atmospheric conditions
- oceanographic conditions
- distance to deep water
- navigational suitability
- anchorage suitability
- ice formation
- land conflicts

In the El Paso Alaska System FEIS, the Anderson Bay site was then rejected as an alternative site based on more favorable topographic, seismic, and anchorage conditions at the Gravina Point site. Although not specifically discussed in the El Paso FEIS, the Coast Guard was, at the time, also concerned with the passage of LNG ships (with their relative high "sail" area) through the Valdez Narrows under high wind conditions.

The Anderson Bay site was re-examined in studies leading to the TAGS FEIS in 1988.2/ The TAGS LNG site selection process involved a variety of steps and considerations. Using general guidelines, the coastal regions of Alaska were screened for sites that would allow for development of a pipeline system and LNG and marine facilities capable of transporting natural gas from Prudhoe Bay for year-round export to Asian Pacific Rim markets. This screening involved review of alternatives considered in previous studies of a similar nature such as TAPS and the El Paso Alaska System. Combinations of routes and terminal sites in Norton Sound, Bristol Bay, Cook Inlet, Prince William Sound, Yakutat Bay, and Lynn Canal/Chatham Strait were examined. Following initial screening, one major regional pipeline route alternative and six alternative LNG plant and marine terminal locations were considered in detail along with the now proposed site at Anderson Bay.

Eleven pipeline criteria, 10 LNG plant site criteria, and 6 criteria related to the marine terminal were used to determine the degree of favorability for each of the alternative sites. Results of this analysis are summarized on figure 2.2-1. LNG siting criteria for the Anderson Bay site were all favorable or moderately favorable. No site was determined to have an overriding advantage over the Anderson Bay site. Unfavorable characteristics identified in the El Paso Alaska System FEIS were not found to be significant problems in the TAGS study. Table 2.2-1 compares the evaluation ratings presented in the 1988 TAGS FEIS with similar criteria unfavorably rated in the 1976 El Paso Alaska System FEIS.

Between the time of the studies presented in the El Paso Alaska System 1976 FEIS and the TAGS 1988 FEIS, two major changes occurred which influenced selection of the Anderson Bay site. First, during the preparation of the El Paso FEIS and prior to 1980, there were no rigorous Federal siting requirements similar to Part 193 of the DOT's LNG Federal Safety Standards (49 CFR Part 193). These DOT standards, established on February 11, 1980, prescribe siting requirements for thermal radiation protection, flammable vapor-gas dispersion protection, seismic investigation and design forces, flooding (including tsunamis), wind and other severe weather and natural conditions, and adjacent site activities. Yukon Pacific contends that it can meet the requirements of Part 193, as well as meet the industry's consensus standards embodied in the NFPA 59A. Thus, these new standards address and supersede some of the earlier concerns with a site at Anderson Bay.

Secondly, since 1977, the construction and operation of the Alyeska oil terminal and tanker operations have given us a great deal of knowledge and experience which simply did not exist prior to and during the preparation of the El Paso FEIS. Design and construction of the Alyeska facility required extensive site preparation similar to what would be expected at the Anderson Bay site. The location of Alyeska facilities on cut and fill terraces has demonstrated the feasibility of that design/construction concept, although the disposal of the rock and other material remains an issue (see section 2.3.2). Operation of the oil tankers to and from the Alyeska Marine Terminal, along with the use of a VTS, has reduced some of the previous

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2/ The criteria and evaluations conducted by the BLM and the COE are described in detail in appendix C of the TAGS FEIS and incorporated herein by reference.

FIGURE 2.2-1 **Criteria Evaluation Matrix for Proposed TAGS Project and Alternative Locations**

	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 delays	□	⠿	□	□	■	■	■
- Minimize potential threat to national security	□	⠿	□	□	⠿	⠿	⠿
- Maximize availability of gas to Alaska consumers	⠿	▦	⠿	⠿	□	□	□
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	⠿	⠿	▦	⠿	□	□	□
Marine Terminal Criteria							
- 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

SOURCE: TAGS FEIS pages 1-15.

TABLE 2.2-1

Comparison of Suitability Criteria Ratings for Anderson Bay Between El Paso Alaska System and TAGS Projects

El Paso Alaska System a/ FEIS Evaluation	TAGS b/ FEIS Evaluation
Seismic Considerations: Unfavorable due to possibility of seismic damage resulting from slide-induced waves.	Seismic Sea Waves: Favorable because the LNG plant would be located at an elevation higher than the highest recorded tsunami run up wave and no major impacts on onshore structures would be anticipated. Minimize Potential Problems Related to Soils and Geohazards: Favorable because 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.
Topographic Conditions: Unfavorable due to the rugged topographic conditions at the site would require extensive site preparation and disposal of large quantities of spoil material.	Minimize Site Preparation: Moderately favorable because approximately 10 million yards of excavated quantities (after bulking) would be utilized and 5 million yards would require disposal. The site would require a substantial amount of earthwork before construction. Soils are of good quality overlying bedrock, and site preparation would not pose major difficulties. Excess material could be used to develop the construction wharf, off-loading area, construction support, and laydown area.
Anchorage Suitability: Unfavorable due to absence of adequate anchorage.	Maximum Suitability ... of Anchoring Areas: Favorable because a new deep water anchorage has now been established within Prince William Sound for oil and LNG tankers.

a/ El Paso Alaska System FEIS page II and figure 79, page 505.

b/ TAGS FEIS, pages C-30 - C34.

navigational concerns. The Coast Guard does not anticipate VTS problems with the increased LNG tanker traffic (see section 4.15.4).3/ A deep water anchorage is also now available for both oil and LNG tankers in Prince William Sound; such an anchorage area was not available in 1976.

In addition to the above improvements in terms of site acceptability, a number of governmental actions have occurred which limit the scope of the FERC's review of the Anderson Bay site and issues associated with alternative sites other than Anderson Bay. These actions are discussed in section 1.1 of this EIS. Of importance here is the fact that DOE/FE

3/ Coast Guard Marine Safety Office letter dated May 25, 1990 to Coast Guard Commandant.

Order 350 granting Yukon Pacific authorization of the export also concluded that "With respect to the place of exportation for the LNG..., all locations other than Port Valdez, Alaska are rejected." This decision was made after evaluation of alternative sites during preparation of the TAGS EIS, taking into account the Port Valdez site and others evaluated in both the TAGS EIS and the El Paso FEIS. Accordingly, further consideration of alternatives sites is outside the scope of this EIS.

2.3 ALTERNATIVE CONSTRUCTION CAMP AND DISPOSAL PLANS

2.3.1 Alternative Construction Camp Sites

As described earlier in section 2.1.4, the construction period for the Yukon Pacific LNG Project spans 8 years reaching a peak construction workforce of 4,000 people during the fifth and sixth summers. Yukon Pacific proposes to house the majority of this workforce in a camp adjacent to the construction site (figure 2.1.4-3). Using land on both banks of Seven Mile Creek at approximately 100 to 175 feet elevation, 47 acres of forest would be cleared to establish the 30 acres of finished area required to erect the housing modules and ancillary facilities. Contouring the site would require the excavation of 0.175 million cubic yards of material. This site is located far enough distant from the actual construction to afford undisturbed sleeping for offshift workers. To supply the 288,000 gpd of potable water required to support the peak workforce, a 40-foot-high dam is proposed to be constructed on Seven Mile Creek just above the waterfall, creating a 3.5-acre reservoir. With package water treatment and use of a large storage tank, all of the onsite potable water supply needs could be met from this source. The site could be developed without interfering with other construction activities, making the camp available for occupation early in the construction schedule. Our analyses described in section 4.0 determined that development of the work camp at this site would result in environmental impact.

In an effort to minimize environmental disturbance at the Anderson Bay site, four site and three access alternatives were screened to identify reasonable alternatives. These included locations other than Seven Mile Creek but still within the Anderson Bay area (onsite options) as well as one offsite location in Valdez. Factors considered in the initial screening were: the amount of land area disturbed to accommodate the camp; the degree of physical disturbance required to prepare the site (excavation/disposal); the availability of water supply; the worker support (quietness, ease of access); and compatibility with construction needs with respect to scheduling, cost, and logistics.

2.3.1.1 Alternatives Eliminated from Further Consideration and for which Public Comment is Sought

The three alternative camp site locations within the Anderson Bay area are shown on figure 2.3.1-1 and characteristics are described below and summarized in table 2.3.1-1. Based on current information and analysis, we have eliminated these alternatives from further detailed analysis; however, we seek additional public comment and remain open to new information on them.

West Side Anderson Bay

This site is located along the bay 0.5 mile west of the cargo dock area. Due to the terrain, and the spatial requirements of the facilities, the site would be situated at an elevation

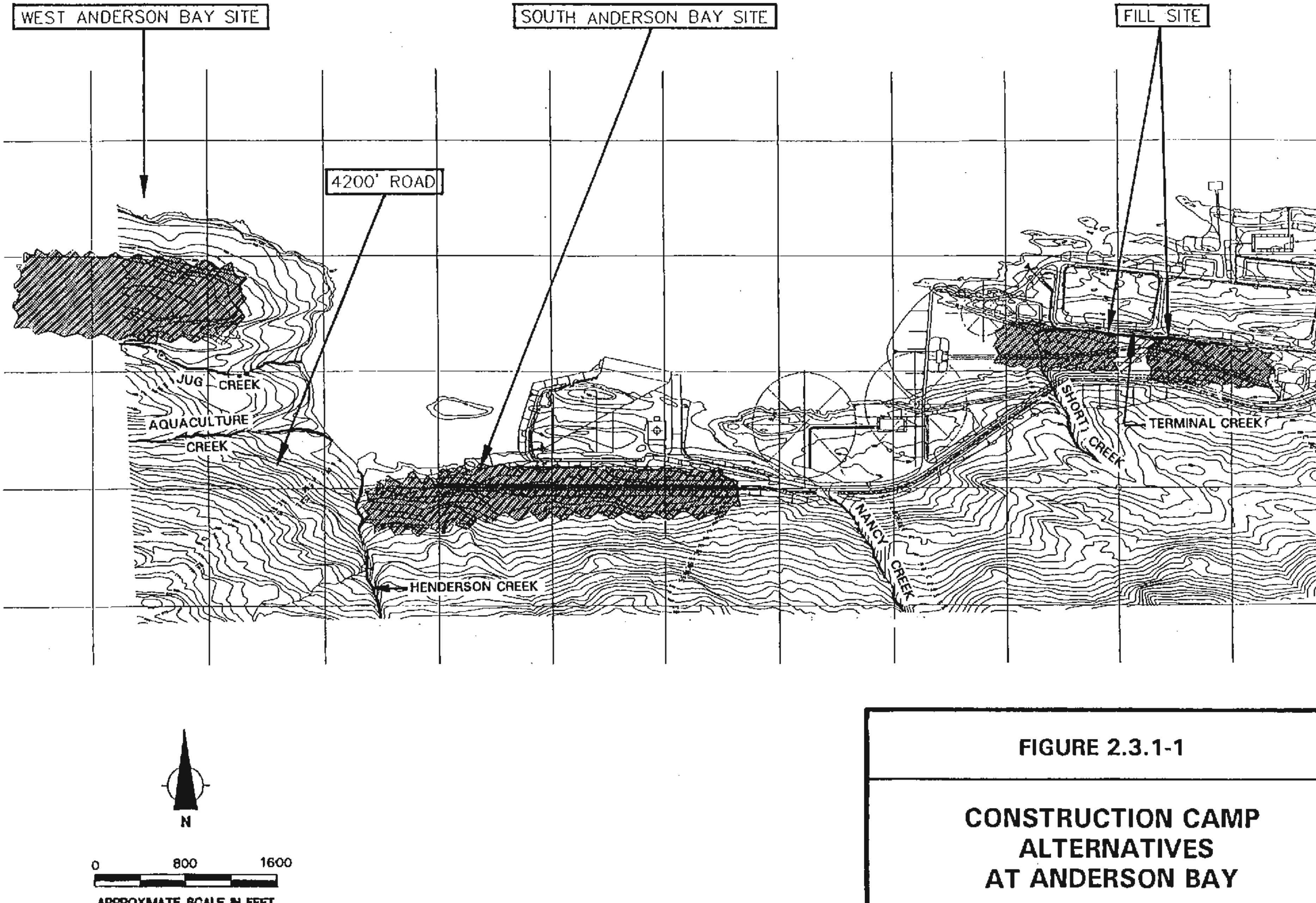


FIGURE 2.3.1-1

CONSTRUCTION CAMP ALTERNATIVES AT ANDERSON BAY

SCALE: AS SHOWN

TABLE 2.3.1-1

Characteristics of Construction Camp Site Access Alternatives for Yukon Pacific LNG Project

Alternative	Site Preparation	Habitat	Worker Satisfaction	Schedule	Water Supply	Engineering	Other
ONSITE OPTIONS							
West Side Anderson Bay	• 60 acres cleared • elevation 250-275 ft, therefore, highly visible away from and higher than plant. • 1.5 million yd³ n* + $25 - 30 million a/	• No direct effect on streams but access road would have to be extended ≥ 2,000 ft and cross Jug, Aquaculture, and Henderson Creeks • 3.5 acres extra clearing for road	• Site quiet (removed from construction) • Site isolated (from community)	Compatible	Local creeks probably insufficient, therefore, barge from Valdez or from Seven Mile Creek and/or desalination needed ($13 million) b/.		
South Side Anderson Bay	• 70 acres cleared • elevation 200 - 250 ft, therefore, visible behind cargo wharf. • 2.5 million yd³ n* + $30 - 35 million a/	No additional stream crossings	• Site far enough removed from construction to be quiet • Site isolated (from community)	Compatible	Some from Nancy Creek but not enough, therefore, barge from Valdez or Seven Mile Creek and/or desalination supplement needed ($13 million) b/.		
Fill Site	• No additional excavation or clearing. • Visually hidden.	No additional impact.	• Noisy location so close to primary construction. • Site isolated	Not compatible with current schedule. Could not be made available for 3 years.	Some available from Nancy Creek but barge from Valdez or from Seven Mile Creek and/or desalination needed ($11 million) b/.	Not feasible due to scheduling	
Seven Mile Creek	• 47 acres cleared • elevation 75 - 200 ft, therefore, would not be particularly distinguishable from the plant.	Seven Mile Creek major impact from need to build dam to supply water. (Reservoir 3.5 acres.)	• Quiet location • Site isolated	Compatible	Available through impoundment of Seven Mile Creek to create storage reservoir ($2 million).	Feasible	

a/ * n = Base cost of preparing Seven Mile Creek site. Yukon Pacific provided other site preparation costs relative to this.

b/ The cost of desalination was calculated by Yukon Pacific to be comparable to barging from Valdez. Barging from Seven Mile Creek would be somewhat less costly. Blasting and excavation makes piping from Seven Mile Creek impractical during first 3 years of site preparation.

TABLE 2.3.1-1 (cont'd)

Alternative	Site Preparation	Habitat	Worker Satisfaction	Schedule	Water Supply	Engineering	Other
OFFSITE OPTIONS							
Valdez Camp with road access within pipeline right-of-way on south side of Alyeska facility	Camp site already available near airport. Expansion possible within existing property.	• No direct effect from camp • New road would consist of 0.4 mile new road joining existing Dayville Road to right-of-way east of Alyeska site (4 acres). • Remaining road would be within proposed right-of-way. Therefore no additional clearing required. • 5 stream crossings (Allison, Unnamed, Sawmill, Salmon, Seven Mile Creeks)	• Time of travel would be about 40 minutes. • Valdez less isolated base. • Max. 40-bus convoy x 3 trips in and 3 trips out/day for 2 shifts. • Risk of landslide/rockfall high (safety issue).	Would require minor adjustment in pipeline construction schedule to prepare the western 5.4 miles of the 796-mile-long pipeline right-of-way in advance.	Town of Valdez can supply with development of new well.	New road south of Alyeska would climb and descend 700 feet in 2 miles, necessitating a > 13 percent average slope. Compliance with AASHTO design criteria not practically achievable.	
Valdez Camp with road access using existing road then to its end in Alyeska property, extended 1 mile to join the proposed pipeline alignment at Sawmill Spit and from there, remain within the right-of-way to Anderson Bay.	Camp site already available near airport.	• No direct effect from camp • 1 mile of off-right-of-way road would require ≤ 9 acres of forest clearing • 3 stream crossings (Sawmill, Salmon, Seven Mile)	• Commuting time half hour • Valdez less isolated base. • Max. 40-bus convoy x 3 trips in and 3 trips out/day.	Would require minor adjustment in pipeline construction schedule to prepare the western 2.0 miles of the 796-mile-long pipeline right-of-way in advance.	Town of Valdez can supply with development of new well.	West of Sawmill Spit the proposed right-of-way is within 75-150 feet elevation with inclines acceptable to bus traffic achievable.	• Potential disruption to Alyeska operations during Yukon Pacific shift changes. • Buses $2.5 million.

a/ * n = Base cost of preparing Seven Mile Creek site. Yukon Pacific provided other site preparation costs relative to this.

b/ The cost of desalination was calculated by Yukon Pacific to be comparable to barging from Valdez. Barging from Seven Mile Creek would be somewhat less costly. Blasting and excavation makes piping from Seven Mile Creek impractical during first 3 years of site preparation.

TABLE 2.3.1-1 (cont'd)

Alternative	Site Preparation	Habitat	Worker Satisfaction	Schedule	Water Supply	Engineering	Other
Valdez Camp with boat access	Camp site already available.	No direct effect from camp	• Minimum 90 minute commuting time each way using 4 dedicated ferries, each making 2 trips per shift change. • Longer shifts and more workers required	Compatible with current schedule.	Town of Valdez can supply with development of new well.	• Logistical problems with staggered shifts. • 20 percent larger workforce required.	• Yukon Pacific projected $400 million extra labor costs. • Ferries $50 million; buses $2.5 million.

a/ * n = Base cost of preparing Seven Mile Creek site. Yukon Pacific provided other site preparation costs relative to this.

b/ The cost of desalination was calculated by Yukon Pacific to be comparable to barging from Valdez. Barging from Seven Mile Creek would be somewhat less costly. Blasting and excavation makes piping from Seven Mile Creek impractical during first 3 years of site preparation.

of 250 to 275 feet MLLW, as compared with the Seven Mile Creek site elevation of 100 to 175 feet MLLW, making it highly visible from the bay. The total area which would have to be disturbed to prepare the site would be 60 acres, most of which is forested and would require clearing. To establish sufficient acreage on the steep terrain would require the excavation of 1.5 million cubic yards of material which would be graded to produce a comparatively flat area for erection of the required buildings. There are no nearby surface waterways with sufficient flow to provide a source for potable water. It would therefore be necessary to barge water to the site from Valdez or from the dam at Seven Mile Creek and/or rely on desalination. Blasting and excavation makes pipe delivery from Seven Mile Creek impractical during the first 3 years of site development. The site is remote from the scene of construction, making it suitably quiet for off-duty workers; however, the transport of workers to the site, would require the construction of about 0.5 mile of road which would have to cross Jug, Aquaculture, and Henderson Creeks and would disturb an additional 3 to 4 acres of land. It is estimated that the site preparation costs would be approximately $25-30 million more than the proposed Seven Mile Creek site. Generally, this site offers no environmental benefits over the proposed Seven Mile Creek site while impacting more acreage for site and access development. As a result, we have eliminated this site from further consideration.

South Side of Anderson Bay

The South Side site is situated behind the cargo dock and extends west as far as Henderson Creek. It is far enough away from the construction activity to allow undisturbed sleeping for offshift workers; however, the very steep terrain would necessitate the excavation of 2.5 million cubic yards of material and the disturbance of 70 acres of predominantly forested land to create a suitable area (30 acres). Some natural water is available but the majority of the required potable water supply would have to be barged in from Valdez or from the proposed dam on Seven Mile Creek or provided by desalination. This site is at an elevation of 200 to 250 feet MLLW, well above the height of the cargo dock and Seven Mile Creek site and therefore more visible. Schedule-wise, it could be developed immediately upon the commencement of construction to be available early in the construction sequence. It is estimated that the site preparation costs would be approximately $30-35 million more than the proposed Seven Mile Creek site. For the same reasons that the West Side site was eliminated this site was also eliminated from further consideration.

Fill Site

A third alternative location for a work camp is on the fill area created by the disposal of excess excavated rock. There are three significant disadvantages of this site. First, the fill required to create the site would be generated as a result of excavation to establish the bedrock benches on which the plant structures would be erected. The filling process would not be complete, and the site therefore not ready for camp installation, until the summer of the third construction year. This would then necessitate housing workers at another location as an interim measure. Second, once the camp was established, offshift workers would be exposed to construction noise associated with the erection and installation of nearby storage tanks and LNG process trains. Third, part of the 28-acre site area would be devoted to storage and laydown space during the later 5 years of project construction. Also, there would be no natural water source at this onsite location, and all water would be barged from Valdez or from the proposed dam on Seven Mile Creek or provided through desalination. As the site is manmade fill, however, there would be no requirement for additional excavation or vegetation removal.

This site is at a low elevation (75 to 100 feet MLLW but high enough to be above the design wave (100-year tsunami- runup 75 feet).

In examining these onsite options, it was clear that the Fill Site was impractical from a scheduling point of view and was not sensitive to worker needs. The remaining two options (South and West Anderson Bay) were found to be feasible but environmentally more disturbing (extensive amounts of excavation/disposal and clearing necessitated by the topographic configuration). All three of these onsite options were eliminated from further consideration as they offered no environmental advantages over the proposed Seven Mile Creek site.

Valdez Camp Site with Boat Access

The option of housing workers at the Valdez camp site and transporting them to Anderson Bay by water was considered. In this scenario workers would be bused from the camp to the dock in the City of Valdez where they would load onto 1 of 4 dedicated passenger vessels, each capable of carrying 250 persons. During the peak of construction this would necessitate each vessel making two trips per shift. Yukon Pacific estimates the "door to door" travel time to be 90 to 135 minutes each way. This would necessitate longer work days for the workers, and a 20 percent larger workforce to maintain schedule. Yukon Pacific estimated that labor costs would increase by $400 million (4 hours/day x total job work days x $55 time and one-half labor rate). However, this additional cost would be partially offset by avoiding the cost of constructing a totally new camp site at Seven Mile Creek.

The staff, however, is more concerned with the practicality of this alternative and the logistics involved with transporting workers using both boats and buses versus a camp site (Seven Mile Creek) which is physically located onsite. At present, we cannot conclude that the marine/land transportation logistics over an 8-year construction period is a reasonable alternative. However, we wish to remain open on this issue. Public comment is specifically sought on this camp site issue, along with specific documentation as to the appropriateness and feasibility of this camp site, and any other environmental or engineering factors, versus the proposed Seven Mile Creek site.

Valdez Camp Site with Road Access South of Alyeska Terminal

An all-road option for transporting workers from the Valdez Camp Site, while avoiding the operational area of the Alyeska Marine Terminal is the South Access Road. This alternative would follow the existing public access road (Dayville Road) from Valdez to a point 0.5 mile east of the Alyeska eastern property line and connect with the proposed TAGS pipeline right-of-way to the south (see figure 2.3.1-2). This new connector road would be about 0.4 mile in length. The south access road alternative in concept would then follow the right-of-way of the proposed TAGS pipeline for 5.4 miles to the Anderson Bay Site.

The elevation at the east terminus is about 200 feet. Proceeding west, the topography becomes very steep with the pipeline right-of-way rising about 700 feet over the next mile. This represents an average grade of more than 13 percent. Subsequently, it drops back to 300 feet elevation in a distance of 5,000 feet (12 percent slope) and continues to drop to less than 100 feet by the time it reaches Sawmill Spit. From this point west to where it crosses Seven Mile Creek (west terminus), the pipeline right-of-way generally follows the shoreline and remains comparatively level. The right-of-way crosses Allison Creek, an unnamed creek aligned with the approximate center of the Alyeska site, Sawmill Creek (a mile upstream from the

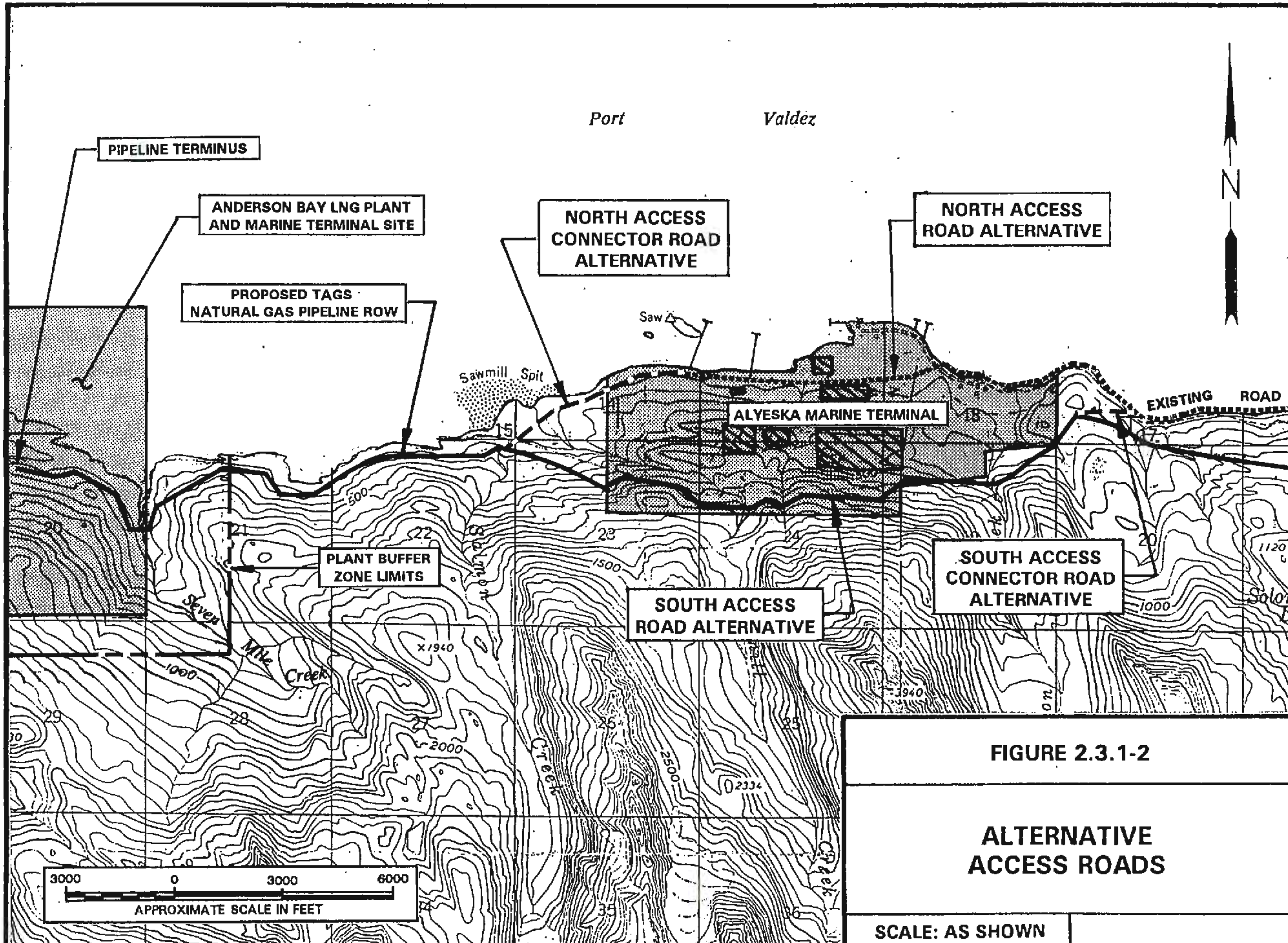


FIGURE 2.3.1-2

ALTERNATIVE ACCESS ROADS

SCALE: AS SHOWN

mouth), Salmon Creek (500 feet upstream from its exit into Sawmill Spit), and Seven Mile Creek.

The construction of pipelines in severe/steep terrain differs significantly from highway construction in the same area. Pipelines are commonly routed across the contour line to minimize side cut requirements and reduce environmental disturbance. Slopes of more than 40 percent grade have been constructed in this manner. Further, a right-of-way is only prepared as necessary to accommodate side booms and provide transit of slow-moving wheeled and tracked equipment. Based on discussions with the Alaska Department of Transportation (DOT) and Alyeska, the use of the TAGS right-of-way as a road alignment, because of the extreme terrain, appears to be highly questionable from a technical point of view (Tooley, 1993; Jenson, 1993).

The Alaska DOT uses the American Association of State Highway and Transportation Officials (AASHTO) 1990 Design "Green Book" entitled Geometric Design for Streets, with supplement by the State of Alaska Preconstruction Manual. These design manuals specify recommended design geometry based on road purpose and Average Daily Traffic, although local government design standards may apply as well. Among other design parameters, the Alaska DOT tries to ensure road grades of less than 7 percent. Yukon Pacific, if it were to construct a road for private use, is not legally bound by this design specification, but would probably not deviate from it for reasons of liability, particularly since the road would be used primarily for worker movements. To achieve grades of this order in the topography south of the Alyeska Marine Terminal would necessitate major switchbacking and sidecutting into the slopes. Conversely, it is preferable to make a direct traverse of steep slopes while avoiding side slopes in routing and constructing a pipeline. The eventual road length would be considerably longer than the direct pipeline route distance of 5.5 miles and the cuts would be highly visible at the elevations required.

Of equal practical concern is maintenance. Precipitation in the Valdez area is quite high but rates are significantly higher with even small increases in elevation. Alyeska never designs steep roads in its terminal area because of the problems it has experienced with heavy rain erosion, snow removal, and excessive icing. This road alignment option, because of its elevation, would be susceptible to very high precipitation necessitating grades even less than the 7 percent design. It is also likely that load design would be double what Alyeska already uses and perhaps four times the Alaska DOT standard of 100 pounds per square foot. This has major excavation, filling, and slope reinforcement implications.

These factors, combined with the high risk of rock slide and avalanche, with associated safety risks for workers, eliminated this alternative from further consideration.

2.3.1.2 Alternatives Retained

Valdez Camp Site with Road Access Through the Alyeska Terminal

Based on our screening analysis, the only alternative considered to be reasonable, was that of using the commercial camp in Valdez and accessing the Anderson Bay site via a road through the Alyeska Marine Terminal property. The existing camp facility at Valdez is located near the airport (figure 2.1.4-2), is privately owned, and is well established. It was developed to its current size to serve the workforce associated with cleanup of the Exxon Valdez oil spill and continues to be used for projects in the Valdez area. The camp facility has 700 beds and is expandable to 4,000 beds without occupying any additional property. The camp uses City of Valdez utilities for water and sewer. Although the sewer system has sufficient capacity to handle the added burden, a new water well would have to be drilled to provide the added water capacity. Since the camp already exists, it would be available for immediate use at the commencement of construction with expansion of the facilities being scheduled on an as-required basis.

Transportation of workers from the Valdez camp to the Anderson Bay site could be accomplished over land by passing through the Alyeska property. This access road alternative would involve the use of the existing Dayville Road from Valdez to where it ends at the Alyeska security gates. The access road would then follow the existing main road through the marine terminal to a point approximately 0.4 mile east of the western property line. From that point, it would continue west 0.6 mile to connect with the proposed pipeline right-of-way near Sawmill Spit (figure 2.1.4-2). The additional new road requirement to reach the pipeline right-of-way would be about 1 mile. Assuming that a 75-foot-width would be disturbed in establishing the 40-foot road bed, the total land disturbance would approximately 9 acres. An additional 2.0 miles of road would have to be constructed within the proposed pipeline right-of-way. Unlike the south access road alternative, the final 2 miles of pipeline right-of-way are in relatively level terrain which could be developed to accommodate vehicular traffic. The pipeline construction right-of-way would be wide enough to accommodate the access road without additional clearing. The total 3.0-mile-long new access road would cross Sawmill, Salmon, and Seven Mile Creeks to reach the construction site. It would require an adjustment to the currently proposed construction schedule to allow the southern 2.5 miles of the TAGS pipeline right-of-way to be constructed in advance.

The largest obstacles to this alternative would be the potential disruption to Alyeska's operations during Yukon Pacific's shift changes and the potential impact on security within Alyeska proper, a matter which Alyeska takes very seriously. There are also legal and other institutional questions which would have to be resolved with respect to requiring Alyeska to grant access through its property and compensation. None of these latter issues have been addressed by any of the parties and the FERC staff is seeking specific comments concerning these issues, particularly from Alyeska.

Compounding this issue is a requirement both within the DOT LNG siting regulations and the National Fire Protection Association (NFPA) Standards for LNG Facilities—NFPA 59A—for emergency access to the plant. Specifically, 49 CFR Part 193.2055 in Subpart B - Siting Requirements requires in part:

> ...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. (emphasis added)

Plant access is also addressed in NFPA 59A. Under Section 2-2.1:

(b) Accessibility to plant; at least one **all-weather vehicular road** shall be provided. (emphasis added)

The principal reliance on waterborne transportation for emergency evacuation of personnel and for access of medical and emergency personnel and equipment raises questions on compliance with the **all-weather vehicular road** requirement in NFPA 59A, as well as the ability of waterborne access to meet the **ease of access** requirement in Part 193.2055.

Another advantage of an all-weather vehicular access road connecting the Alyeska and Yukon Pacific Terminals is that it would enable both facilities to "pool" their mobile fire fighting equipment and provide mutual aid in the event of a serious incident at either facility.

The staff notes here that the necessity for an all-weather access road through the Alyeska Marine Terminal during the operational phase of the Yukon Pacific Terminal does not necessarily justify its use as a commuter road during the construction phase for the Yukon Pacific pipeline and LNG Terminal, i.e., the later need for an all-weather vehicular road for operational emergencies does not alone justify the Valdez Camp Site alternative with a road through Alyeska. Access/egress of emergency equipment through Alyeska, perhaps once or twice a year, is far less intrusive than 8 years of up to six daily transits of bus convoys during construction. However, we are seeking serious comments from those who would be affected and from anyone else who can provide constructive ideas. The staff also hopes to meet with Alyeska and to discuss these issues further in the FEIS.

2.3.2 Alternative Disposal Sites

Developing the Anderson Bay site to accommodate the LNG plant and marine terminal would involve major rock excavation and disposal activities. The excavation and disposal volumes are presented in table 2.3.2-1. Based on rough grading estimates, Yukon Pacific has calculated that approximately 3,018,000 cubic yards of overburden and 6,655,000 cubic yards of rock would require excavation in order to be able to site all critical facilities on bedrock. Of these volumes, 5,920,000 cubic yards of rock would be used for structural fill onsite and 735,000 cubic yards of rock and 3,018,000 cubic yards of overburden would require disposal.

Approximately 396,000 cubic yards of this overburden material would be disposed of in the cargo dock area, since it is estimated that the overburden generated from the excavation of the cargo dock area is expected to be composed primarily of weathered rock with a minimal organic component. The remaining 2,622,000 cubic yards of overburden material and 735,000 cubic yards of rock would require disposal in a separate disposal area.

The overburden material, the natural materials that overlay sound bedrock, includes organic soils, stumps, roots, till, and broken or weathered rock. The percentage of organic material that makes up the overburden will vary considerably at the site since parts of the site consist of steep rocky ridges with little or no organic component, while other parts of the site consist of glacial troughs, which geotechnical bore holes have indicated contain sediments as thick as 20 feet. These sediments consist of organic soils, unconsolidated sediments, and glacial tills. Based on air photo analyses, geologic mapping, and drilling, the overburden material from the site has been estimated to consist of up to approximately 50 percent organic materials. Since the organic soils at the site are generally very thin, tree roots often extend into the upper, weathered and broken rock layers. Stripping of the organics would therefore include most if not all of the broken and loose bedrock.

TABLE 2.3.2-1

Summary of LNG Plant Site Excavation and Disposal Volumes

	Excavation Material Generated (cubic yards) Overburden	Rock	Structural Rock Fill Required (cubic yards)
Plant Site	2,520,000	5,720,000	4,300,000
Cargo Dock	396,000	803,000	1,400,000
Construction Facilities	102,000	132,000	220,000
	3,018,000	6,655,000	5,920,000

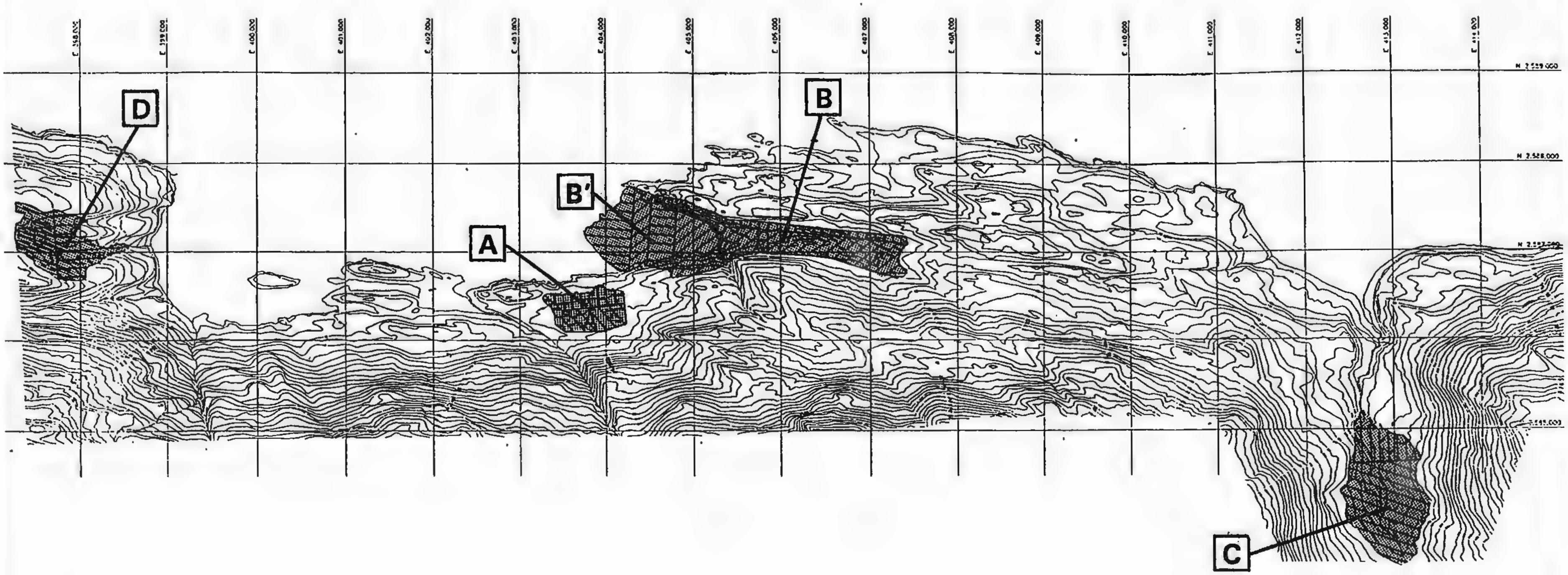
Material Requiring Disposal	Rock	735,000
	Overburden	3,018,000 a/

a/ Approximately 396,000 cubic yards of this overburden material would be disposed of in the cargo dock area, where it was excavated.

Yukon Pacific identified six potential locations for disposal of waste excavation materials (see figure 2.3.2-1). The storage volumes of these areas were calculated using areal and contour data, assuming that the area would be filled to a level at or below the surrounding elevations (Eliason, 1993b). Height was limited to conform with adjacent benches. Four of these sites are located on land and either within or in relatively close proximity to the site boundaries. A fifth site (the proposed disposal site) uses area both on land and in the east end of Anderson Bay. The sixth disposal alternative evaluated utilized a deep water disposal location situated between 0.5 and 1.0 mile out into Port Valdez. Since four of these alternative disposal sites are too limited in storage capacity to contain the entire volume of waste material requiring disposal, we also evaluated the potential for using a combination of several sites, including a deep water disposal of clean rock combined with the use of two onshore sites for disposal of the overburden. Finally we evaluated, as a disposal alternative, using the completed disposal Site B' for the construction of the proposed cargo dock facilities to reduce the overall impact on the shoreline area of Anderson Bay.

The primary criteria used by Yukon Pacific to evaluate the alternative disposal sites included the following considerations:

- Maximize the accessibility to the disposal site from the main areas where excavated materials would be produced;
- Minimize the spoil haul distance;
- Provide adequate capacity to handle the volume of spoil material produced;
- Minimize the use of shoreline and tidal areas;



- KEY -

AREA	VOLUME (cuyds x 10^6)
A	0.25
B	0.47
B' (Includes Site B)	3.88
C	1.62
D	1.01

N

0 1000 2000 3000
APPROXIMATE SCALE IN FEET

FIGURE 2.3.2-1

ALTERNATIVE SPOIL DISPOSAL SITES

SCALE: AS SHOWN

- Maximize the efficiency of disposal (disposal rate) by minimizing the total footprint of the disposal sites;
- Minimize the cost of spoil disposal;
- Try to avoid the development of new areas located offsite and the potential for construction of additional haul roads;
- Avoid impacts on existing surface waters;
- Minimize the potential interference between spoil disposal activities and site location and the temporary and permanent facilities.

Other less critical criteria included:

- Minimize the hauling of spoil material up hill;
- Maximize the use of the disposal area for temporary staging and material laydown storage.

The site characteristics and advantages and disadvantages for each of the alternative disposal sites are presented in table 2.3.2-2.

Site A

Site A is relatively small, with an overall storage capacity of only 250,000 cubic yards. It is located within the site boundaries on a hillside in an upland area between Nancy Creek and Short Creek. This site has a number of advantages, including its potential low cost of disposal, its onsite location, its proximity to the construction area, and potential use for staging or laydown during construction. The primary disadvantage of this site is that its storage capacity is insufficient for the amount of material to be disposed of during construction. Even if used in combination with Site B, there would be insufficient capacity to accept the volumes requiring disposal. This low storage capacity, combined with the relatively large size, leads to an inefficient use of space on the site plan.

Site B

Site B is located entirely on land and is situated to the east of Anderson Bay, in a glacial trough between two rock ridges. Because it is also located directly south of the LNG storage tank platform, it would also be in close proximity to the excavation areas, providing easy access with short haul distances. The close proximity would also result in the lowest cost per cubic yard of disposal material and a potential for use as additional staging or storage area during construction. Similar to Site A, however, its major disadvantage is its limited capacity. By itself, it could store less than 18 percent of the total volume of overburden material which requires disposal. Because of its small storage capacity, but relatively large surface area (18.2 acres) it has a very low disposal rate which is an indication of inefficient use of space.

TABLE 2.3.2-2

Alternative Disposal Site Characteristics

Alternative Disposal Sites	Spoil Capacity (yd^3)	Surface Area (acres)	Haul Distance (feet)	Cost/yd^3 Fill (dollars)	Disposal Rate a/ (yd^3/acre footprint)	Advantages	Disadvantages
Site A	250,000	8.6	4,800	7.80	29,070	• located entirely on land • located entirely within site boundaries • can be used for staging and material storage area • low cost/cubic yard	• insufficient storage capacity • low disposal rate per acre footprint • could interfere with concrete batch plant operation at Site A
Site B	470,000	18.2	2,300	7.45	25,824	• located entirely on land • located entirely within site boundaries • easy access to site • can be used for staging and material storage area • low cost/cubic yard	• insufficient storage capacity • low disposal rate per acre footprint
Site B′	3,880,000	42.1	4,000	7.70	92,162	• sufficient capacity to hold all spoil • easy access to site • can be used for additional staging and material storage area • high disposal rate per acre footprint	• partially located on water • requires filling of 16.9 acres of east end of Anderson Bay • loss of intertidal and subtidal wetland areas
Site C	1,620,000	24.6	5,800	9.35	65,854	• located entirely on land • high disposal rate per acre footprint	• insufficient storage capacity • long haul distance • would require construction of additional access road • requires uphill hauling • impact on Seven Mile Creek • high cost/cubic yard • impact on water impoundment on Seven Mile Creek (siltation/turbidity)

TABLE 2.3.2-2 (cont'd)

Alternative Disposal Sites	Spoil Capacity (yd^3)	Surface Area (acres)	Haul Distance (feet)	Cost/yd^3 Fill (dollars)	Disposal Rate a/ (yd^3/acre footprint)	Advantages	Disadvantages
Site D	1,010,000	13.8	11,600	16.85	73,188	• located entirely on land • high disposal rate per acre footprint	• insufficient storage capacity • located off-site • difficult access, requires construction of off-site road over difficult terrain • requires uphill hauling • impact on Aquaculture Creek • high cost/cubic yard • requires additional clearing and development of 13.8 acres outside site boundaries
Offshore Site	Unlimited	N/A	4,000/ 0.5 mile b/	11.90	N/A	• sufficient storage capacity • does not require fill placement near shore • short haul distance to barge	• requires construction of barge loading facility • has high potential for disruption and delay of earthwork activities due to bottleneck at barge loading facility, especially during bad weather • water quality problems during disposal of organic component of overburden • floating organic materials would litter surface of Port Valdez • high cost/cubic yard
Combination Sites A, B, and Offshore c/	720,000 overburden, unlimited for rock	26.8 land surface	4,800	7.45 - 11.90	26,865	• located partially on land • can be used for staging and material storage • unlimited rock disposal • would not fill intertidal or shoreline areas • easy access to site for land portion	• insufficient storage capacity for organic overburden component • low disposal rate per acre footprint for overburden component • could interfere with concrete batch plant operation at Site A • requires construction of barge loading facility

TABLE 2.3.2-2 (cont'd)

Alternative Disposal Sites	Spoil Capacity (yd^3)	Surface Area (acres)	Haul Distance (feet)	Cost/yd^3 Fill (dollars)	Disposal Rate a/ (yd^3/acre footprint)	Advantages	Disadvantages
Cargo Dock Located at Site B′	3,880,000(+)	42.1(+)	4,000		92,162(+)	• would avoid construction of the proposed cargo dock area and associated 12 acres of intertidal wetland • would reduce overall size of the LNG plant site	• insufficient room at Site B′ for entire cargo dock and area components without substantial additional filling and grading • would require additional construction quality rock be excavated to add to overburden component to make suitable for dock area • excavation schedule (3 years) would prohibit Site B′ and therefore cargo dock from being filled and completed, respectively. Therefore a substantial delay in use of the cargo dock.

a/ Indicates disposal efficiency per site. The higher the number of cubic yards per acre footprint, the more efficient the site is for spoil disposal.
b/ 4,000 feet to barge area, up to 0.5 mile barge distance into Port Valdez.
c/ Offshore disposal would include clean rock only.

Because of their small size, Sites A and B, even if combined, would not offer the capacity required to store the amount of fill material generated by the proposed grading activities. Consequently these sites, either by themselves or used together, were eliminated from further consideration as alternative spoil disposal areas.

Site B'

Site B' is an extension of Site B and is the site proposed for use by Yukon Pacific. It utilizes Site B in entirety but extends further to the west into the east end of Anderson Bay. This site would be built in two stages, B first and then B' extension, and would utilize a combination of two rock dikes: a small dike built across the west end of Site B along the existing shore of Anderson Bay, and the second, larger one built also across the eastern portion of Anderson Bay (see figure 2.3.2-1). The second dike could not be constructed until after some of the overburden is stripped from the site and excess blast rock becomes available. The dikes would function to retain the spoil material and prevent it from mixing with the waters of Anderson Bay. The primary advantage of using this site is its large capacity (3.88 millon cubic yards) which exceeds the estimated spoil volumes. Site B' is close to the excavation areas, and would provide easy access for spoil disposal, and like Site B, would provide a relatively large, flat surface that would be used during the last 5 years of construction for staging and laydown space. Because it has a large capacity relative to its surface area (42.1 acres), it has a very high disposal rate and therefore would be very efficient to use.

Its major disadvantage is that it would require the filling of 16.9 acres of Anderson Bay. Although this area is relatively deep water, it has been delineated to consist entirely of intertidal and subtidal wetlands (see figure 3.4.2-1, polygons 3, 49, and 50). It would also result in the loss of the associated shoreline habitat currently surrounding the east end of Anderson Bay. It should be noted, however, that Yukon Pacific has proposed to grade down and stabilize the entire shoreline on the site, which presumably would include this area even if it weren't used for spoil disposal (see section 4.10).

Site C

Site C would be located in the lower drainage basin of Seven Mile Creek approximately 1,000 feet upstream from where the creek enters Port Valdez. Because the Seven Mile Creek valley has fairly steep sides, a large amount of spoil (1.62 million cubic yards) could be disposed of in a fairly small area (24.6 acres). Although this results in a comparatively high disposal rate per acre footprint, this site would have several significant disadvantages. Seven Mile Creek would have to be rerouted during construction and filling of the area and then reestablished across the surface of the spoil fill after construction is completed. This is likely to cause unstable conditions and high levels of erosion, resulting in increased levels of sedimentation downstream of the fill site and, most significantly, in the intertidal confluence area of the stream and Anderson Bay where pink salmon are known to spawn. Although Yukon Pacific has also proposed to construct a water supply impoundment on Seven Mile Creek downstream of this site, which could result in sedimentation and increased turbidity levels, we have recommended protection procedures during the construction and operation of these facilities that would mitigate impacts related to both water quality and reduced flows. We do not believe that the impacts on Seven Mile Creek that would result from the use of this area for spoil storage could be mitigated.

Other disadvantages to using this site relate to its location away from the main area of construction. To use this area for disposal, a fairly long, new construction haul road would have to be built to provide access. This would traverse steep grades that could make transportation of spoil both difficult and time consuming, especially during bad weather conditions. Finally, the site's 1.62 million cubic yard capacity is insufficient to contain all of the spoil generated during construction. Its small capacity and the potential to severely impact Seven Mile Creek caused this site to be eliminated from further consideration as an alternative disposal area, either alone or in combination with any other site(s).

Site D

Site D is located approximately 400 feet to the west of Anderson Bay in the valley formed by Aquaculture Creek. It is completely outside the boundaries of the proposed LNG plant site. Although Site D offers storage efficiency (1.01 million cubic yards in 13.8 acres), it still has insufficient capacity to store all the materials produced during excavation. Other disadvantages of using this site include the need to construct a new access road over approximately 1 mile of rough and steep terrain that would be located outside of the affected area of the plant site. In addition to increasing the cost of disposal beyond an acceptable limit, the disposal site and the road construction would require the additional clearing and development of approximately 17.3 acres (disposal site plus road) outside the site boundaries.

Development of Site D would also impact Aquaculture Creek. The streambed would have to be relocated during construction and reestablished after construction on top of the spoil fill, potentially resulting in increased erosion and water quality problems in Anderson Bay. For these reasons, this site was also eliminated from further consideration as a potential disposal site.

Offshore Site

This option for disposal of spoil materials in the deep waters of Port Valdez would involve the construction of a barge loading facility along the shore on the east end of Anderson Bay near Sites A and B. Material would be brought to the barging area, loaded onto barges, and taken from between 0.5 and 1.0 mile off shore. It would then be dumped into the port for disposal in waters between 600 and 700 feet deep. The advantages of this option is that there is an unlimited deep water storage capacity and it would represent a relatively short haul distance from the excavation area to the barge loading platform.

The offshore disposal option may cause the disruption or delay of grading activities due to potential delays caused by bottlenecking during the barge loading activities. This is likely to occur if spoil material is generated faster than it can be loaded onto the barges for disposal. If stockpiling is required, then additional space would be needed and the spoil materials would have to be handled more than once. To construct the barge loading slips and facilities, Yukon Pacific (Eliason, 1993a) has indicated that some amount of shoreline along Anderson Bay would require grading and possibly filling to construct the docks and barge loading facilities.

There are several key disadvantages of this alternative. First, all spoil materials, including the organic component of the overburden, would be disposed in Port Valdez. Discussions with the NMFS (Hanson, 1993) have indicated that the dumping of large volumes of organic materials (e.g., tree stumps, roots, mosses, slash) into Port Valdez may not be acceptable since it would be in an uncontained site and would probably result in increased turbidity, sedimentation, and floating materials on the surface of the waters of Port Valdez. This could affect fisheries, benthos, and plankton communities throughout the water column. Second, disposal of material into the Port would be regulated under the jurisdiction of the COE (Section 404 and Section 10), under the State of Alaska (Section 401), and under EPA's Ocean Disposal Discharge and Site Selection Criteria (40 CFR, Parts 227 and 228). The EPA has indicated (EPA, 1993b) that the disposal of the organic portion of the waste materials into Port Valdez would not be acceptable and that disposal of any other materials (i.e., waste rock) within 3 miles of the shoreline would have to meet the Ocean Disposal Criteria (Comerci, 1993; Barton, 1993). We conclude that offshore disposal for <u>all</u> excavated spoils is not a reasonable alternative, considering the regulatory requirements.

Combination of Sites A, B, and Offshore

In order to avoid the dumping of organic materials into the waters of Port Valdez, we assessed a disposal option that utilized a combination of three of the alternative sites discussed above. This option involves the separation of the organic component from the overburden material and disposing of it in a combination of Sites A and B. Both these sites are located entirely on shore and would not affect any previously unaffected surface waters. The mineral and rock component of the remaining spoil material would then be barged offshore for deep water disposal during an acceptable disposal window, assuming that the EPA Ocean Disposal Criteria can be complied with and necessary permits obtained.

This alternative would have the advantages of reducing the potential for water quality impacts in Port Valdez, but would still have several significant disadvantages. Most significant is the fact that there is only enough combined spoil capacity in both Sites A and B for approximately 27 percent of the total overburden material. Assuming that it would be possible to segregate the organic component from the rock component of the overburden during grading activities, and that 50 percent of the overburden (1.3 million cubic yards) consisted of organic materials, there would still remain a considerable amount of organic material (591,000 cubic yards) requiring offshore disposal once the combined storage capacity (720,000 cubic yards) of Sites A and B had been used. This would result in the same type of water quality impacts discussed above under the offshore site, but to a slightly lesser extent due to the lower volume of organic material. As discussed earlier, the EPA has indicated that the disposal of organic material into Port Valdez is not an acceptable alternative.

Additionally, if the filled Sites A and B are to be used as storage or laydown areas during construction or operation, then the fill component could not consist entirely of organic materials, but would have to be mixed with a percentage of rock to increase the fill's structural integrity. This could further reduce the overall volume of organic material that could be stored in Sites A and B and increase the volume of organic material disposed in the Port. Other disadvantages of this alternative are similar to the ones discussed for the offshore disposal site, including the need to construct a barge loading facility along the shoreline of Anderson Bay and the potential for barge loading activities to delay grading and construction activities.

Cargo Dock Located at Site B'

The last alternative we evaluated was that of locating the proposed cargo dock facilities at the disposal Site B', thus eliminating the need to fill 12 acres of intertidal wetland in the area adjacent to the outlet of Nancy Creek. Although the construction of the cargo dock area would result in the generation of 1,199,000 cubic yards of rock and overburden material, all of this would be used in the construction of the cargo dock facility and would consequently not affect the overall net quantities of material requiring disposal from the LNG plant site. This alternative was considered for several other reasons. Yukon Pacific has indicated that Site B', once filled and completed, would be used only during construction as staging and material storage areas. The 42.1 acres of filled area, including 16.9 acres of Anderson Bay, has little functional value to the operation of the LNG facility. The most obvious reason for considering this alternative was to avoid the construction of a separate cargo dock area with its associated impacts on the shoreline of Anderson Bay, while reducing the overall size of the LNG plant site.

There are several disadvantages associated with this alternative that severely limit its feasibility. Most significant is that the excavation for development of the LNG site is scheduled to take up to 3 years to complete. Since Site B' would be used for all excavated spoil material, it would not be completely filled until at least 3 years into the project, with the offshore portion in East Anderson Bay filled last, after the overburden is stripped and blast rock becomes available to build the offshore dike (see description of Site B'). The cargo dock, however, must be in place and operational within the first year of construction in order to bring in materials and equipment used during initial clearing, grading, excavation, and construction of the remainder of the site. The question was raised during discussions with the EPA (EPA, 1993b) regarding the feasibility of utilizing a construction access road to the site for transport of construction equipment, prior to site excavation, thus potentially eliminating the need for a cargo dock. Although construction equipment could potentially be driven to the site via an access road, a cargo dock would still be required to be constructed for transport of the many oversized LNG plant process components, and skid-mounted equipment modules, which are too large for overland transport. As discussed in sections 2.3.1, 4.16, and 5.2.2, we are still investigating the potential construction and use of an access road which would pass through the Alyeska Marine Terminal. At this time and until we can further investigate the feasibility of an access road and the potential impacts associated with its construction and operation, we have considered its use only for the transport of construction workers.

Other disadvantages associated with using Site B' as a cargo dock site is that there would be insufficient area at Site B' as it is presently designed to contain the facilities proposed to be located within the 23-acre cargo dock area (see section 2.1.2.2). These include the 600-foot-long wharf with 100-foot-wide roll-on/roll-off ramp, ferry docking facilities, passenger terminal building, construction offices, diesel refueling, concrete batch plant, and laydown and storage areas for bulk materials (e.g., aggregate) and supplies. Site B' would also require substantial additional filling and grading, particularly along the new shoreline to Anderson Bay, where the dock would be located. The orientation of the dock structure, instead of being parallel to the shoreline, would at this location be perpendicular to the shoreline. This would make the approach and departure to the docks by the numerous cargo ships more difficult, time consuming, and possibly less safe navigationally.

In order to be used as a cargo dock with all of the associated facilities constructed on top of it, the percentage of rock used in the fill at this location would have to be high enough to ensure the necessary compaction and stabilization of the soils. This could require adding additional amounts of rock to the fill material, depending on the final composition of the fill material used at this site. Finally, the flat space provided by the fill at Site B' would be used as storage and laydown space during the latter 5 years of project construction.

While we recognize the alleged constraints associated with the schedule of excavation of the site and the completion of filling of Site B′, in addition to the other disadvantages discussed above, the superior environmental benefits of this alternative, when compared with the filling of 12 acres of intertidal wetlands associated with the proposed construction dock cannot be summarily dismissed. **Therefore, we recommend that Yukon Pacific provide a revised site grading and construction plan reflecting the use of Site B′ for the construction dock. Yukon Pacific should file this plan during the comment period for this DEIS so it can be presented in the FEIS.**

2.4 NO-ACTION OR POSTPONED ACTION

The Commission has basically three options available to it in processing a certificate of public convenience and necessity. It can: 1) grant the certificate with or without conditions; 2) deny the certificate; or 3) postpone action pending further study.

The Place of Export and the proposed facilities are the final link of the TAGS Project to export North Slope gas to markets in Pacific Rim countries. If the Commission were to deny the Yukon Pacific LNG project application for Place of Export, the entire TAGS Project, including the pipeline, could not be built.

If the proposed action does not proceed, the impacts on the environment resulting from construction and operation of the liquefaction and transport facilities and tanker movement described in subsequent chapters would not occur.

3.0 AFFECTED ENVIRONMENT

3.1 GEOLOGY AND SOILS

Port Valdez is an east-west trending fjord approximately 14 miles long and 3 miles wide surrounded by the glaciated Chugach Mountains. Local peaks attain heights greater than 2,600 feet. Bedrock along the fjord is metamorphosed sedimentary and volcanic rocks of the Valdez Group (Nelson et al., 1985). The sedimentary rocks are predominantly interbedded sandstone and siltstone. Metamorphism has produced additional foliation approximately parallel to the bedding planes. These bedding planes and foliation form horizons of weakness along which the rock layers can separate. The bedding and foliation planes run east-west and dip fairly steeply to the north.

Surficial deposits in Port Valdez are predominantly related to Pleistocene deglaciation as well as subsequent erosion and sedimentation. Glacial deposits in the vicinity of Anderson Bay are predominantly till. These deposits have been reworked since deglaciation by minor slope processes and small streams. Glacial retreat within the fjord waters also deposited a variety of till and fine-grained sediment which blankets the submarine portions of the port, including the steep sideslopes.

Anderson Bay is relatively shallow and underlain by bedrock so that its slopes are fairly stable. At Shoup Bay, across Port Valdez to the north-northwest of Anderson Bay, the Shoup Glacier stabilized forming a large moraine that partially blocks the mouth of the bay. Shoup Bay is much shallower than Port Valdez; consequently, the slope from the moraine to the bottom of the port is quite steep. The loose morainal debris and other deposits on the steep slopes of Port Valdez have the potential to slump, producing underwater landslides. In Port Valdez, such slumping has been caused by earthquakes. This is discussed in section 3.2 in more detail.

Anderson Bay is located on the south shore of Port Valdez. The shoreline at the plant site consists of steep rocky cliffs, 30 to 50 feet in height, that are occasionally broken by shallow beaches at the outfalls of streams. The upland site is crossed by a series of heavily timbered east-west trending bedrock ridges. The soils reflect the short growing season with cool temperatures and abundant rain. Soils in the Anderson Bay area have developed on either bedrock or glacial till and fall into two major soil groups, organic and mineral. The organic soils are associated with poorly drained sites where plant matter decays very slowly. At Anderson Bay, these poorly drained sites are associated with shallow troughs that form in more easily erodible bedrock layers and parallel the east-west bedrock trend. These sites are muskeg and the partially decayed organic matter may be very shallow to many feet in thickness.

The soils that develop in better drained sites are mineral soils that are leached, nutrient poor, and acidic. The compact till parent material of these soils has been loosened by soil formation. However, the soil is still relatively erosion resistant because of a thick dry, organic layer which protects it. When the dry, organic layer is disturbed, the underlying soil and till parent material is highly erodible. Since the Anderson Bay area is located outside of the permafrost zone, and because of the mild winter temperatures and a heavy snow cover, the soils are seldom frozen. Largely due to the steep slopes at the proposed project site, most of the soils have severe limitations for structures and other engineering uses.

The revegetation potential of the soils on the proposed LNG facility site is moderate to high. Relatively undisturbed soils would revegetate quickly with alder and other native species already present on the site. More disturbed soils could be somewhat slower to revegetate, although the revegetation period of these heavily disturbed soils could be shortened by application of soil amendments and seedmixes adapted to the site.

The site of the proposed facility is located in Alaska's south-central snow avalanche region (Hackett, 1980). The snowpack in this area is highly dynamic and generally unstable. Snow avalanches release both loose snow and snow slabs. Early winter snow avalanches are common in November and December. Hackett (1980) rated the area near Valdez as having a "high potential" for snow avalanches. More recent information indicates that the area does not have a high snow avalanche potential (Reger, 1993). Fesler and Fredston (1991) provide details on snow avalanche potential along the south shore of Port Valdez. They identified five snow avalanche paths near the proposed facility.

3.2 SEISMICITY

This section briefly discusses the results of Yukon Pacific's analysis of the earthquake hazards that the LNG facility would be exposed to, and its proposed design measures to address the risk of earthquake-induced damage to the facility. No attempt is made here to present in detail the various and extensive geoseismic studies and reports prepared by Yukon Pacific. Those studies and reports contain the baseline data, assumptions, and rationale behind the proposed earthquake engineering design measures. More information is in the applicant's FERC filings; in particular, the July 26, 1991 data response, Volumes VI and VII, available for review at the Commission's offices in Washington, DC, and at the JPO in Anchorage.

Section 4.2 of this EIS discusses the results of the our review of Yukon Pacific's seismic risk studies and its proposed earthquake design measures. Our conclusions and recommended certificate conditions dealing with seismicity are also contained in section 4.2.

Yukon Pacific has done extensive studies to assess and document the local and regional seismicity and geology surrounding the Anderson Bay site. The purpose of these studies was to:

- demonstrate compliance with the seismic design requirements and the site exclusion criteria of the DOT regulations;
- collect baseline data for estimating potential earthquake-related effects at the site for developing seismic design criteria; and
- inspect, in detail, the site and surrounding area to determine the potential for onsite and nearby faulting.

DOT Requirements

The proposed facility must meet the minimum siting and design requirements of the DOT regulations in 49 CFR 193.2061: Seismic investigation and design forces. A comprehensive study of the historical seismicity and evaluation of the site and surrounding regions is required to quantify the potential effects on the LNG facility from earthquakes and earthquake-related phenomena.

Section 193.2061(f) of the DOT regulations lists the following geologic conditions that, if present or likely to occur, render the site of a proposed LNG facility unsuitable unless the Administrator of the DOT grants a specific approval. An LNG storage tank or its impounding system may not be located at a site where [paraphrasing]:

- the estimated design level for ground shaking exceeds a ground acceleration value of 0.8g (g = the acceleration due to gravity, or approximately 980 cm/s^2) at the tank or dike foundation;

- there is a potential for active surface fault displacement beneath the tank and dike area of more than 30 inches;

- there is more than 60 inches of displacement on a Quaternary fault within 1 mile of the tank foundation, if the potential for displacement beneath the tank and dike area cannot be determined.

Yukon Pacific's geoseismic studies conclude that none of the criteria render the Anderson Bay site unsuitable. Also, studies done of faults on the site and nearby indicate that surface faults in the site area have not been active for at least 16,000 years.

NFPA 59A Requirements

The NFPA has established Standards for the Production, Storage, and Handling of LNG: NFPA 59A, which would apply to the proposed facility. Section 4-1.3 of NFPA 59A addresses the seismic design requirements. In general, as with the DOT regulations, a detailed geological study of the site and surrounding regions is required to quantify the potential effects on the LNG facility from earthquakes. However, NFPA 59A is somewhat less detailed than the DOT regulations, and does not contain any seismic site exclusion criteria.

Geoseismic Investigation

The primary objective of Yukon Pacific's geoseismic study was to evaluate potential seismic sources in the region and their relative contributions to the earthquake hazard exposure at the proposed LNG plant site. The historical seismicity of the region was also studied to gain a greater understanding of the temporal and regional variations of seismic activity, and to develop earthquake recurrence estimates for the area.

The great earthquake of March 27, 1964 dominates the historic seismicity of the region. The event had an estimated magnitude of M_w 9.2 (moment magnitude). It had a focus (point of origin) at the north end of Prince William Sound, approximately 40 miles west of Anderson Bay, and 12 to 30 miles below the surface. The earthquake caused intense ground shaking over a large area; extensive landsliding, soil liquefaction, and other ground failures, both on land and in subsea locations; and damaging waves. The duration of strong ground shaking was reported in most areas to be between 3 and 4 minutes.

Geologically, the rupture that initiated the event was on the northward dipping fault that separates the oceanic crust from the overlying continental crust. Such geologic terrains, or "seismotectonic provinces", are referred to as "subduction zones" and the fault separating the two is referred to as a "megathrust"—in this case, the Aleutian megathrust. This fault passes under the Anderson Bay site at a depth of approximately 12 miles. A great earthquake can therefore occur on this fault immediately below the site.

The 1964 earthquake is of obvious importance to the seismic risk at the site. The relative contribution to ground shaking hazard from shallow crustal faults (which are physically smaller) is low compared to the seismic exposure associated with a great subduction zone earthquake. However, faults nearer to the site than the megathrust may be capable of causing significant ground shaking. Therefore, emphasis was placed on identifying active surface faults within 12 miles of the site (i.e., those closer than the megathrust). No evidence for active faults was identified within this area.

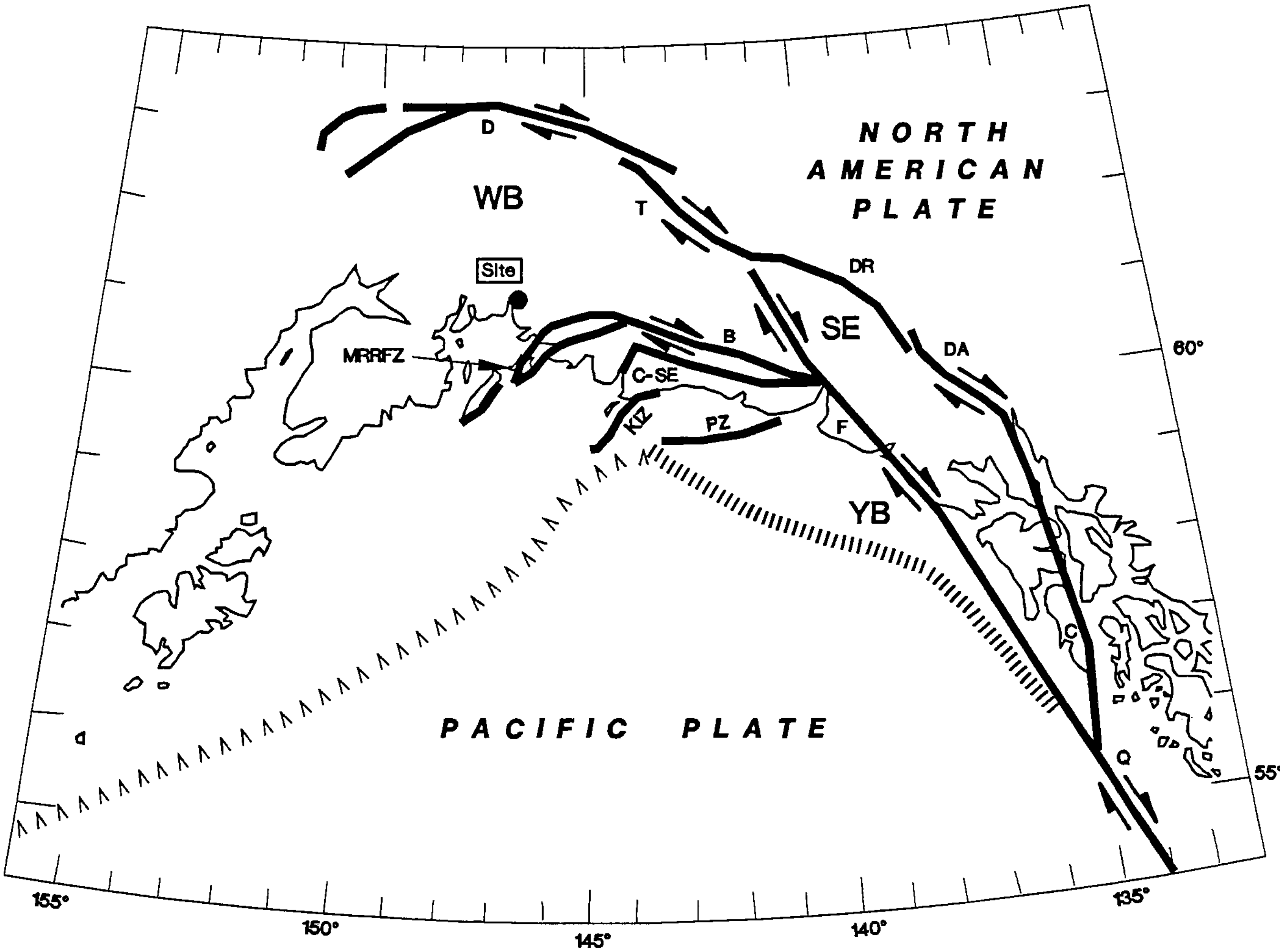
Yukon Pacific also conducted regional studies in Southcentral Alaska to evaluate the historic and geological evidence of earthquakes on the Aleutian megathrust and other active faults. Information obtained during the regional geoseismic investigation and study of the historical seismicity was used to identify and characterize potential seismic sources for use in estimating strong ground motion at the site. Principal regional faults in southern Alaska are shown on figure 3.2-1. Table 3.2-1 lists all the major faults that might generate earthquakes affecting the site, their distances from the site, and Yukon Pacific's estimate of the maximum likely earthquake magnitude ("limiting magnitude") for each. The nearest known surface fault with apparent recent displacement is part of the Montague-Rude River Fault Zone, located about 30 miles south of the Anderson Bay site.

TABLE 3.2-1

Major Faults Potentially Affecting the Proposed LNG Site

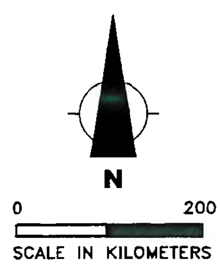
Seismic Source	Proposed Limiting Magnitude (M_w)	Distance from Site (mi)
Aleutian Megathrust Intracycle Event	7.75	12 (directly below)
Yakataga Subduction Zone Gap-Filling Event	8.75	60
Yakataga Subduction Zone Intracycle Event	7.5	45
Montague-Rude River Fault Zone	7.5-7.75	30
Castle Mountain Fault Zone	7.5	60
Johnstone Bay Fault	7.0	73
Bagley Fault	7.5	55
Chugach-St. Elias Fault	8	74
Kayak Island Fault Zone	7.5	99
Ragged Mountain Fault	6.75	74

Field investigations conducted by Yukon Pacific to extend current knowledge of the prehistoric activity on the megathrust revealed evidence of at least six, and perhaps as many



KEY :

(heavy line)	TRANSFORM FAULTS	B —	BAGLEY FAULT
∧ ∧ ∧ ∧	ALEUTIAN MEGATHRUST PLATE BOUNDARY	C-SE —	CUGACH - ST. ELIAS FAULT
IIIIIIIIII	TRANSITION ZONE	KIZ —	KAYAK ISLAND ZONE
YB —	YAKUTAT BLOCK	PZ —	PAMPLONA ZONE
WB —	WRANGELL BLOCK	MRRFZ —	MONTAGUE ISLAND - RUDE RIVER FAULT ZONE
SE —	ST. ELIAS BLOCK	D —	DENALI FAULT
(arrows) —	HORIZONTAL SLIP ACROSS INDICATED ZONE (CM/YR)	DA —	DALTON FAULT
Q —	QUEEN CHARLOTTE ISLANDS FAULT	DR —	DUKE RIVER FAULT
T —	TOTSCHUNDA	C —	CHATHAM STRAIT FAULT
F —	FAIRWEATHER FAULT		



Source: modified after Lahr and Plafker, 1980.
Plate motions from NOVEL 1 plate model (DeMets and others, 1990; DeMets, personnal communication, 1991)

FIGURE 3.2-1

PRINCIPAL REGIONAL FAULTS IN SOUTHERN ALASKA

SCALE: AS SHOWN

DWG:FERC226

as eight, earthquakes believed comparable in magnitude to the 1964 event. Based on the geologic evidence, repeat times for such events are estimated to range between 600 and 950 years and average about 700 years. Given these findings, Yukon Pacific believes that the potential for a repeat of a 1964-type earthquake in the Prince William Sound area during the life of the facility is extremely remote and therefore can be neglected for facility design purposes. A lower magnitude earthquake—the so-called "Intracycle Event"—on the megathrust beneath the site, is considered by Yukon Pacific to be a more credible event. Yukon Pacific estimates the magnitude of the Intracycle Event as M_w 7.75.

The area to the southeast of the 1964 fault rupture and aftershock zone has been termed the "Yakataga seismic gap" because of its relatively low level of recent earthquake activity. Strain energy within this zone was not relieved during the 1964 event, nor does the scientific community believe that the strain was fully relieved during two historical M_w 8.1 earthquakes that occurred in that area in 1899. Yukon Pacific concludes that the Yakataga seismic gap poses the greatest potential to generate a great earthquake in the site region during the life of the facility. The estimated magnitude of such an event is given as M_w 8.75. The postulated distance between the site and the focus of the design earthquake is approximately 60 miles.

Seismic Design Criteria

The DOT regulations specify that the proposed facility must be designed and built to withstand, without loss of structural or functional integrity, the most critical ground motion with a yearly probability of exceedance of 10^{-4} (an average repeat time between events of 10,000 years). The most critical ground motion may be calculated; "probabilistically", when the available earthquake data are sufficient to perform the statistical analysis, or; "deterministically", where available earthquake data are insufficient for statistical analysis.

For comparative purposes, Yukon Pacific used both probabilistic and the deterministic analyses to derive its estimates of the most critical ground motion for the site. Based on these analyses, Yukon Pacific estimates a "zero period acceleration" (ZPA) of 0.39g (deterministically), and 0.54g (probabilistically) for the most critical ground motion with a yearly probability of exceedance of 10^{-4}. Both estimates were made using the results and assumptions regarding seismic sources and estimated limiting magnitudes discussed above; in particular, the assumption that a repeat of an earthquake similar to the 1964 event will not occur during the life of the project.

Yukon Pacific has prepared preliminary seismic design criteria for the proposed facility. It proposes to apply a dual level earthquake philosophy; a lower level event—Operating Basis Earthquake (OBE)—(ZPA=0.4g), and a higher level event—Maximum Design Earthquake (MDE)—(ZPA=0.55g). The MDE value of acceleration is based on the cumulative probability contribution of the earthquake activity from the various seismic sources described above. The OBE value of acceleration, although somewhat arbitrary, is derived as ⅔ the MDE rounded up to 0.4g, based on engineering judgement.

The OBE represents the level of ground shaking through which the facility should be able to operate and continue operating after its occurrence; with perhaps only a brief shutdown for a safety inspection to confirm that no damage occurred. The larger MDE represents the level of ground shaking that should not damage the vital, safety-related components of the facility in such a way that they could not perform their function. Nevertheless, significant repairs may be needed after a MDE occurrence. Generally, the following components would be designed to withstand a MDE without loss of functional integrity:

- LNG Storage Tanks and Foundations
- LNG Tank Containment Dikes
- Fire and Leak Protection Systems
- Fire Station and Special Warehouses
- Control Building and Critical Control Panel Components
- Diesel-driven Power Generators and Fuel Systems
- Emergency Lighting
- Radio and Microwave Communications Systems
- Shutdown System
- Vent and Pressure Relief System

NFPA 59A specifies a two level seismic design approach. The geological investigation must determine the potential vibratory effects at the site from a "Safe Shutdown Earthquake" (SSE) and an "Operating Basis Earthquake" (OBE). While Yukon Pacific has adopted this dual level earthquake philosophy for facility design purposes, the proposed design levels would go well beyond the minimum requirements of NFPA 59A.

Briefly, the SSE is equivalent to the MDE discussed above (i.e., potential vibratory ground motion with a mean recurrence interval of 10,000 years). However, the NFPA 59A OBE is specified as having a mean recurrence interval of only 475 years. Based on Yukon Pacific's probabilistic ground motion study, the OBE under the NFPA standards would be about 0.2g; significantly lower than the proposed design level. Furthermore, NFPA states that "[a]n LNG container shall be designed for the OBE and a stress limit check made for the SSE". Yukon Pacific's own seismic design consultant has stated that this value is too low for the basic design of the LNG tanks under the circumstances.

Seismic Soil Liquefaction

All critical components of the LNG plant would be founded either on bedrock or engineered fill. This would preclude the potential for significant damage or hazard to these facilities due to seismic soil liquefaction.

Tsunami/Seiche/Subsea Slide-Induced Wave

The proposed LNG plant could be affected to various degrees by earthquake-induced water waves. Onshore runup—the elevation to which a breaking wave would reach—with consequent inundation and pounding effects of the water mass on plant structures, is the primary concern. Damaging waves can be produced both outside as well as inside the Port

Valdez basin. Out-of-basin tsunamis, caused by direct fault movement, volcanic activity, or massive landslides are a limited hazard to the plant site because of the dampening effect of the wave energy at the port inlet and by shoaling in Prince William Sound. Estimated tsunami wave runup at Anderson Bay ranges from 13.1 to 32.2 feet. Storm surges and seiche effects from out-of-basin sources are relatively small for onland facilities. However, forces on ships and docks by resulting vertical and horizontal movements could be significant and should be considered in the design and operational procedures for the plant.

Direct in-basin generated tsunami risk to the proposed LNG plant is considered low because of the absence of significant active faulting in Port Valdez. However, the hazard due to in-basin generated waves caused by subsea slope failures is high and constitutes the most significant potential wave effects for the proposed facility. Subsea slides associated with regional earthquakes over the past 100 years have resulted in significant wave runup at the plant site and surrounding area. It is likely that most areas of potential subsea slides in Port Valdez were activated by the 1964 earthquake. The destruction of the docks at old Valdez and subsequent damaging waves were the result of a massive subsea slide. Critical areas for subsea slides that could cause significant wave runup at Anderson Bay include:

- Anderson Bay area
- Cliff Mine area
- Shoup Bay area
- Lowe River/old Valdez dock area
- Mineral Creek

Other areas within Port Valdez may have also been active in the past but are considered to represent less direct risk because of their size, location, or orientation with respect to the plant site.

The runup-prone areas at the site are at the end of bays or inlets within or adjacent to Anderson Bay. The geometry of the shoreline in these areas causes the wave energy to converge with resulting peak wave heights. A likely severe case scenario would involve a wave generated from subsea sliding on the Shoup Bay delta during high tide. Such a wave could result in peak runup on the order of 93 feet in the runup-prone areas of the plant site. Properly constructed energy dissipation devices could reduce the peak runup to approximately 67 feet.

To ensure that the LNG plant facilities and other important structures on the site would not be subject to such wave damage, Yukon Pacific proposes to:

- Use a combination of seawalls and other energy dissipation devices.
- Locate all important plant components above the 75-foot elevation.
- Reduce peak runup potential at the plant site by placing large amounts of fill in the runup-prone areas.

3.3 FRESHWATER ECOLOGY

3.3.1 Water Resources

Freshwater resources within the Anderson Bay project area include Jug Creek, Aquaculture Creek, Henderson Creek, Nancy Creek, Short Creek, Terminal Creek, Strike Creek, and Seven Mile Creek, as well as groundwater resources. There are no lakes and only one pond within the project area.

3.3.1.1 Surface Water Hydrology

The Anderson Bay project area is adjacent to a steep slope which contains short, high gradient streams with rocky channels (figure 3.3.1-1). Flow within these nonglacial streams is primarily derived from precipitation and snowmelt and tends to be highly seasonal. Flow from groundwater may also contribute to the surface water flow. Terminal Creek originates from a small pond approximately 1 acre in size. Proposed potential water sources for the project include Nancy, Short, and Seven Mile Creeks. Accordingly, the hydrology of these streams has received greater attention than that of the other five area streams. Hydrologic parameters of Nancy Creek, Short Creek, and Seven Mile Creek are presented in table 3.3.1-1. Seven Mile Creek is the largest of the three streams with a drainage area of 4.40 square miles. Stream flow is highest during the spring period during snow melt and generally reaches low levels of flow during the winter season (table 3.3.1-1). All of the streams discharge directly into Port Valdez, with varying degrees of tidal exchange. Those with significant tidal exchange, such as Seven Mile and Nancy Creeks, provide habitat for fish populations and salmon spawning (see section 3.3.2).

TABLE 3.3.1-1

Hydrologic Parameters of Nancy Creek, Short Creek, and Seven Mile Creek

Creek	Drainage Area (sq mi)	Maximum Elevation (ft)	Treeless Area (%)	Slope (ft/1,000)	Distance (mi)
Nancy	1.67	2,815	70	218	50
Short	0.17	850	1	221	50
Seven Mile	4.40	3,727	60	193	50

Source: HYDMET, Inc. (1992).

Weather conditions in Port Valdez are generally cool with abundant precipitation. Temperatures in the Anderson Bay area average 22°F during December and January and 55°F during July. Total precipitation (combined rain and snow equivalent) averages 61 inches per year. Precipitation is most abundant during September and October, which generally contribute approximately 8 inches per month. April, May, and June, typically the driest months, only contribute an average of 2.7 inches per month. Snowfall is also abundant, and averages about 294 inches per year, with an average of 39 inches per month from December through March.

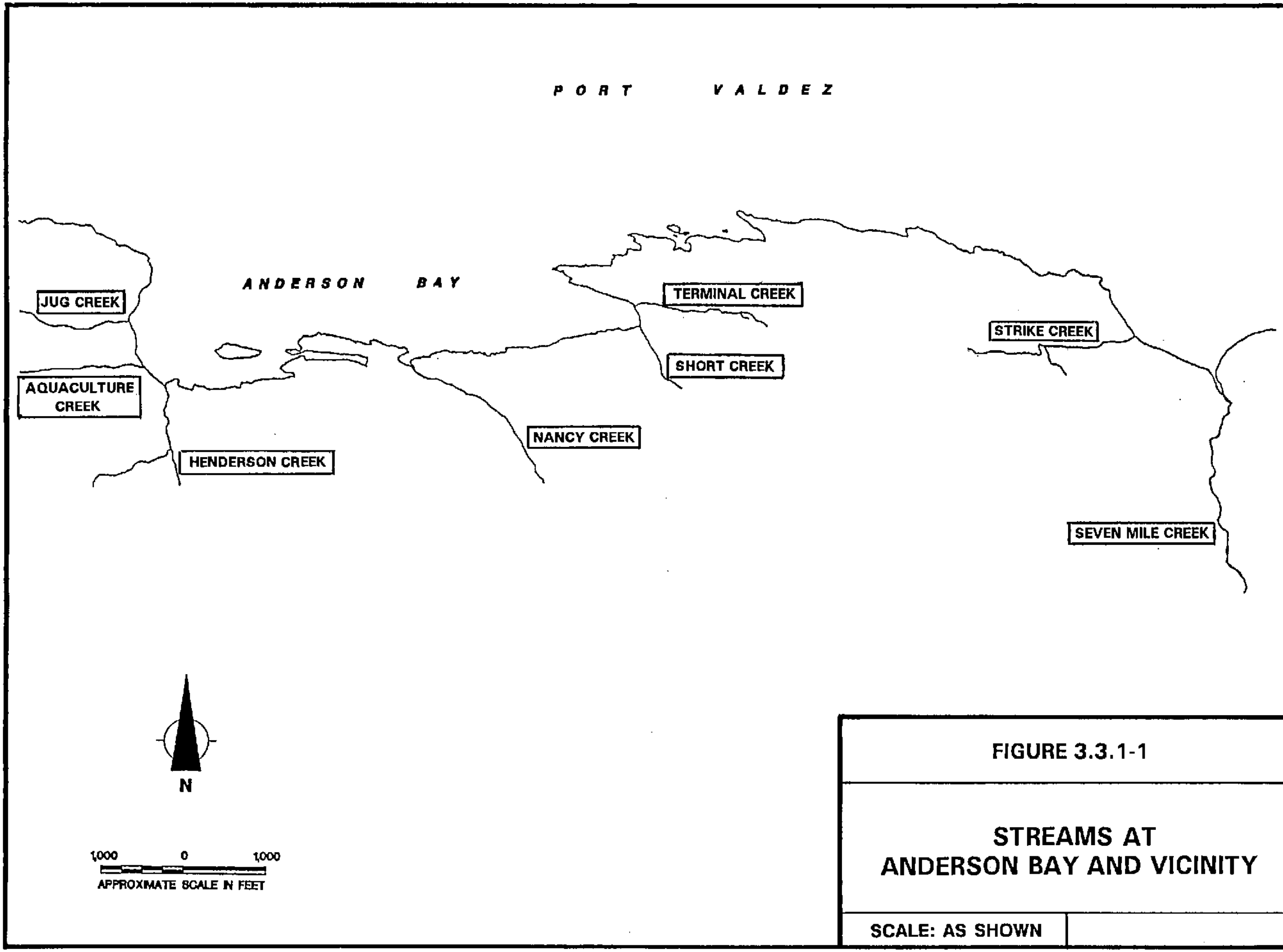


FIGURE 3.3.1-1

STREAMS AT
ANDERSON BAY AND VICINITY

SCALE: AS SHOWN

Currently, no site-specific stream flow data are available for these streams. Data will soon be available for Seven Mile, Nancy, and Terminal Creeks since stream gages were installed mid-July 1992. In the meantime, Nancy, Short, and Seven Mile Creeks flow was estimated using a regression equation calibrated with comparable stream gage records. West Fork Olsen Bay Creek near Cordova (4.8 square miles, 17 years of records) was used by HYDMET, Inc. (1992) as a comparable stream since it has basin characteristics similar to those of Nancy and Seven Mile Creeks. Results of this analysis are presented in table 3.3.1-2. Average flows for Nancy, Short, and Seven Mile Creeks were estimated at 8.3, 0.8, and 23.5 cubic feet per second (cfs), respectively. Flows range from 0.1 to 22.6 cfs in Nancy Creek, 0.01 to 1.5 cfs in Short Creek, and from 0.2 to 65.6 cfs in Seven Mile Creek. Flow is highest from May through October, with maximum flows in June. Seven-day, 10-year recurrence low flows (7Q10) estimates are also presented in table 3.3.1-2. The magnitude of 7Q10 flows relative to the amount of water to be withdrawn is an important consideration. Even during periods of low flow, a sufficient amount of water must remain following water withdrawal to satisfy state flow requirements for resident fish populations. Minimum flow requirements for these streams will be established following approximately 2 years of in-stream flow measurements (Brna, 1992b).

TABLE 3.3.1-2

Estimated Average and Low Flows for Nancy Creek, Short Creek, and Seven Mile Creek

Month	Nancy Creek Average (cfs)	Nancy Creek 7Q10 (cfs)	Short Creek Average (cfs)	Short Creek 7Q10 (cfs)	Seven Mile Average (cfs)	Seven Mile 7Q10 (cfs)
January	1.5	0.1	0.3	0.02	4.4	0.2
February	1.6	0.1	0.4	0.02	4.5	0.3
March	1.0	0.1	0.2	0.01	3.0	0.2
April	2.8	0.2	0.5	0.04	7.4	0.6
May	11.9	2.4	1.5	0.30	30.8	6.2
June	22.6	9.3	1.3	0.53	65.5	26.9
July	20.6	4.9	0.8	0.19	61.7	14.8
August	15.7	2.0	0.8	0.10	45.9	6.0
September	14.3	1.4	1.2	0.12	41.5	4.2
October	7.6	0.6	0.8	0.07	22.6	1.9
November	4.5	0.3	0.6	0.05	4.8	0.9
December	1.6	0.1	0.2	0.01	4.8	0.3
Annual Average	8.3	0.1	0.8	0.01	23.5	0.2

7Q10 = 7-day, 10-year recurrence low flows

Source: HYDMET, Inc. (1992).

3.3.1.2 Groundwater Depth and Flow

Based upon several boreholes drilled during the summer of 1990 in the Anderson Bay project area, groundwater conditions at the site appear to consist of pressurized, partially confined surficial groundwater, as well as deeper groundwater connected through multiple fracture systems. Numerous small springs, seeps, and boggy areas throughout the project area are indicative of the presence of surficial groundwater. The fracture systems appear to be variable. In some cases, they appear to be well defined with water flowing through a several foot thick zone of fractured rock. In other cases, the water producing zone appears to be more expansive with a broad, moderately fractured zone extending over tens of feet. Artesian water pressures have been encountered at depth. When first penetrated, head within the artesian water producing zones was only sufficient to create flow at the ground surface with artesian flow rates of approximately 1 to 2 gpm. One drillhole, however, yielded approximately 14 gpm with higher pressures.

The overall direction of flow appears to be in a north to northeast direction. The velocity, volume, and identity of groundwater, however, are unknown. Saltwater intrusion, which is common in many of the coastal areas in Alaska (U.S. Geological Survey [USGS], 1986), may also occur in the project area due to the large tidal flux in Port Valdez.

3.3.2 Water Quality

3.3.2.1 Surface Water Quality

Nancy, Short, and Seven Mile Creeks are nonglacial streams with small drainage areas and relatively low flows. In general, nonglacial streams of this type transport less than 100 milligrams per liter (mg/l) suspended sediment during the spring melt or during periods of heavy rainfall (USGS, 1986). Between January and April, before the spring melt, the suspended sediment concentration is generally less than 20 mg/l for all Alaskan streams. Less than 50 percent of nonglacial sediment is material finer than 0.062 millimeter (mm) (silt-clay fraction).

No site-specific water quality data are available for the streams within the Anderson Bay project area. Instead, water quality has been inferred from stream studies with similar basin, flow, and climatic conditions such as West Fork Olsen Bay Creek near Cordova. Selected water quality parameters for West Fork Olsen Bay Creek are presented in table 3.3.2-1. In general, these streams are of the calcium bicarbonate type with relatively low dissolved solids, low productivity, low turbidity, high dissolved oxygen, and slightly acidic conditions. Water temperatures at West Fork Olsen Bay Creek ranged from 32°F to 49°F during water years 1965 to 1979. A spot sample was also obtained from Allison Creek, located 5 miles east of the Anderson Bay area. Cadmium, chromium, lead, mercury, and selenium concentrations (mg/l) were below unspecified detection limits. The concentration of arsenic was reported to be 0.002 mg/l. No information is available on stream sediment quality, but it is assumed that the streams are in their pristine state. See section 3.1 for soils and geology information.

Fresh water bodies in Alaska are classified according to their designated use. The streams in the project area have not been classified by the State of Alaska, thus these streams are assumed to meet the strictest use designation: water supply for drinking, culinary, and food processing and preparation (Nenahlo, 1992). Alaska water quality standards for fresh water are presented in table 3.3.2-2.

3.3.2.2 Groundwater Quality

No data are available on the groundwater quality in the Anderson Bay project area. Most groundwater in unconsolidated aquifers, similar to those near the surface at the proposed facility, contain less than the state's recommended limit of 500 mg/l dissolved solids (USGS,

TABLE 3.3.2-1

Water Quality Parameters of West Fork Olsen Bay Creek for Use as Representative Water Quality Parameters for Nancy, Short, and Seven Mile Creeks

Date	Streamflow (cfs)	Specific Conductance (μmhos)	pH (units)	Turbidity (NTU), and Suspended Sediment (SS)(mg/l)	Dissolved Oxygen (mg/l)	Dissolved CA, Mg, HCO_3 (mg/l)	Total Dissolved N,P, (mg/l as N,P)
10/12/78	30	22	6.8	turb: -- SS: 2	13.1	Ca: 2.9 Mg: 0.3 HCO_3: 10	N: 0.32 P: 0.00
12/14/78	10	25	6.0	turb: 0.0 SS: 1	13.6	Ca: 3.0 Mg: 0.3 HCO_3: 6	N: -- P: --
5/1/79	53	22	5.8	turb: < 1.0 SS: 1	13.4	Ca: 2.9 Mg: 0.5 HCO_3: 6	N: 0.48 P: 0.02
6/5/79	46	18	6.4	turb: < 1.0 SS: 0	12.2	Ca: 2.5 Mg: 0.2 HCO_3: 6	N: 0.32 P: 0.01
7/25/79	60	14	5.8	turb: < 1.0 SS: 3	10.0	Ca: 2.3 Mg: 0.2 HCO_3: 6	N: 0.41 P: 0.03
8/15/79	71	22	6.2	turb: 2.0 SS: 5	10.9	Ca: 3.0 Mg: 0.4 HCO_3: 6	N: 0.27 P: 0.00
9/26/79	37	20	5.7	turb: 1.0 SS: 1	11.4	Ca: 2.5 Mg: 0.3 HCO_3: 8	N: 0.32 P: 0.00

-- = lack of data.

Source: USGS (1979).

TABLE 3.3.2-2

Alaska Water Quality Standards for Freshwater

Water Quality Parameter	Freshwater Criteria for (A) Water Supply (i) drinking, culinary, and food processing
Fecal Coliform Bacteria	Based on a minimum of five samples taken in a period of 30 days, mean shall not exceed 20 FC/100 ml, and not more than 10 percent of the samples shall exceed 40 FC/100 ml. For groundwater, the FC concentration shall be less than 1 FC/100 ml when using the fecal coliform Membrane Filter Technique or less than 3 FC/100 ml when using the fecal coliform MPN technique.
Dissolved Oxygen	Dissolved oxygen shall be greater than or equal to 4 mg/l (this does not apply to lakes or reservoirs in which supplies are taken from below the thermocline, or to groundwater).
pH	$6.0 < pH < 8.5$. Shall not vary more than 0.5 pH unit from natural conditions.
Turbidity	Shall not exceed 5 NTU above natural conditions when the natural turbidity level is 50 NTU or less, and not more than 10 percent increase when the natural conditions is more than 50 NTU, not to exceed a maximum increase of 25 NTU.
Temperature	Shall not exceed 15°C.
Total Dissolved Solids (TDS)	TDS from all sources shall not exceed 50 mg/l. Neither chlorides nor sulfates shall exceed 200 mg/l.
Sediment	No increase in concentration of sediment, including settleable solids, above natural conditions.
Toxic or Deleterious Substances	Shall not exceed Alaska Drinking Water Standards (18 AAC 80) or EPA Quality Criteria for Water as applicable to substances.
Color	Shall not exceed 75 color units where water supply is or will be treated. Shall not exceed 5 color units where water supply is not treated.
Petroleum hydrocarbons, oils, and grease	Shall not cause a visible sheen upon the surface of the water. Shall not exceed concentrations which individually or in combination impart odor or taste as determined by organoleptic tests.
Radioactivity	Shall not exceed the concentrations specified in the Alaska Drinking Water Standards (18 AAC 80), and shall not exceed limits specified in Title 10, Code of Federal Regulations, Part 20 and National Bureau of Standards, Handbook 69.
Residues (floating solids, debris, sludge, deposits, foam, scum—not applicable to groundwater supplies).	Shall not alone or in combination with other substances or wastes make the water unfit or unsafe for use; cause a film, sheen, or discoloration on the surface of the water or adjoining shoreline; cause a leaching of toxic or deleterious substances; or cause a sludge, solid, or emulsion to be deposited beneath or upon the surface of the water, within the water column, on the bottom, or upon adjoining shorelines.

1986). Calcium, magnesium, and bicarbonate are the major dissolved ions, although iron concentrations greater than 1.0 mg/l are also common. Water is generally of the sodium bicarbonate type, although saltwater intrusion near the coast can result in significant sodium chloride as well. Very little is known about bedrock water quality. In general, it is quite variable and contains higher dissolved solids concentrations than surface unconfined groundwater (USGS, 1986).

3.3.3 Fisheries

The eight streams located on and near the proposed construction site all have steep gradients, small drainage basins, and seasonal flows which limit the distribution of resident fishes. Nancy Creek, Seven Mile Creek, and Terminal Creek are the only streams located onsite which have suitable resident fish habitat. However, electrofishing surveys conducted in 1992 in these streams found no resident fish in Seven Mile or Terminal Creeks. The surveys found threespined sticklebacks, slimy sculpins, and several year classes of dolly varden in Nancy Creek (ADFG, 1992). Dolly varden are typically the only resident fish found in similar high gradient Prince William Sound streams (Thompson, 1992).

3.4 TERRESTRIAL ECOLOGY

3.4.1 Wildlife

More than 200 species of birds (Isleib and Kessel, 1973) and 24 species of terrestrial mammals (Morsell, 1979) occur in the Prince William Sound region. Intertidal wetlands, coastal forests, and protected shoreline areas within this region provide important habitat for a variety of birds and mammals, including shorebirds, waterfowl, raptors, and large and small mammals. The distribution and abundance of these species are related primarily to seasonal availability of food resources within the Prince William Sound area. Peak use of terrestrial habitats by wildlife in this region occurs during the summer breeding season (May to August), and when a number of species (e.g., waterfowl, shorebirds) seasonally concentrate in the area during the spring (March to May) and fall (August to October) migration periods. Notably, major migratory routes of waterfowl in this region occur directly across Prince William Sound or up the Copper River Valley rather than across the heads of fjords like Port Valdez (Hemming and Erikson, 1979). In addition, the major staging ground for millions of waterfowl and shorebirds on the Pacific Flyway occurs approximately 80 miles east of Port Valdez on the Copper River Delta (Isleib and Kessel, 1973).

3.4.1.1 Waterfowl

Tidal flats and salt marshes within the Port Valdez area provide important habitat for waterfowl (Hogan and Irons, 1988). DeGange and Sanger (1986) listed 28 species of waterfowl (including loons and grebes) occurring in the Gulf of Alaska region and Hogan and Irons (1988) recorded 26 species in the Port Valdez area. Dominant waterfowl occurring in Valdez Arm include Canada geese, mallards, Harlequin ducks, scoters, and Barrow's goldeneyes (Hogan and Irons, 1988). Nesting habitat for waterfowl in the Port Valdez area is limited primarily to the freshwater marsh at Robe Lake on the east end of Port Valdez (Hemming and Erikson, 1979). Essentially no waterfowl nesting habitat is present in the Anderson Bay area due to the lack of islands and preponderance of seacliffs along the shoreline.

During winter, waterfowl diversity is low in the Port Valdez area (Hogan and Irons, 1988), although large concentrations of Barrow's goldeneyes and surf scoters can be found. Wintering seaducks move onto the intertidal flats during high tide to feed on abundant pink-shelled clams (Hemming and Erikson, 1979). Tidal mudflats and intertidal marshes in the Anderson Bay area provide stop-over and foraging areas for migrating sea ducks, dabbling ducks, and geese during the spring and fall (BLM and COE, 1988; Brna, 1992a).

3.4.1.2 Shorebirds

Twenty-two species of shorebirds have been listed as common at some time of the year in the Gulf of Alaska region (DeGange and Sanger, 1986). Hemming and Erikson (1979) listed 16 shorebirds (18 including sandhill crane and great blue heron) occurring in the Port Valdez area. Common summer residents include semipalmated plover, common snipe, spotted sandpiper, and northern phalarope. Island Flats, Mineral Creek delta, and Robe Lake marsh are important feeding and breeding habitats for these species. Common migrants include greater yellowlegs, least sandpipers, and short-billed dowitcher. The only shorebird common during winter in Port Valdez is the rock sandpiper (Hogan and Irons, 1988).

3.4.1.3 Raptors

Both the common raven and the bald eagle are considered common nesting raptors in the Prince William Sound region (Hemming and Erikson, 1979). Although the bald eagle is not a federally listed species in Alaska, individual birds and their nest sites are federally protected under the Bald and Golden Eagle Protection Act (16 U.S.C. § 668 (1988)). This act prohibits disturbance of bald eagles and removal of their nest sites. A total of 39 eagle nest sites, 0.48 nests per kilometer of shoreline, have been identified within the Port Valdez area (Hogan and Irons, 1988). Six of these nests were active in 1988 and four of these were near salmon streams. Bald eagle nesting densities in this area are comparable to nesting densities reported for shoreline areas in southeast Alaska (i.e., 0.38 nests per kilometer of shoreline, [Hanson and Hodges, 1985]).

Two bald eagle nest sites were reported within the LNG project area along the shoreline of Anderson Bay during nest surveys performed by Yukon Pacific in 1986; one of these nest sites was at Nancy Creek in the middle of the project area and the other was at the pipeline terminus (Yukon Pacific, 1991). The nest site at Nancy Creek blew down in 1989 (Stackhouse, 1992a). A third eagle nest site was reported by Yukon Pacific along the shoreline approximately 400 feet northwest of the project area boundary and at the northwestern most point of Anderson Bay. However, the FWS and the ADFG were unable to confirm any nests or breeding pairs within the vicinity of the reported nest sites during helicopter surveys performed in June of 1991 and 1992 (Stackhouse, 1992a; Brna, 1992a).

Large concentrations of bald eagles were also observed at Jack Bay (approximately 100 birds) approximately 3 miles south of the project area in July 1992 (Stackhouse, 1992a; Brna, 1992a), and along the Lowe River (approximately 50 birds) at the east end of Port Valdez during the early October to mid-November salmon spawning season in 1979 (Hemming and Erikson, 1979; BLM and COE, 1988).

Additional raptors known to occur in the Port Valdez area include the goshawk, sharp-shinned hawk, and peregrine falcon (Hemming and Erikson, 1979). Peregrine falcons are discussed in further detail in section 3.6.

The deciduous and conifer forest types in the Port Valdez area provide habitat for numerous migratory, breeding, and overwintering birds, including rufous hummingbird, belted kingfisher, downy woodpecker, and 42 passerine species (Hemming and Erikson, 1979). However, bird densities are considered low in this area compared with other nearby areas such as the Copper River Delta (Isleib and Kessel, 1973).

3.4.1.4 Large Mammals

Three species of large ungulates occur within the Port Valdez area, including moose, mountain goat, and Sitka black-tailed deer (Roberson, 1986). Moose occur in small populations primarily along the lower 25 miles of the Lowe River Valley at the east end of Port Valdez where they feed on aquatic plants, shrubs, and small trees (Gusey, 1978). Mountain goats occur throughout the Coastal Mountains surrounding northern Prince William Sound and have been observed in the project area (Brna, 1992a), but are considered abundant only in mountains east of Valdez Arm (BLM and COE, 1988). Goats summer high in steep alpine habitat where they feed on alpine vegetation. Alpine and cliff sites at Sulphide and Abercrombie gulches, east of the project area, are goat kidding areas during late May to early June (Brna, 1992a). The ADFG observed eight goats using kidding areas in the project area during June 1991. During the winter, goats move to lower elevations and wind-blown areas where cover and food are available. Sitka black-tailed deer occur only occasionally in the Valdez area, which represents a recent range extension of this species (Morsell, 1979).

Large predatory mammals that occur in the Port Valdez area include the brown bear, black bear, lynx, wolf, coyote, and wolverine (Morsell, 1979; BLM and COE, 1988). Both brown and black bears are considered common residents of the Port Valdez area (Morsell, 1979. These bears use a variety of habitats, concentrating in lowlands and tidal flats in the early spring, in mountain slopes following spring green-up, and in berry patches and along salmon spawning streams in late summer (Stackhouse, 1992a). Large concentrations of brown bears have been reported along an unnamed stream draining into Jack Bay, 3 miles south of the project area (Yukon Pacific, 1991). However, concentrations of brown bears have also been frequently observed at the Anderson Bay project site (Brna, 1992a), although no bear den sites are known to occur in the project area. The FWS observed several brown bears and one black bear in the project area in June 1991 (Stackhouse, 1992a). In addition, a dead brown bear was found along the shoreline of Anderson Bay during the June 1991 survey.

3.4.1.5 Small Mammals and Furbearers

Diversity of small mammal species is considered low in the Sitka spruce-western hemlock association and in the deciduous forest types in the Port Valdez area (Morsell, 1979). Three of the most common small mammals occurring in this area include the red-backed vole, tundra vole, and masked shrew. The red-backed vole is the most widespread and abundant small mammal that occurs in deciduous and conifer forest types, and commonly occurs in deciduous forest types in this area (Morsell, 1979). Both tundra vole and masked shrew occur primarily in moist ecotones between green alder shrub and deciduous forest types (Morsell, 1979). Additional small mammals occurring in the Port Valdez area include pika, hoary marmot, Arctic ground squirrel, and red squirrel (Morsell, 1979).

Other mammals occurring in the deciduous and coastal spruce-hemlock association of the Port Valdez area include the little brown bat, porcupine, snowshoe hare, red fox, pine marten, and ermine (Morsell, 1979; Brna, 1992a). Mink and river otters inhabit the river and lake systems of Port Valdez. Mink also forage along the marine shorelines.

3.4.2 Vegetation

The majority of the proposed LNG plant site is covered by mature coastal spruce and hemlock forest (figure 3.4.2-1). Shrub types occur in small, isolated clusters throughout the site near stream valleys and seeps. Scattered wetlands also occur on the site. These consist primarily of estuarine intertidal wetlands along the shoreline and isolated inland palustrine shrub bogs and marshes (see section 3.4.3 for more detailed discussion of wetland vegetation).

Mature coastal spruce and hemlock forest dominated by Sitka spruce at the lower elevations along the coast and western hemlock at the higher elevations cover approximately 85 percent or 364.1 acres of the area within the proposed construction limits of the LNG site. The size of trees on the site vary according to the species, age, and microclimatic conditions. Many of the larger trees on the site are 36 inches in diameter at breast height (Stackhouse, 1992b). Common species in the forest understory include young Sitka spruce and western hemlock, Devil's Club, salmon berry, blueberry, lichens, ferns, and mosses.

The upland shrub community occupies approximately 3 percent or 13.4 acres of the area within the proposed construction limits of the site. The dominant shrub is alder. The shrub understory includes grasses, lichens, mosses, and liverworts.

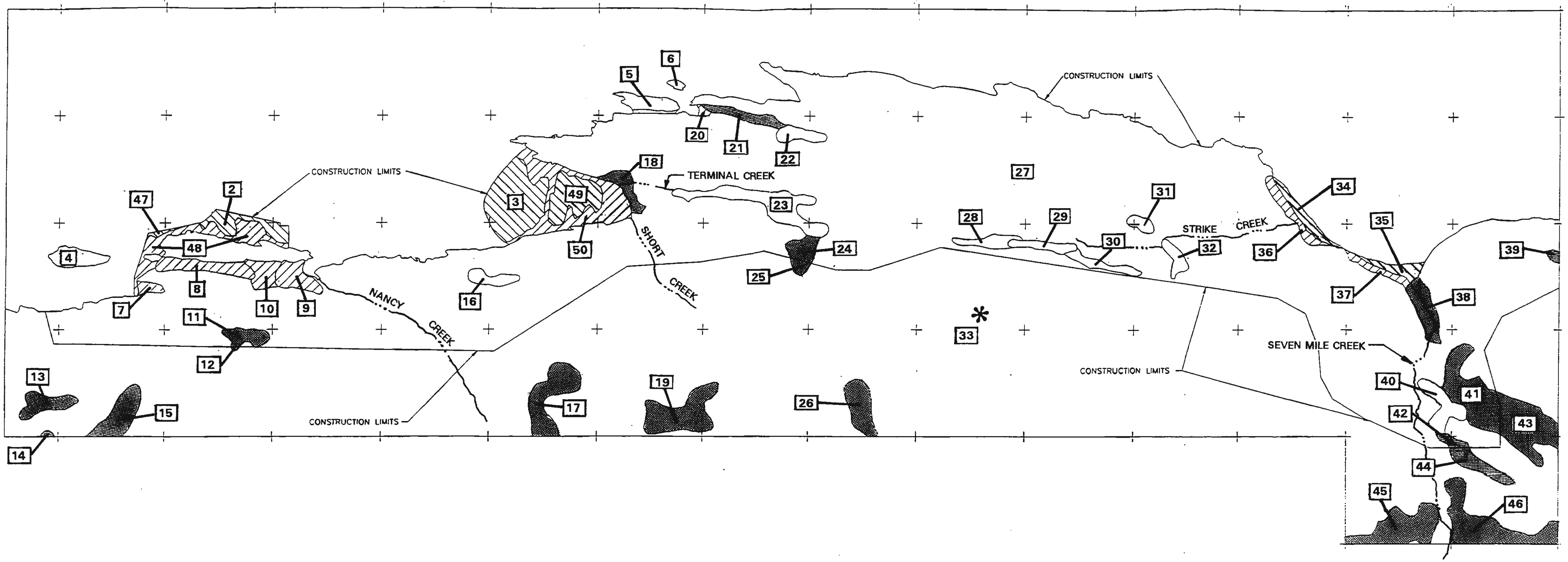
3.4.3 Wetlands

Wetlands perform a number of important functions, including water quality improvement, flood and stormwater control, and erosion control. They can also provide recreational opportunities and habitat for fish and wildlife. Wetlands help to maintain water quality through the removal and retention of nutrients and the reduction of sediment loads. In their natural undisturbed condition, inland wetlands can act as a temporary storage area for flood waters, protecting downstream areas from damage. Wetlands are also important sources of groundwater recharge and primary production (detritus) for streams. The abundant and diverse vegetation associated with both inland and intertidal wetlands acts as the primary erosion deterrent, as root systems bind sediments and reduce wave action and current velocity.

A variety of recreational activities are associated with wetlands, including hunting and fishing, hiking, canoeing, bird watching, and photography. In the Port Valdez area, however, wetlands primarily provide important breeding, migratory, and forage habitats for a number of birds, mammals, and fish.

The wetlands potentially affected by the proposed Yukon Pacific Project facilities consist of both estuarine and inland freshwater wetlands. A wetland is defined as follows:

> Areas that are inundated or saturated by surface or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas (33 CFR § 328.3 (1992) and 40 CFR § 230.3 (1992)).



LEGEND:

50 POLYGON # — WETLANDS AND MAJOR VEGETATION TYPES WITHIN CONSTRUCTION LIMITS

SHRUB VEGETATION

INTERTIDAL AND SUBTIDAL VEGETATION

* — REMAINING UNDELINEATED POLYGON CONSISTS OF COASTAL SPRUCE/HEMLOCK FOREST

NOTE:
SEE TABLE 3.4.3-1 FOR NWI CODES AND ACREAGE DATA FOR ABOVE WETLANDS AND VEGETATION DELINEATIONS.

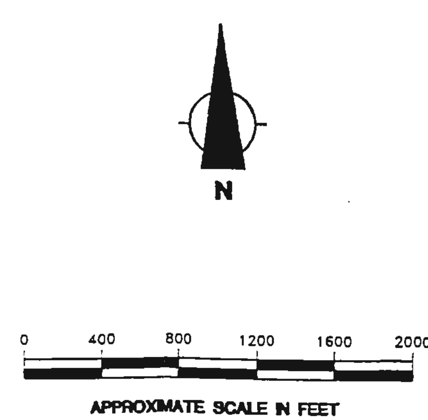


FIGURE 3.4.2-1

VEGETATION AND WETLANDS WITHIN THE LNG AND MARINE TERMINAL CONSTRUCTION ZONE

SCALE: AS SHOWN

The FWS expands this definition to include both vegetated and non-vegetated wetlands, recognizing that some types of wetlands lack vegetation (e.g., mud flats, rocky shores, gravel beaches) (Cowardin et al., 1979).

Wetlands on the proposed LNG site were identified using the FWS National Wetlands Inventory (NWI) methodology. This delineation method relies primarily on aerial photographs, but includes some selected site visits to confirm the location, shape, and size of wetlands. There is a total of approximately 48.8 acres of estuarine and freshwater wetlands within the proposed construction limits of the LNG site. Table 3.4.3-1 lists the NWI classification type, dominant vegetation, and total acreage of each of the wetlands within the construction limits of the proposed LNG facility site.

Approximately 70 percent or 34.3 acres of the wetlands within the proposed construction limits of the site are estuarine types. These include 13.1 acres of subtidal, algae covered, unconsolidated bottom wetlands; 17.3 acres of intertidal, algae covered, regularly flooded, unconsolidated shores and bottoms; 2.0 acres of intertidal, unvegetated, irregularly flooded, unconsolidated shores; and 1.9 acres of intertidal, grass and sedge covered, irregularly flooded, emergent wetlands. Most of these estuarine wetlands are located near the mouths of Terminal Creek, Short Creek, and Nancy Creek, along the shores near the mouth of Seven Mile Creek, and in the shallow bottoms and shores surrounding Terminal Island.

The remaining 14.5 acres (30 percent) of wetlands within the construction limits of the proposed site are unforested freshwater types. These include 12.2 acres of widely dispersed sedge and grass covered emergent wetlands, a single 1.2 acres of scrub-shrub wetland, and one elongated 1.1 acres of permanently flooded, unconsolidated bottom wetland.

3.5 MARINE ECOLOGY

3.5.1 Bathymetry and Circulation

3.5.1.1 Anderson Bay and Port Valdez

Port Valdez is an east-west trending fjord approximately 3 miles wide and 11 miles long. The bathymetry of Port Valdez consists of four main physiographic regions: a narrow shoreline shelf; a ridge-and-trough area, a steep slope; and a flat, relatively featureless basin at approximately 37.8 meters deep (see figure 3.5.1-1). The shoreline consists of extensive mudflats and glacial streams in the eastern half of Port Valdez, and of steep, rocky shores with boulder-cobble beaches in the western half. The Chugach Mountains line the southern coast of Port Valdez.

On the western end of Port Valdez, the Valdez Narrows, a narrow, double-silled entrance, serves as the tidal connection between Port Valdez and Prince William Sound. Flow conditions through the narrows are driven by the relative magnitudes of tidal currents and freshwater streamflow from streams within Port Valdez (Muench and Nebert, 1973). In March, significant net transport of deep water into Port Valdez occurs in response to surface outflow associated with freshwater input from snow melt and precipitation. In December, flow into Port Valdez occurs at approximately mid-depth with outflow in surface and deep waters. Current speeds through the narrows up to 3 cm/s have been observed (Cooney and Coyle, 1988).

TABLE 3.4.3-1

Wetland Areas Affected by the Proposed Yukon Pacific LNG Project

NWI Classification a/	Polygons Represented	Dominant Plant Species	Acres Within Proposed Construction Limits	Functional Value Score per Acre b/
E1UBL	2, 3, 47, 49	Algae	13.1	--
E2USN	8, 34, 35, 36, 37	Algae	7.2	100-140
E2UBN	48, 50	Algae	10.1	100-120
E2USP	9, 20	Unvegetated	2.0	100
E2EM1P	7, 10	Lyngbye's sedge, seaside arrow grass, alkali grass, sea lyme grass	1.9	160
PEM1B	16, 23, 28 30, 31, 32, 40	Few-flower sedge, black alpine sedge, deer cabbage, sphagnum moss	12.2	80
PSS1B	22	Green alder, willow, bog blueberry, mountain cranberry	1.2	60
PUBH	29	Pondweed, water milfoil	1.1	120
TOTAL			48.8	

a/ NWI Wetland Types
E1UBL = Estuarine, Subtidal, Unconsolidated Bottom, Subtidal
E2USN = Estuarine, Unconsolidated Shore, Regularly Flooded
E2UBN = Estuarine, Unconsolidated Bottom, Regularly Flooded
E2USP = Estuarine, Unconsolidated Shore, Irregularly Flooded
E2EM1P = Estuarine, Intertidal, Emergent, Persistent, Irregularly Flooded
PEM1B = Palustrine, Emergent, Persistent, Saturated
PSS1B = Palustrine, Scrub-shrub, Saturated
PUBH = Palustrine, Unconsolidated Bottom, Permanently Flooded

b/ Relative functional values of wetlands on the proposed LNG facility site were determined using the wetland evaluation technique developed by the Wetland Evaluation Working Group. No functional value was given by Yukon Pacific for E1UBL wetlands.

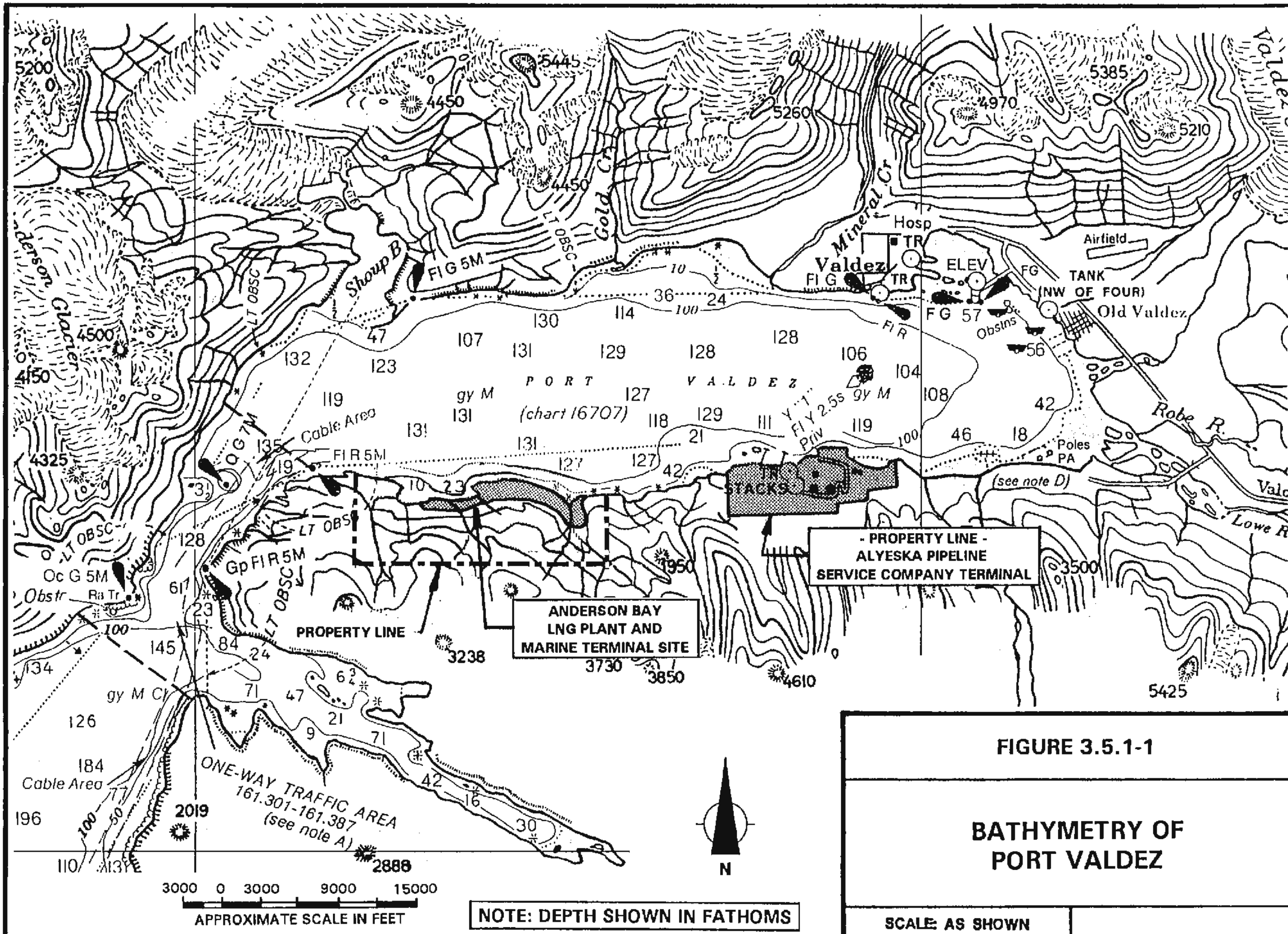


FIGURE 3.5.1-1

BATHYMETRY OF PORT VALDEZ

SCALE: AS SHOWN

Circulation within Port Valdez is dictated by the interaction of tidal currents, wind-driven currents, and freshwater input from surrounding streams. Semi-diurnal tides, with daily tidal ranges of 9 to 12 feet, dominate the circulation. Current direction varies with depth, but generally runs in an east-west orientation, along the major axis of the fjord (Muench and Nebert, 1973; Dames and Moore 1990b). Current velocities range from 5.1 cm/s to 15.4 to 20.6 cm/s in the upper portions of the water column, and are about 5.1 cm/s at approximately 100 foot depth (Dames and Moore, 1990b).

Port Valdez circulation is typical of estuarine fjords (Cooney and Coyle, 1988). During early spring, the water column is well mixed with salinities from 32 to 33 parts per thousand (ppt) and temperatures around 38°F (see figure 3.5.1-2). Stratification of the water column begins in late April and May as a result of seasonal warming and freshwater input from snowmelt. During this period, surface salinity drops below 30 ppt and temperatures exceed 42°F. By July and August, the water column is fully stratified and surface salinities below 1 ppt and water temperatures about 52°F are commonly observed (Cooney and Coyle, 1988). Stratified conditions persist through October but by December, due to high winds and decreasing temperature, the water column is again well mixed. Assuming well-mixed conditions, the flushing time of Port Valdez is approximately 4 weeks (Colonell et al., 1988). While the stratified conditions during the warmer months may tend to limit tidal mixing, and thus extend the flushing time, stratification is not expected to significantly alter the residence time of contaminants in Port Valdez.

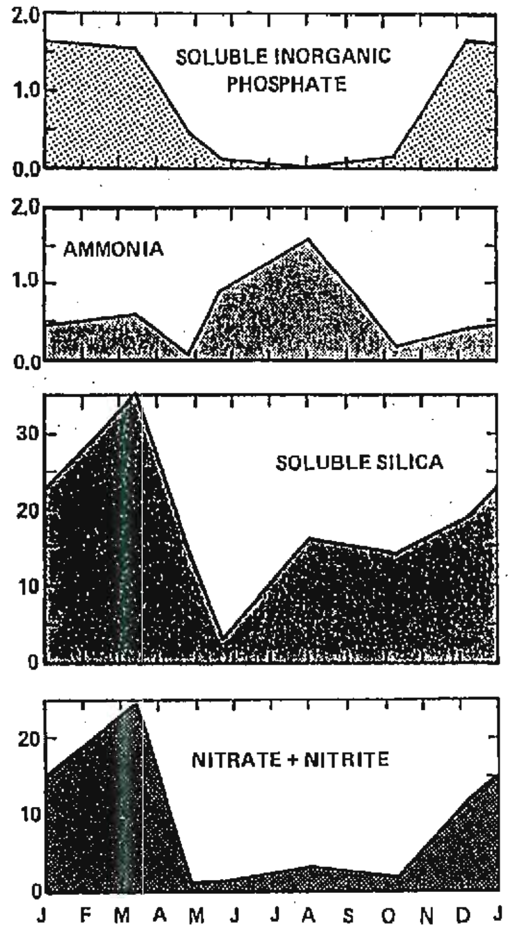
3.5.1.2 Prince William Sound

Prince William Sound, which is located off the northern Gulf of Alaska, serves as a fjord-type estuarine system linking several peripheral fjords (Orca Bay, Port Wells, and Port Valdez) and the Gulf of Alaska (see figure 3.5.1-3). Water exchange with the Gulf of Alaska primarily occurs through two openings, the Montague Strait and Hinchinbrook Entrance, since the remaining smaller channels are tortuous and shallow (Muench and Schmidt, 1974). Exchange through the Hinchinbrook Entrance dominates deep water renewal.

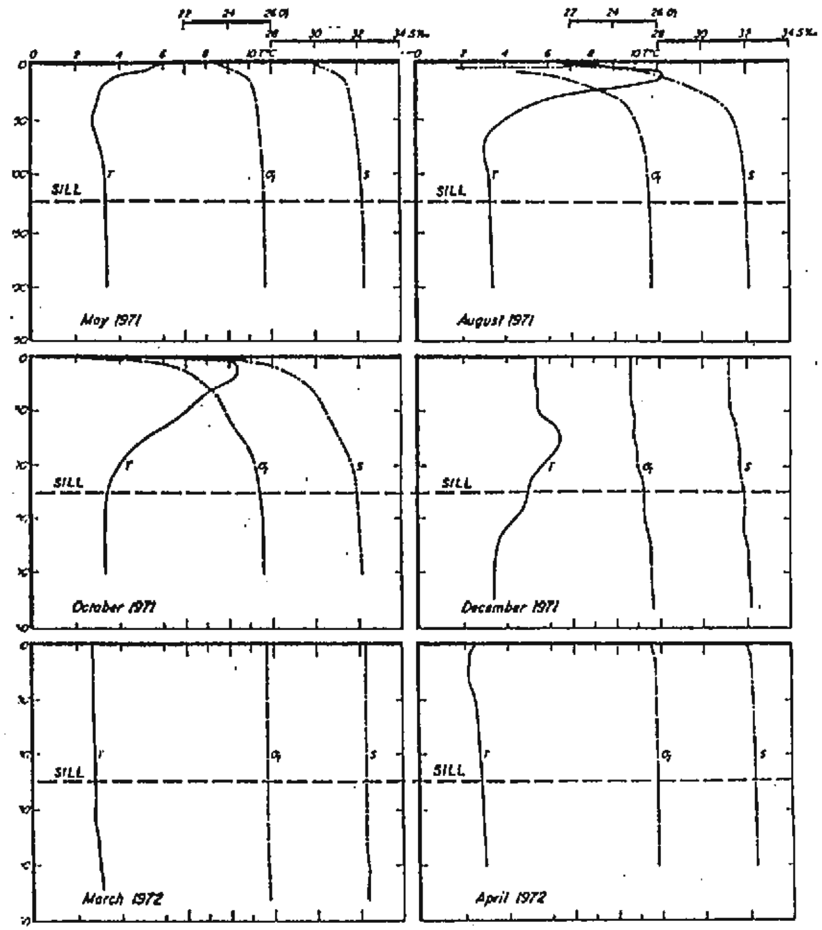
The bathymetry of Prince William Sound is complex. In general, a series of trenches extending down to nearly 2,600 feet exists in the western portion of the Sound, and a broad north-south trending basin approximately 980 to 1,640 feet deep is located in the eastern portion. Montague Strait and Hinchinbrook Entrance sill depths are approximately 320 and 590 feet, respectively.

Circulation within Prince William Sound is driven by freshwater runoff, surface winds, tides, deep water renewal, and seasonal temperature variations. Both vertical diffusion and thermohaline convection are important (Muench and Schmidt, 1974). Consistent with classical estuarine circulation, the water column generally stratifies during the warmer summer months with high freshwater input, but is increasingly well mixed during the colder winter months with low freshwater input and higher wind speeds. Vertical mixing generally extends 98 to 164 feet deep in the central portion of the Sound (Muench and Schmidt, 1974). Appreciable horizontal circulation is expected due to the large horizontal extent of Prince William Sound and due to high regional wind speeds.

Mean seasonal air temperatures at Cape Hinchinbrook range from 55° to 57°F in July and August to 23°F in January. The mean annual precipitation is variable, and ranges from 180 inches at Latouche to about 61 inches at Valdez. Most of the summer runoff occurs in July



Concentration of nutrients in ppm at the 50% light level (Goering et al. 1973a).



Vertical distribution of temperature, salinity and density (Muench and Nebert, 1973)

Key:

- ——— Temperature (°C)
- – – – – Density
- –·–·–·– Salinity (°/oo)

FIGURE 3.5.1-2

PORT VALDEZ WATER QUALITY

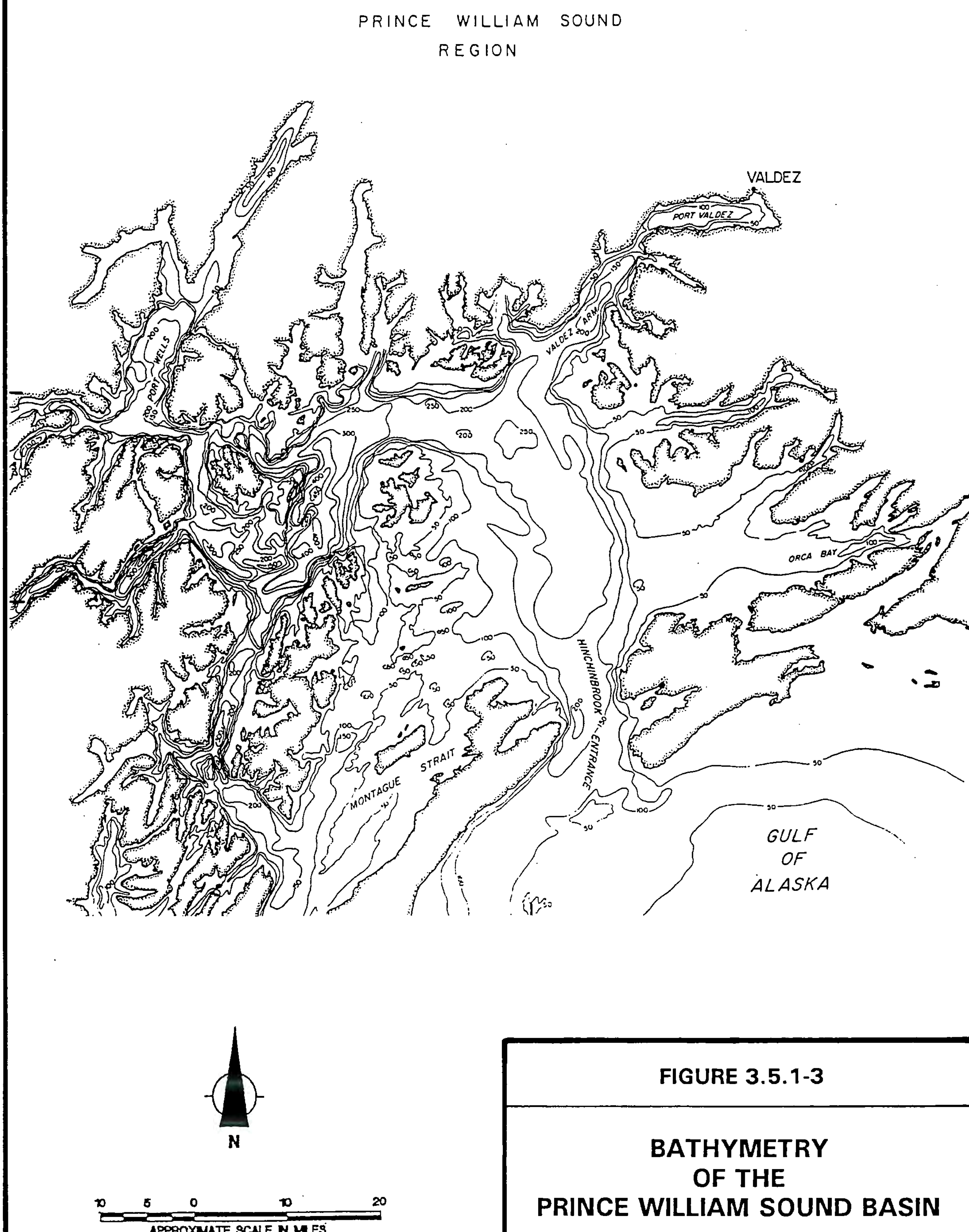


FIGURE 3.5.1-3

BATHYMETRY OF THE PRINCE WILLIAM SOUND BASIN

SCALE: AS SHOWN

and August. Tidal ranges in Prince William Sound are generally on the order of 10 to 12 feet. Although considerable directional variability exists, the winds are normally northeasterly, more northerly in the winter and more easterly in the summer (Muench and Schmidt, 1974).

The vertical temperature structure exhibits large seasonal variations (less than 35°F to 54°F) in the upper 246 feet, while smaller variations are observed in water depths below 246 feet (37°F to 43°F) (Muench and Schmidt, 1974). Similarly, the vertical salinity structure shows large seasonal variations in the upper 246 feet (25 ppt to 32 ppt). Salinity variations in water depths greater than 820 feet are very small (32 ppt to 32.8 ppt). The density structure parallels that of the salinity structure.

3.5.2 Water Quality

3.5.2.1 Anderson Bay and Port Valdez

Water quality profiles in Port Valdez of temperature, salinity, pH, and dissolved oxygen were measured in October 1990 as a function of depth (table 3.5.2-1). pH values in the upper 100 feet of water ranged from 7.6 to 8.0, while dissolved oxygen concentrations ranged from 5.9 to 8.6 mg/l in the upper 50 feet of water. Dissolved oxygen readings below this depth were not reported, but no evidence for seasonal oxygen depletion in deep water exists (Cooney and Coyle, 1988). The temperature and salinity profiles sampled in October showed temperature variations from 42° to 47°F and salinity variations from 29.6 to 31.9 ppt. In October, remnants of summer stratification can be seen in the profile (lower surface salinity), but cooler temperatures have already begun to increase the surface water density leading to destabilization of the water column. By December, well mixed conditions should be evident (see section 3.5.1.1).

Nutrient concentrations in Port Valdez surface waters prior to spring stratification are generally high: combined nitrate and nitrite concentrations exceed 20 micromoles per liter (μmoles/l); silicate concentrations are approximately 35 μmoles/l; and phosphate concentrations exceed 1.5 μmoles/l (Goering et al., 1973) (figure 3.5.2-1). High nutrient concentrations coupled with sufficient light result in an intense phytoplankton bloom in April and May which essentially depletes the surface waters of nutrients (Cooney and Coyle, 1988). Nutrient concentrations generally do not reach pre-bloom levels again until November or December.

Significant sediment loading into Port Valdez occurs during the spring snowmelt and during periods of high rainfall. Approximately 2.63 x 10^{12} grams (2,590 thousand tons) of fine-grain sediments are delivered to Port Valdez each year, primarily through Mineral Creek on the northern shore and the Lowe and Robe Rivers on the eastern shore (Naidu and Klein, 1988). These fine-grained sediments do not settle well and generally remain in the upper 32 to 65 feet, with maximum concentrations 16 to 33 feet below the water surface. The presence of these sediments reduces the depth of the euphorc zone often to less than 3.3 feet, and thus is one of the limiting factors in primary productivity in Port Valdez (Cooney and Coyle, 1988).

Water column sampling was conducted near Anderson Bay on October 19, 1990 to determine baseline levels of total petroleum hydrocarbons (TPH); benzene, toluene, ethylbenzene, and xylene (BTEX); and copper, iron, nickel, zinc, arsenic, cadmium, lead, and mercury. Relatively low concentrations of TPH were found, and none of the samples contained measurable concentrations of BTEX (table 3.5.2-2). Copper, iron, nickel, and zinc were present at relatively low levels in surface and bottom waters. Twelve water samples were taken

TABLE 3.5.2-1

Vertical Water Quality Profile of Port Valdez

Depth (m)	Depth (ft)	Temperature (°C)	ph	Dissolved Oxygen (mg/l)	Salinity ppt
1	3.3	5.8	7.9	5.9	
2	6.6	6.1	7.9	5.9	29.6
3	9.8	6.6	7.9	5.9	29.9
4	13.1	6.7	7.9	6.1	29.9
5	16.4	6.7	7.9	6.1	30.0
6	19.7	6.8	7.9	6.2	30.1
7	23.0	6.8	8.0	6.2	30.1
8	26.2	6.8	8.0	6.2	30.2
9	29.5	6.7	8.0	6.3	30.2
10	32.8	6.9	8.0	6.3	30.3
11	36.1	7.0	8.0	6.4	30.3
12	39.4	7.1	7.9	6.4	30.4
13	42.6	7.2	7.9	6.5	31.0
14	45.9	7.3	7.9	6.5	31.4
15	49.2	7.4	7.9	6.3	31.5
16	52.5	7.4	7.8	6.9	31.6
17	55.8	7.4	7.7	7.3	31.7
18	59.0	7.3	7.9	7.3	31.6
19	62.3	7.1	7.6	7.3	31.4
20	65.6	7.2	7.7	6.6	31.7
21	68.9	7.2	7.6	7.0	31.9
22	72.2	6.9	7.9	7.8	31.9
23	75.4	6.8	7.8	8.4	31.9
24	78.7	6.5	7.7	8.6	31.8
24.4	80.0	6.5	7.8	*	31.8
27.4	90.0	6.4	7.8	*	31.8
30.5	100.0	5.9	7.7	*	31.9
33.5	110.0	5.7	7.8	*	31.7

ppt = parts per thousand
mg/l = milligrams per liter
* = erratic readings observed

TABLE 3.5.2-2

Hydrocarbon and Metal Concentrations in the Water Column Offshore of Anderson Bay

	PARAMETERS													
Sample No.	Total Petroleum Hydro-carbons (mg/l)	Benzene (μg/l)	Chloro-benzene (μg/l)	Ethyl-benzene (μg/l)	Toluene (μg/l)	Xylenes (μg/l)	Copper (mg/l)	Iron (mg/l)	Nickel (mg/l)	Zinc (mg/l)	Arsenic (mg/l)	Cadmium (mg/l)	Lead (mg/l)	Mercury (mg/l)
1	0.6	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u	0.043	0.068	0.017	0.041	0.001 u	0.0001 u	0.001 u	0.0003
2	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
3	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
4	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
5	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
6	0.5	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
7	0.5	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
8	0.5	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
9	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
10	2.0 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
11	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								
12	0.4 u	0.2 u	0.2 u	0.2 u	0.3 u	0.6 u	0.066	0.092	0.019	0.044	0.001 u	0.0001 u	0.001 u	0.0002 u
Travel Blank		0.2 u	0.2 u	0.2 u	0.3 u	0.6 u								

Note: u = Below Detection Limit. Detection Limit stated in results.
m/l = milligrams per liter.
μg/l = microgram per liter

Source: Yukon Pacific 1991

at 10-foot depth intervals. Alaska marine water quality standards are listed in table 3.5.2-3. No clear exceedances are present near Anderson Bay.

Under the CWA, all states are required to submit to the EPA, on a biannual basis, water quality data for the state and a 305 B List, which cites 1) impaired, 2) suspect, and 3) waters of concern. Water quality within Port Valdez near the Alyeska terminal was listed as impaired on the 1990 Alaska 305 B list, but was delisted on the 1992 Alaska 305 B list due to insufficient evidence to justify a continued listing (Hubbard, 1993). Water quality near a small boat harbor near Valdez was listed on the 1992 Alaska 305 B list.

3.5.2.2 Prince William Sound and Offshore Water Quality

Water quality within Prince William Sound was listed as impaired on the 1990 Alaska 305 B list due to the 1989 Exxon Valdez oil spill. The extent of impaired areas was refined for the 1992 Alaska 305 B list and the following 17 areas were identified as impaired: Bay of Isles; Cape Douglas; Foul Pass; Herring Bay Knight Island; small unnamed island northwest of Green Island; unnamed island off the mouth of Marsha Bay; north shore of Latouche Island; northeast shore of Eleanor Island; northeast shore of Seal Island; northeast shore of Knight Island; northeast shore of Evans Island; northwest bay of Disk Island; northwest bay of Eleanor Island; Rua Cove on Knight Island; southeast shore of Ingot Island; and Tonsina Bay and Windy Bay off the Kenai Peninsula. While these areas are listed as impaired, it is unlikely additional cleanup activities will occur since the evidence for continuing impacts is less apparent and additional sampling is difficult because the areas are remote (Hubbard, 1993).

3.5.3 Sediment Quality

Sediments within Port Valdez originate from several depositional environments including sediments from glacial moraine and drift deposits, fluvial and turbidite units from channel deposits, and from marine sedimentation of biotic material (Dames and Moore, 1990a). Near Anderson Bay, shallow sediments consist of a bedrock/boulder/cobble mix, whereas sediments at water depths greater than 32 to 50 feet are dominated by silt/sand/clay fractions (Dames and Moore, 1990a). In the construction wharf area, a sediment core consisted of 8 to 12 inches of sandy silt overlying 12 to 16 inches of fine, silty sand over 8 to 12 inches of silty clay over a silty and sandy gravel (Dames and Moore, 1990a). This type of sediment structure is common in an outwash fjord, and probably results from seasonal circulation patterns (Feder and Jewett, 1987; Dames and Moore, 1990a).

The clay fractions present in Port Valdez sediment appear to be glacially derived clay minerals with relatively low ion-exchange (1 - 14 milliequivalents per 100 grams) and adsorptive capacities (Naidu and Klein 1988 and references therein). Studies of periglacial sediments in southcentral Alaska by Malinky and Shaw (1979) indicated only slight sorption of dissolved hydrocarbons. Average organic contents in Port Valdez sediments and in intertidal sediments are 4.7 and 1.1 milligrams per gram on a dry weight basis, respectively (Naidu and Klein, 1988).

Mean concentrations of total and leachable metals in Port Valdez sediments are presented in table 3.5.3-1. The relative percentage of the total metal concentration in the leachable fraction indicates the relative potential for metal mobilization from sediments under changing sedimentary conditions, such as decreasing pH/Eh conditions (Chester and Hughes, 1967). Similar results were obtained from tidal flat sediments in eastern Port Valdez (Naidu et al., 1978) and from suspended sediments (Gosink and Naidu, 1983). These results show that

TABLE 3.5.2-3

Alaska Marine Water Quality Standards

Water Quality Parameter	Freshwater Criteria for (A) Water Supply (i) Aquaculture
Fecal Coliform Bacteria	The mean, based on a minimum of five samples taken in a period of 30 days, shall not exceed 200 FC/100 ml for products normally cooked and 20 FC/100 ml for products not normally cooked. Not more than 10 percent of the samples shall exceed 400 FC/100 ml or 40 FC/100 ml for cooked and noncooked products, respectively.
Dissolved Oxygen	Surface D.O. concentration in coastal water shall not be less than 6.0 mg/l for a depth of 1 meter except when natural conditions cause this value to be depressed. D.O. shall not be reduced below 4 mg/l at any point beneath the surface. D.O. concentrations in estuaries and tidal tributaries shall not be less than 5.0 mg/l except where natural conditions cause this value to be depressed. In no case shall D.O. levels above 17 mg/l be permitted.
pH	$6.0 < pH < 8.5$. Shall not vary more than 0.1 pH unit from natural conditions.
Turbidity	Shall not exceed 25 NTU.
Temperature	Shall not cause the weekly average temperature to increase more than 1°C. The maximum rate of change shall not exceed 0.5°C per hour. Normal daily temperature cycles shall not be altered in amplitude or frequency.
Total Dissolved Solids	No man-induced alterations shall be made that would cause a change in the water's isohaline patterns of more than 10 percent of the natural variations.
Sediment	No imposed loads that will interfere with established water supply treatment levels.
Toxic or Deleterious Substances	Substances shall not individually or in combination exceed 0.01 times the lowest measured 96 hour LC_{50} for life stages of species identified by the department as being the most sensitive, biologically important to the location, or exceed criteria cited in EPA Quality Criteria for Water of Alaska Drinking Water Substances (18 AAC 80), whichever concentration is less. Substances shall not be present or exceed concentrations which individually or in combination impart undesirable odor or taste to fish or other aquatic organisms as determined by bioassay or organoleptic test.
Color	Shall not exceed 50 color units.
Petroleum hydrocarbons, oils, and grease	Shall not exceed 0.01 times the continuous flow 96 hour LC_{50} or, if not available, the static test 96 hour LC_{50} for the species involved.
Radioactivity	Shall not exceed the concentrations specified in the Alaska Drinking Water Standards.
Total Residual Chlorine	Concentrations shall not exceed 2.0 μg/l for salmonid fish, or 10.0 μg/l for other organisms.
Residues (floating solids, debris, sludge, deposits, foam, scum—not applicable to groundwater supplies).	Shall not alone or in combination with other substances or wastes cause the water to be unfit or unsafe for use. Shall not cause detrimental effects on established water supply treatment levels.

iron has the largest potential for mobilization followed by zinc, cobalt, copper, nickel, and manganese. Chromium and vanadium are the least mobile under low pH/Eh conditions.

TABLE 3.5.3-1

Mean Concentrations of Metals in the Total Sediment and Hydroxylamine Hydrochloride-Acetic Acid Extract of Sediment of Port Valdez a/

	Zn	Co	Cr	Cu	Ni	V	Mn	Fe
Total								
Mean	125	36	133	75	62	243	1,342	5.112
SD	23	19	16	17	11	44	623	1.046
Extractable								
Mean	32	10	3	29	11	7	504	3.607
SD	15	3	1	3	1	3	644	0.455

a/ All concentrations are expressed as $\mu g/g$ of dry weight sediment except for Fe concentrations, which are expressed as 10^{-4} $\mu g/g$ (percent). Means are based on analysis of 14 samples.

Source: Naidu and Klein, 1988.

As a result of crude oil stranding and discharge of treated ballast water by the existing TAPS oil terminal, sediments near the TAPS oil terminal have been affected. Naidu et al. (1978) demonstrated significant mobilization of iron, manganese, cobalt, copper, chromium, cadmium, nickel, and vanadium from tidal flat sediments due to decreases in pH/Eh conditions following oxidative decomposition of stranded crude oil and treated ballast water discharge. Furthermore, total hydrocarbons in surficial sediments near the diffuser showed significant increases from 1980 to 1982 (Karinen, 1988). However, since hydrocarbon concentrations decreased with increasing distance from the diffuser (Karinen, 1988), hydrocarbon concentrations should be well within background levels near Anderson Bay .

3.5.4 Fisheries

Five species of salmon occur in Port Valdez, and contribute to fisheries in the eastern, northern, and western portions of Prince William Sound (Merrell, 1988). Port Valdez and the Valdez Arm support the largest sport fishery in Prince William Sound (Solomon Gulch Hatchery Management Plan [SGHMP], 1991). Pink salmon are the most abundant, followed by chum salmon, coho, and sockeye salmon. Chinook salmon are occasionally caught by commercial and recreational fishermen, but are not known to spawn within Port Valdez. The Solomon Gulch Hatchery, located at the east end of Port Valdez, supports a common property fishery in Port Valdez and other Prince William Sound locations by raising and releasing pink and chum salmon fry as well as coho and chinook salmon smolts. Pink and chum salmon are the only salmon species known to spawn in streams at the proposed Anderson Bay project site (Thompson, 1992).

There are 24 documented pink salmon spawning streams in Port Valdez. Spawning pink salmon have been documented in Seven Mile, Henderson, and Nancy Creeks (Thompson, 1992, 1993); adult pink salmon have occasionally been observed in Short Creek (Dames and Moore, 1991; Thompson, 1992, 1993) (see table 3.5.4-1). Based on a comparison of 1991 ADFG, commercial fisheries division aerial survey data, the runs to Seven Mile and Anderson Bay streams appear to be important contributors to the Port Valdez wild stock return (Thompson, 1992). The production from Seven Mile and Anderson Bay streams appears to be limited by spawning and rearing habitat.

TABLE 3.5.4-1

Pink and Chum Salmon Peak Spawning Counts in Anderson Bay Streams, 1991 and 1992

Stream	1991 Pink	1991 Chum	1992 Pink	1992 Chum
Seven Mile Creek	982	161	1,067	83
Nancy Creek	250	3	7	1
Short Creek	-	-	3	-
Terminal Creek	-	-	-	-
Henderson Creek	12	--	3	-
Aquaculture Creek	-	-	-	-
Jug Creek	-	-	-	-

Pink salmon have a 2-year life cycle, with larger runs historically occurring in odd years, although releases from Solomon Gulch Hatchery have diminished the differences in yearly run sizes. The adults spawn from late June to September, with the peak spawning occurring in late July. Eggs hatch in late winter and fry emerge from the streambed gravel in April or May. Fry are released from the Solomon Gulch Hatchery net pens when plankton production begins to peak in the spring. The fry immediately migrate into estuarine areas and congregate in feeding schools. The pink salmon fry released from the hatchery use Anderson Bay as a nursery area while migrating along the side of Port Valdez, apparently avoiding the turbid surface water along the northern and eastern shores (Jewett, 1990; Jewett and Sark, 1991). They migrate to the ocean by the end of summer. The Valdez area pink salmon sport fishery is the largest in the State of Alaska (SGHMP, 1990).

Chum salmon life history is similar to pink salmon except they spend two to five winters rearing in the Gulf of Alaska and there is no cyclic dominance in run size. Spawning chum salmon have been observed in Seven Mile and Nancy Creeks (Thompson, 1992). Chum salmon fry have been observed in mixed schools with pink salmon and herring in the western portion of Port Valdez (Mattson, 1977). Wild fry emerging from rivers at the eastern end of the port moved westerly along the northern shore although few samples were taken along the southern shore (Morsell and Perkins, 1979).

Pacific herring are the only other economically important fishery resource occurring in Port Valdez. Herring spawn yearly in Valdez Arm and occasionally spawning will extend into Port Valdez near Anderson Bay, but kelp, an important spawning substrate, is not abundant. There is no harvest of eggs on kelp in Port Valdez because of contamination by glacial silt rendering them unsuitable for human consumption (Merrell, 1988). There are summer feeding grounds in the west end of Port Valdez and Valdez Arm. Part of the Valdez herring stock overwinters in the City of Valdez's small boat harbor where residents catch them for personal use as bait (Merrell, 1988).

Pacific halibut, rockfish, and lingcod are occasionally taken for personal use as are Dungeness crab, tanner crab, king crab, spot shrimp, and coonstripe shrimp (Dames and Moore, 1991; Merrell, 1988; Feder and Jewett, 1988). Demersal fish and shellfish occurring in Port Valdez are not abundant and the species composition has not been thoroughly sampled. Sculpins, flathead sole, and juvenile pollock appear to be the most common bottom fishes present (Smith et al., 1969; Feder and Paul, 1977). This is similar to Prince William Sound, where extensive trawl surveys have found relatively small numbers of low value species such as walleye pollock, eulachon, skates, turbot, flathead sole, and sculpins (Parks and Zenger, 1979).

3.5.5 Benthic

The rocky intertidal benthic community is characterized by a patchy distribution and relatively low species diversity (Dames and Moore, 1991). This is due in part to the rigorous physical and chemical conditions in Port Valdez. Surface salinity can fluctuate widely and rapidly reaching almost 0 ppt during spring runoff or fall rains and nearshore ice flows and slush ice can damage intertidal organisms (O'Clair and Zimmerman, 1987). Rockweed (*Fucus sp.*) and mussels (*Mytilus edulis*) dominate the intertidal zone in rock areas, forming dense clumps in all but the highest and lowest intertidal levels (Dames and Moore, 1991; Feder and Keiser, 1980). Red algae (mostly *Odonthalia floccosa*) occurs in the mid-intertidal zone and *Ulva fenestrata* dominates the low intertidal zone. Also present but not common are barnacles (*Semibalanus balanoides*, *S. cariosus*, *Balnus glandula*), polychaete worms, and other minor taxa as well as the predatory snail (*Nucella lamellosa*) and sea stars (*Pycnopodia helianthoides*, *Evasterias troschelii* and *Dermasterias imbricata*) (Dames and Moore, 1991).

Several eel grass beds are located on the west side of the proposed cargo dock area, in the proposed fill disposal area off of the mouth of Short Creek and in one of the inlets on the north side of the proposed construction site (Dames and Moore, 1991). Kelps (*Agarum cribrosum*) and lamanarians (*Laminaria groenlandica* and *L. saccharina*) are seasonally present in dense stands with cover varying from 25 to 100 percent in shallow subtidal zones. Rocky substrate gives way to silty sand below 15 meters depth with no plant cover although there are occasional patches of the large white sea pen (*Virgularia sp.*) (Dames and Moore, 1991). Benthic plants appear to account for less than 1 percent of the total production in Port Valdez (Hood, 1973).

The subtidal benthic habitat in Port Valdez is characterized by a soft/clay silty bottom and is chronically disturbed by the annual deposition of large quantities of glacially derived sediments (Feder and Matheke, 1980). The infauna off of the proposed construction site is characteristic of areas with high levels of glacial sediment deposition, and is dominated by polychaete worms with bivalve molluscs and arthropod crustaceans of secondary importance (Feder and Jewett, 1988). Epifaunal macroinvertebrates are sparsely distributed, probably due to a lack of large polychaetes and clams for food (Feder and Jewett, 1987). Pandalid shrimp are the dominant shrimp in Port Valdez; spot shrimp and northern pink shrimp (*P. borealis*) occur near the proposed construction site (Dames and Moore, 1991; Feder and Jewett, 1987; Feder and Jewett, 1988).

3.5.6 Wildlife

3.5.6.1 Seabirds

Hogan and Irons (1988) listed 12 species of seabirds occurring in the vicinity of Port Valdez. Gulls dominate the seabird community with glaucous-winged gulls, black-legged kittiwakes, and mew gulls being the most common. Small breeding colonies of black-legged kittiwakes, glaucous-winged gulls, and Arctic terns nest at Shoup Bay, directly across Port Valdez from the project area (Hogan and Irons, 1988), and forage in the Anderson Bay area (BLM and COE, 1988).

During winter, common murres are the most dominant seabird in the Port Valdez area along with gulls and pelagic cormorants, while marbled murrelets are the most common alcid during the summer (Hogan and Irons, 1988). However, McRoy and Stoker (1969) found marbled murrelets more concentrated in the Valdez Narrows rather than Port Valdez proper.

In general, summer densities of seabirds, especially gulls, in Valdez Arm are strongly linked to breeding opportunities and salmon runs while winter densities are marked by greater numbers of common murres moving inshore where they apparently feed on capelin (Forsell and Gould, 1981).

3.5.6.2 Marine Mammals

Sea otters and harbor seals are the most common marine mammals found in Port Valdez (Hogan and Irons, 1988). Killer whales, Dall's porpoise, and Steller sea lions occasionally occur within Valdez Arm (McRoy and Stoker, 1969; Hogan and Irons, 1988). Harbor porpoises, minke whales, fin whales, and humpback whales frequenting Prince William Sound may also occasionally enter Valdez Arm.

Officially, sea otters were first recorded in Port Valdez in 1974 when a single animal was sighted (Pitcher, 1975). By 1985 at least 76 otters were using the area (Irons et al., 1988) and 116 were recorded in 1986 (Hogan and Irons, 1988) indicating an expanding population in Port Valdez. The significance of this growing population may have increased with the loss of nearly half (3,500 to 5,500 otters) of the Prince William Sound sea otter population from the 1989 *Exxon Valdez* oil spill (Exxon Valdez Oil Spill Trustees, 1992). Most sea otter concentrations are found in shallow areas (Hogan and Irons, 1988) where they feed largely on clams (*Mya* spp.), mussels (*Mytilus* spp.), and horse crabs (Calkins, 1978; Estes et al., 1981).

McRoy and Stoker (1969) estimated that approximately 100 harbor seals were using Port Valdez in 1969; however, by 1985, only 30 individuals were recorded (Hogan and Irons, 1988). In general, the Gulf of Alaska stock has declined substantially since 1973 (DeGange and Sanger, 1986; Pitcher, 1990). The Prince William Sound population, estimated at 590 to 946 in 1979 (Hall, 1979), was further devastated by the loss of an estimated 200 seals from the *Exxon Valdez* oil spill (Exxon Valdez Oil Spill Trustees, 1992). A portion of the lost animals may have included Valdez Arm as part of their seasonal range. Port Valdez harbor seals are most often seen near salmon streams in summer and generally haul-out on rocks near Island Flat and ice floes near Shoup Glacier (Hogan and Irons, 1988).

Also of note are beluga whales. Although they have never been recorded in Valdez Arm, they do occasionally enter Prince William Sound with a high count of 200 in 1983

(DeGange and Sanger, 1986). A more detailed discussion on fin whales, humpback whales, and Steller sea lions is provided in section 3.6.

3.6 ENDANGERED AND THREATENED SPECIES

To comply with requirements of Section 7 of the ESA, the Commission has conducted informal consultation with the FWS and the NMFS regarding the presence of federally listed or proposed endangered and threatened species in the project area. Yukon Pacific, as a non-Federal party, has assisted the Commission in meeting Section 7 requirements by conducting informal consultation with the FWS.

3.6.1 Plants

The FWS indicated in a letter dated February 20, 1992 that "no listed, proposed, or candidate species [including plants] for which the U.S. Fish and Wildlife Service (FWS) has responsibility are known to occur in the project area." In an April 19, 1993 letter the FWS confirmed that the information is current for 1993.

3.6.2 Terrestrial Wildlife

No federally listed or proposed endangered or threatened terrestrial wildlife species were reported in the vicinity of the Anderson Bay project area (Stackhouse, 1992a). However, the endangered American and threatened Arctic subspecies of the peregrine falcon may occasionally occur in the area.

Peregrine Falcon

Three subspecies of peregrine falcons (*Falco peregrinus*) occur in Alaska: American (*F. p. anatum*), Arctic (*F. p. tundrius*), and Peale's (*F. p. pealei*). The American peregrine falcon, a federally endangered species, nests in interior Alaska, primarily along the Yukon and Tanana Rivers while the threatened Arctic peregrine falcon generally nests in arctic north slope. However, both subspecies may pass through the Prince William Sound area as they migrate between breeding sites and southern wintering grounds (Swem, 1993), although Copper Delta region may be more important (BLM and COE, 1988). Prince William Sound falls within the breeding range of the nonendangered Peale's peregrine falcon only (Craig, 1986), although an unconfirmed American peregrine falcon nest site has been reported near Cordova, Alaska, approximately 50 miles southeast of Port Valdez (Isleib and Kessel, 1973).

3.6.3 Marine Wildlife

Three species of endangered whales and one species of sea lion presently occur in the Prince William Sound region. Additionally, two endangered whales, the northern right whale and the blue whale, historically occurred in the Gulf of Alaska.

Gray Whale

This whale passes through the Prince William Sound area twice each year on its annual migration to and from winter breeding grounds in Mexico and summer feeding grounds in the Bering and Chukchi Seas (Braham, 1984). Timing of passage is usually in the spring (March to May) and fall (November to January). Gray whales closely follow the coast around the Gulf of Alaska, frequently passing through both Hinchinbrook Entrance and Montague Strait (Hall, 1979). Although gray whales occur in Prince William Sound, they have seldom been reported in the Valdez Arm and are considered a rare visitor at that locality.

Humpback Whale

This whale occurs primarily in two distinct areas of Prince William Sound during two separate periods (Hall, 1979). During May to late June they are most frequently reported in the area between Perry, Naked, and Eleanor Islands (see figure 3.6.3-1) which is characterized by high primary and secondary productivity during the spring of the year. By early July, most move to near Icy and Whale Bays near Chenega Island (Hall, 1979). Individuals are observed throughout Prince William Sound and occasionally are seen in the Valdez Arm where they are considered a rare visitor.

Fin Whale

Fin whales occur in the Gulf of Alaska from May to November (Berzin and Rovnin, 1966) where they have generally been found feeding in deeper waters along submarine canyons and the shelf break (Consiglieri and Braham, 1982; Leatherwood et al., 1983; Brueggeman et al., 1987, 1988). Hall (1979) observed fin whales in Prince William Sound from April to June, but believed these animals were primarily transients. A few animals have been known to wander into Valdez Arm, but are considered a rare visitor there.

Northern Right Whale

This is probably the most endangered whale in the North Pacific. Recent estimates place the North Pacific population at between 100 to 200 individuals (Braham and Rice, 1984). Northern right whales have not been observed in the Prince William Sound area in recent times. However, Prince William Sound lays adjacent to the Gulf of Alaska where, historically, major concentrations occurred (Scarff, 1986). Consequently, the possibility of encountering a right whale in the Prince William Sound area does exist given their traditional use of the area. However, this possibility is very slight given the small size of the existing population and the lack of evidence for recovery in the North Pacific (Scarff, 1986).

Blue Whale

Blue whales, although present in the North Pacific at higher numbers than right whales (1,400 to 1,900; Gambell, 1976), are rarely sighted in the Gulf of Alaska (Calkins, 1986). Historically, they summered in the western Gulf of Alaska (Berzin and Rovnin, 1966). There are no recent records of blue whales occurring in Prince William Sound.

Steller Sea Lion

This sea lion is found in Prince William Sound throughout the year. A major breeding rookery occurs at Seal Rocks at the southern end of the sound and several haulout sites occur throughout Prince William Sound (figure 3.6.3-1). Neither the rookery or any of the major haulout sites occur near Valdez Arm (Calkins and Pitcher, 1993) and all haulout sites occur 6 to 25 miles west of the shipping lanes. The closest haulout site to Valdez Arm is Glacier Island which is used only in the winter (Calkins and Pitcher, 1993). Steller sea lion use of Valdez Arm is only occasional and sporadic. A spring influx into the arm may occur if spawning

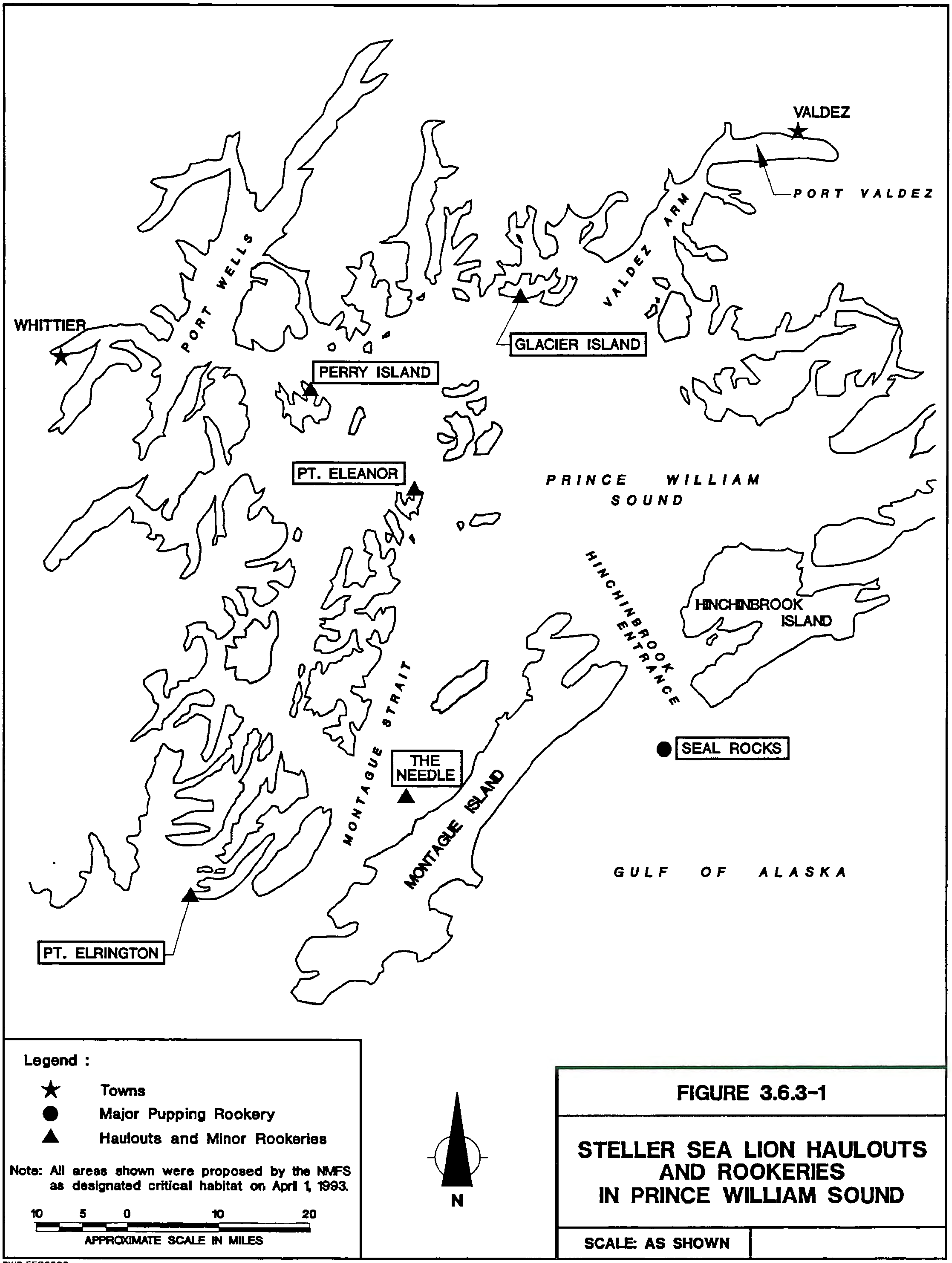


FIGURE 3.6.3-1

STELLER SEA LION HAULOUTS AND ROOKERIES IN PRINCE WILLIAM SOUND

SCALE: AS SHOWN

DWG:FERC222

herring are present, but herring use of Valdez Arm is also occasional and sporadic. Consequently, Steller sea lions are considered occasional visitors to Valdez Arm.

The NMFS proposed to designate specific Steller sea lion rookeries and haulouts in Prince William Sound as critical habitat on April 1, 1993 (58 CFR 17181 (1993)). These areas, recommended by the Steller Sea Lion Recovery Team, include the Seal Rocks rookery, and The Needle, Wooded Island, Perry Island, Point Elrington, and Point Eleanor haulout sites (see figure 3.6.3-1). As proposed by the NMFS, the designated critical habitat at each of these locations would extend 3,000 feet landward and 20 nautical miles seaward from the area's shoreline at MLLW.

In general, gray, humpback, and fin whales can be found seasonally in Prince William Sound and may occasionally enter Valdez Arm, with humpback whales the most likely to enter. Steller sea lions are found in Prince William Sound year-round and may occur in Valdez Arm in numbers if spawning herring are present. But for the most part, major use areas of all four species are located in Prince William Sound far from Valdez Arm. Northern right and blue whales occur in such low numbers in the North Pacific that their possibility of entering Valdez Arm is extremely remote.

3.7 AIR QUALITY

Air quality can be affected by both the construction and operation of the LNG plant. Air quality effects from onsite construction activities can be divided into two areas: the generation of fugitive particulate matter dust due to construction operations and the emissions of gaseous criteria pollutants from construction equipment. Air quality during operation would result from the emissions of natural gas-fired turbines and equipment, fuel use in LNG tankers, and operation of an incinerator and wastewater treatment systems.

The Alaska Department of Environmental Conservation (ADEC) regulates air quality in the project area and would require a full review of potential air quality impacts that would result from the proposed facility. The first step in an air quality analyses is to collect data on the existing ambient air quality in the area. Two types of data are required to assess the existing air quality conditions. One is meteorological data which gives information on the local climate at the site and on the nature of dispersion conditions that will govern the behavior of emission from the proposed facility. Secondly, the baseline ambient concentration of the pollutants which would be emitted from the facility must be known. In 1989, Yukon Pacific installed and began operation of a meteorological monitoring station at the Anderson Bay site. Site monitoring of ambient concentrations will probably be required at the proposed LNG facility due to the size of potential emissions. Since 1989, the Alyeska Marine Terminal has been monitoring ambient concentrations of criteria pollutants.

3.7.1 Meteorology

The transport and dispersion of air contaminants in the project vicinity is related to the meteorology of Anderson Bay. The wind speed, direction, and atmospheric stability determine how emissions from the facility would be transported through the airshed and the resulting ground level concentrations from the emissions.

The ridgeline surrounding the bay is generally 2,000 to 4,000 feet in elevation with higher peaks and several intersecting valleys and glaciers. Near surface level winds are channeled both along the bay and along the intersecting valleys. Up and down valley flows dominate the near surface winds and result in complex wind field, especially along the ridgeline where outflow from the intersecting valleys causes local eddies.

Temperature, precipitation, atmospheric stability, and wind patterns in the project area are all influenced by this rugged terrain. Based on 1 year of data (September 1989 to August 1990) collected from the Yukon Pacific meteorological station site, winds are predicted to be predominately from the east-northeast (21 percent) (see figure 3.7.1-1. Although the winds blow infrequently from the plant toward the community of Valdez (approximately 10 percent from the west and west-southwest), severe topography in the area creates swirling winds that could bring facility emissions to the community from other directions.

Precipitation is abundant in all seasons of the year and is greatest in September and October. The average annual precipitation is 61 inches and yearly snowfall is 294 inches. Cloudy conditions with greater than 80 percent cloud cover occur 60 to 70 percent of the year.

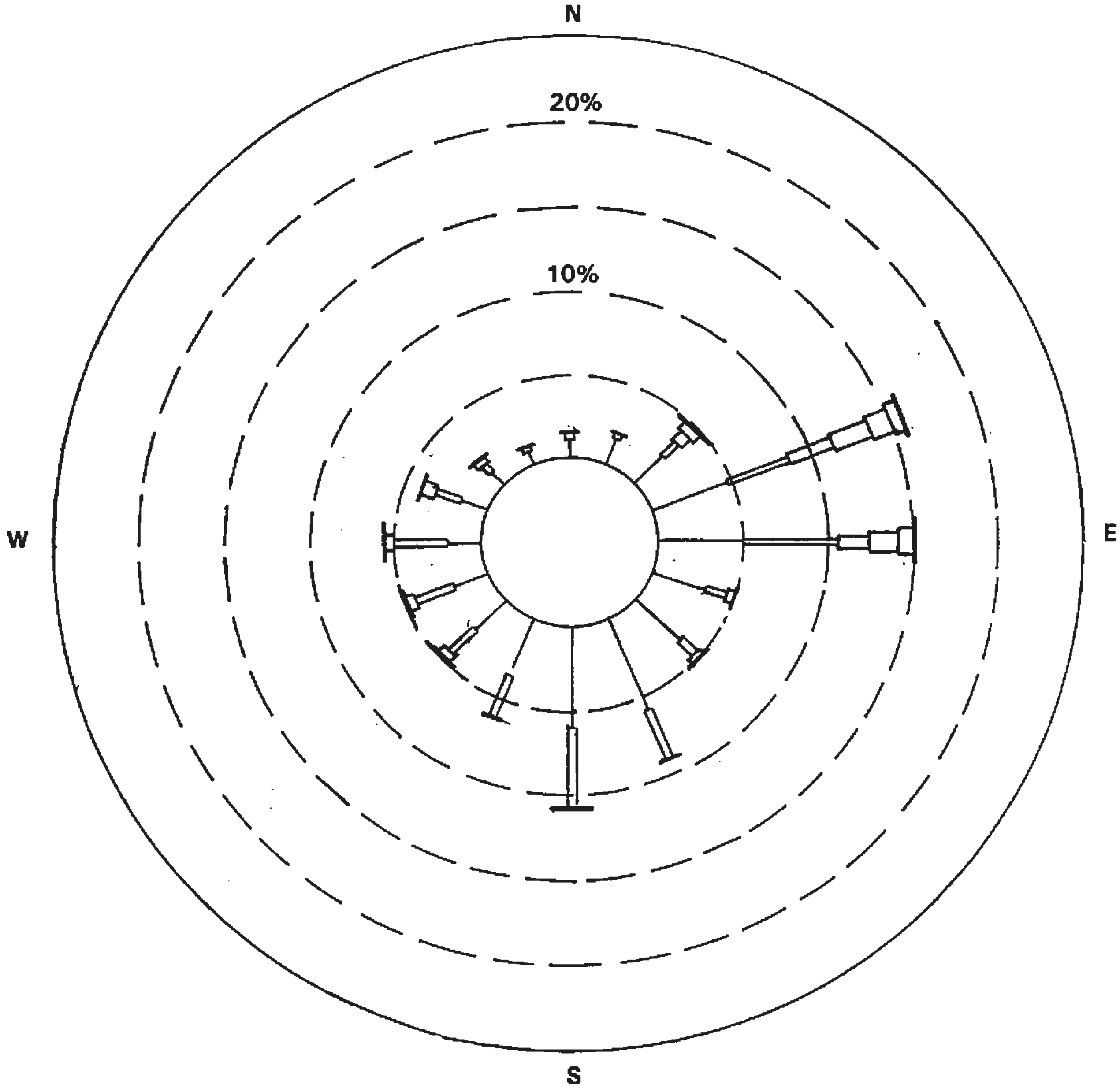
3.7.2 Ambient Air Quality

Ambient air quality is protected by Federal and state regulations. The EPA has developed National Ambient Air Quality Standards (NAAQS) for certain criteria air pollutants. The NAAQS are the maximum allowable concentration of a pollutant in the atmosphere. Air quality standards for a state may not be less stringent that the NAAQS. For a new source, compliance with any NAAQS is based upon the total estimated air quality. This is the sum of the ambient estimates resulting from existing sources of air pollution, and the modeled ambient impact caused by the new facility's proposed emissions.

Table 3.7.2-1 lists the criteria air pollutants, the NAAQS, and ambient concentrations in the project area for those criteria air pollutants potentially affected by the proposed LNG project. Emissions of lead and ammonia would be negligible. The proposed LNG facility would be in the South Central Alaska Intrastate Air Quality Control Region (AQCR) which is in attainment for all criteria pollutants.

Existing ambient air quality is also protected by the EPA's PSD regulations. These regulations are intended to preserve the existing air quality in areas where pollutant levels are below the NAAQS. PSD regulations impose specific limits to the amount that new or modified major stationary sources may contribute to existing air quality levels. An air pollutant point source that is subject to PSD review is required to submit a review of existing air quality, use modeling analyses to demonstrate compliance with the NAAQS and applicable increments, apply best available control technology (BACT), and include an analysis of the general impact on the environment. Table 3.7.2-2 identifies the allowable Class I and II PSD increments for the criteria air pollutants.

Air quality permitting in Alaska is conducted by the ADEC. The proposed LNG plant would require a Permit to Operate in accordance with the Alaska Administrative Code (AAC), Title 18, Section 50.300. The project's impact area is the geographical area for which the required air quality analyses for the NAAQS and PSD increments are carried out. This area includes all locations where predicted emissions of a criteria pollutant from the proposed LNG facility would potentially cause a significant impact on ambient levels.



WSA CLASS LIMITS (MPS)

	≥ 20.0
	15.0 TO < 20.0
	12.0 TO < 15.0
	9.0 TO < 12.0
	6.0 TO < 9.0
	3.0 TO < 6.0
	1.1 TO < 3.0
	0.0 TO < 1.1

CALMS 49.9%

PERIOD: 9/01/89 - 08/31/90

FIGURE 3.7.1-1

WIND ROSE FOR ANDERSON BAY AREA

TABLE 3.7.2-1

Ambient Air Quality Standards and Ambient Concentrations

Pollutant	Averaging Period	National a/	State b/	Ambient Concentration c/	Attainment Status
Sulfur Dioxide (SO_2) ($\mu g/m^3$)	Annual	80 d/	80 d/	15.7	In
	24-hour	365 e/	365 e/	44.5	In
	3-hour	1,300 e/	1,300 e/	133.5	In
	30-minute	--	50 e/	N/A	In
Respirable Particulates (PM_{10}) ($\mu g/m^3$)	Annual	50 d/	50 d/	10.1	In
	24-hour	150 e/	150 e/	63.6	In
Carbon Monoxide (CO) (mg/m^3)	8-hour	10 e/	10 e/	1.0	In
	1-hour	40 e/	40 e/	3.6	In
Ozone (O_3) ($\mu g/m^3$)	1-hour	235 f/	235 e/	122.0	In
Nitrogen Dioxide (NO_2) ($\mu g/m^{3)}$	Annual	100 d/	100 d/	9.4	In
Lead (Pb) ($\mu g/m^3$)	Calendar Quarter	1.5 d/	1.5 d/	0.08	In
Ammonia (NH_4) (mg/m^3)	8-hour	--	2.1 g/	N/A	In

a/ 40 CFR Part 50

b/ 18 AAC 50

c/ Measured at the Alyeska Marine Terminal, 1992.

d/ Never to be exceeded.

e/ Not to be exceeded more than once per year.

f/ Number of days per year with maximum hourly average above 235 $\mu g/m^3$ must be equal to or less than one.

g/ Not to exceed 2.1 mg/m^3 averaged over any consecutive 8 hours more than once each year.

-- = no standard exists

N/A = not available

The PSD regulations also require an analysis of the impact on nearby Class I areas. Congress established certain areas, such as wilderness areas and National Parks, as mandatory Class I areas. In all Class I areas stringent limits on increments for sulfur dioxide (SO_2), particulate matter (PM_{10}), and nitrogen dioxide (NO_2) are imposed to avoid air quality degradation. The nearest Class I areas include Denali National Park, and Tuxedni and Simeonof National Wilderness Areas, which are located 158 miles, 240 miles, and 640 miles, respectively, from the proposed Anderson Bay site.

The Federal land managing agency has responsibility to protect air quality related values for the area which may be adversely affected by the cumulative ambient pollutant concentrations. An analysis of impacts on visibility and other air quality related values must be provided to determine the effect on the Class I area. The Federal land managing agency

TABLE 3.7.2-2

PSD Increments

Pollutant	Averaging Period	Class I PSD Increment ($\mu g/m^3$)	Class II PSD Increment ($\mu g/m^3$)
SO_2	Annual	2	20
	24-hour	5	91
	3-hour	25	512
NO_2	Annual	2.5	25
PM_{10}	Annual	5	19
	24-hour	10	37

of the Class I area is responsible for evaluating a source's projected impact on the area and recommending that the ADEC either approve or disapprove the source's permit application based on anticipated impacts.

3.8 NOISE

At any location, both the magnitude and frequency of environmental noise may vary considerably over the course of the day and throughout the week. This variation is caused in part by changing weather conditions and the effects of seasonal vegetative cover. Two measures commonly used by Federal agencies to relate the time-varying quality of environmental noise to its known effect on people are the 24-hour equivalent sound level (Leq(24)) and the day-night sound level (Ldn). The Leq(24) is the level of steady sound with the same total (equivalent) energy as the time-varying sound of interest, averaged over a 24-hour period. The Ldn is the Leq(24) with a 10 decibels of the A-weighted scale (dBA) weighing applied to nighttime sound levels between the hours of 10 p.m. and 7 a.m., to account for people's greater sensitivity to sound during nighttime hours.

No measurements of the background noise levels in the vicinity of the Anderson Bay site are available. In the absence of actual monitoring data, some deductions based on existing land use and the level of human occupancy may serve to define anthropogenic noise levels. At this time, no residences or businesses are known to be present on Anderson Bay. The size of the land unit to be controlled by the LNG facility precludes any residences from being constructed immediately adjacent to operating units which might be a source of noise.

Noise levels created by natural sources can be quite loud in wilderness areas with rugged terrain and ample rain or snowfall. Numerous small, rapid streams and waterfalls can create noise which elevates the background noise levels to over 40 dBA. In very quiet locations, the normal noise levels are likely to be in the low 30s dBA.

Due to noise reflection from hard rock surfaces and unattenuated propagation over water surfaces of Port Valdez, it is likely that distinctive noises of human origin, such as bells, whistles, and alarms might well be heard distinctly over considerable distances on the shoreline.

Some undocumented experience may have been gained in the characteristics of industrial noise environment due to operations of the crude oil terminal in Port Valdez.

The LNG facility is proposed to be located in a presently undeveloped area of southwest Port Valdez where there are few anthropogenic noise sources. Shipping traffic associated with the crude oil terminal is assumed to cause occasional noise impacts, although no measurements have been made to determine background noise levels from this source. Rugged mountains along a very narrow coastline at Anderson Bay afford little opportunity for human habitation. Noise-sensitive areas (NSAs) potentially affected by the project are discussed in section 4.8.

3.9 LAND USE AND RECREATION

3.9.1 Land Use

3.9.1.1 Regional

The Prince William Sound region is a large, primarily undeveloped area, composed of rugged coastline, timbered slopes, and high jagged mountains. Land uses tend to capitalize on the area's natural resources and coastal setting, and include recreation, wildlife habitat, mineral extraction, forestry, mariculture, energy-related industry, various types of commercial uses, small industry, and settlement (ADNR, 1988).

Principal landowners in Prince William Sound are the Federal government, the State of Alaska, and various native corporations. Federal land, which is managed by the U.S. Forest Service (FS) as Chugach National Forest, comprises approximately 70 percent of land in the Prince William Sound region (ADNR, 1988). Land owned, selected, or proposed for selection by the State of Alaska accounts for an additional 20 percent. The largest contiguous area of land owned, selected, or proposed for selection by the state (approximately 680 square miles), occurs east of Port Valdez. In addition to uplands, the state also owns land beneath navigable lakes and streams and most tidal and submerged lands (ADNR, 1988).

Native-owned and selected lands comprise approximately 10 percent of the land in the Prince William Sound region and are scattered throughout the region. The closest Native lands to the project site are owned by the Tatitlek Corporation, and are located approximately 6 to 8 miles south of Port Valdez.

Private or municipally owned lands make up a very small percentage of the land in the Prince William Sound region. Privately owned lands are located in small tracts throughout the Sound, primarily near developed communities.

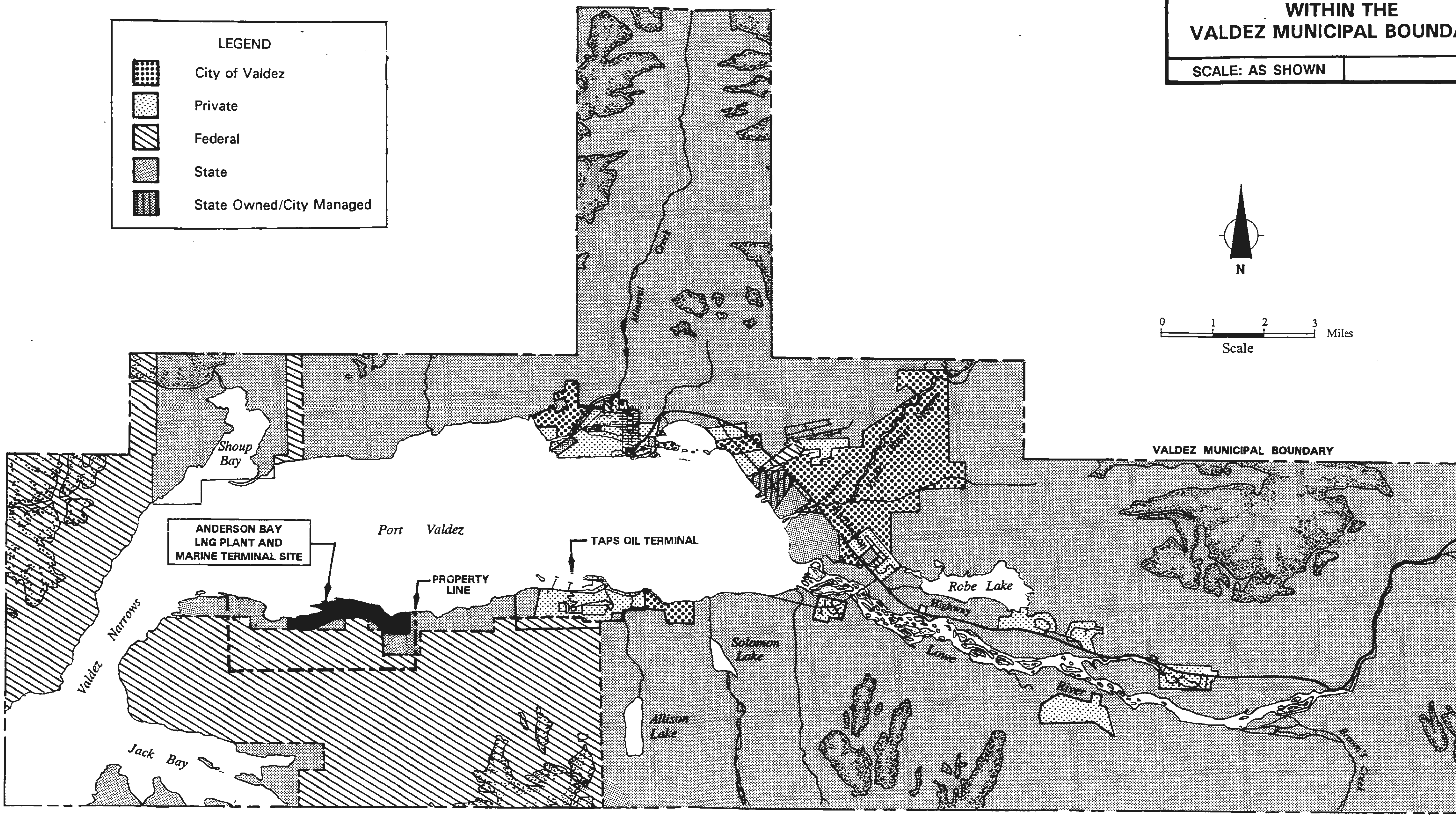
3.9.1.2 City of Valdez

The Valdez municipal area consists of 274 square miles of land and water, and includes much of the area known as Port Valdez. The western edge of the municipal boundary is the west end of Valdez Narrows. The municipal area extends 36 miles east from the Narrows to Keystone Canyon. The northernmost section of the municipal area includes the headwaters of Mineral Creek. The southern boundary is located approximately 25 miles south of the northern edge (see figure 3.9.1-1). Most of the land within the municipal area is mountainous, undeveloped, remote, and not easily accessible.

FIGURE 3.9.1-1

LAND OWNERSHIP WITHIN THE VALDEZ MUNICIPAL BOUNDARY

SCALE: AS SHOWN



Source: Information was derived from the State of Alaska's Valdez Coastal Management Program Map.

Land uses and land use designations within the municipal area include: recreation, wildlife habitat, forestry, energy-related industry, settlement, and transportation (ADNR, 1988). Much of the state land in Valdez is available for mineral leasing. At this time, however, the only mineral extraction occurring in the Port Valdez area is gravel extraction from the Valdez Glacier stream floodplain that is used for local construction projects and highway improvements (City of Valdez, 1986; Dengel, 1992).

Chugach National Forest lands within the western part of the municipal boundaries are classified as "timber production" (FS, 1984). As such, the lands are eligible to be used for timber production. However, there has been no significant harvest on Forest land to date and the FS plans no timber sales on land within the city boundaries within the near future (Behrends, 1992). As with state lands, most National Forest lands are open to mineral exploration and extraction. However, there are no active mining claims on the National Forest land within the municipal boundary. The only special use permit issued on National Forest land located within the municipal boundaries is a permit issued to a commercial hunting guide for an area that includes lands near the project area.

The greatest concentration of development in the Valdez municipal area occurs in "central Valdez" which includes residential neighborhoods, the central business district, schools, parks, the city dock, the Alaska Marine Highway ferry terminal, the boat harbor, and other public facilities. Future planned uses include continued expansion of the commercial and residential districts, and expansion of the Valdez Boat Harbor (City of Valdez, 1986).

Dayville Road provides the only vehicular access to developments located on the south side of Port Valdez. This area contains several major developments: the Alyeska Marine Terminal, the Solomon Gulch Hydroelectric Project, Fort Liscum, and the Valdez Fisheries Development Association fish hatchery. The Alyeska Marine Terminal complex is the largest facility, and most intensive land use in Port Valdez, and is located approximately 3.5 miles east of the project site. Major facilities at the complex include 18 crude oil holding tanks, 4 tanker loading berths, a ballast water treatment facility, and biological treatment ponds.

Federal land accounts for approximately 33 percent (48,000 acres) of the land within the Valdez municipal boundary. All Federal land is part of the Chugach National Forest.

Of the 222 square miles of land within the municipal boundary, approximately 61 percent (186,700 acres) is state owned. The City of Valdez will eventually receive title to approximately 6 percent (4,800 acres) of the state-owned lands under the Municipal Entitlement Act (City of Valdez, 1986). The ADNR, through the Public Interest Land Identification project, has identified lands within municipalities that will either be retained and managed by the state, or sold to private interests. State public interest lands in the Port Valdez area that will be retained and managed by the state will serve various functions such as: public recreation, fish and wildlife habitat, watersheds, forests, materials, and public facilities (City of Valdez, 1986). None of the state public interest lands identified in the Valdez District Coastal Management Program (VDCMP) are within 3.5 miles of the project site.

Municipally and privately owned land comprises less than 1 percent of land within the municipal boundary. Municipal and private lands are generally located near the city center. Private land is primarily residential, commercial, and industrial.

3.9.1.3 Project Site

The LNG Plant and Marine Terminal Facility would be located adjacent to and in, Anderson Bay. Approximately 426 acres of land are within the construction limits. The total project area including the buffer zone would encompass 2,500 acres. With the exception of recreation and subsistence gathering (see section 3.9.3.2 and 3.13), there is no active land use presently occurring at the site or on adjacent lands. There are also no improvements on the site, or on adjacent lands. The uplands of the site are covered in forest, and are difficult to reach due to the rugged coastline and steep terrain. FS land adjacent to the site has been classified as timber production, but is primarily managed for recreation (FS, 1984). In addition, Anderson Bay is used by boaters for safe moorage during dangerous weather.

The developed plant site would be located on land selected by the State of Alaska and currently managed by the ADNR. Project area lands have been designated by the ADNR as "reserved use" and are being held by the state specifically for the proposed project. To that end, these lands are closed to mineral entry and settlement. Yukon Pacific applied to the ADNR and received on December 10, 1988 a conditional lease for the TAGS Project, including the LNG Plant and marine terminal area. The buffer zone would encompass both state and Federal lands.

3.9.2 Comprehensive Plans

3.9.2.1 Prince William Sound Area Plan

The Prince William Sound Area Plan (PWSAP) describes how state-owned uplands, tidal, and submerged lands in Prince William Sound will be managed. The plan determines land-use classifications, land disposal locations, administrative designations, land selections, and relinquishments and guidelines for leases and permits on state lands. The PWSAP only pertains to state land, and requires that all activities on tidelands, submerged lands, and uplands within the coastal zone be consistent with the Alaska Coastal Management Program.

The PWSAP has created 29 management units that are generally homogeneous in terms of resources, topography, and land ownership. Each unit has "primary and secondary surface land uses" which indicate general uses that will be allowed in a unit. Each management unit is further broken down into subunits which is the level at which land uses are designated. All state land (including the project site and buffer) on the south side of Port Valdez, west of the Alyeska Marine Terminal is within subunit 21T (Anderson Bay-TAGS Terminal) of Management Unit 21. The land use designation in subunit 21T is transportation. All of subunit 21T has been reserved for construction of the TAGS pipeline and terminal unless a different terminal site is developed.

3.9.2.2 Valdez District Coastal Management Program

The Alaska Coastal Management Program was initiated in 1977 with the adoption of the Alaska Coastal Management Act. The Alaska Coastal Management Program is overseen by the Alaska Coastal Policy Council, which sets policy and reviews coastal district programs for approval. The Coastal Policy Council has adopted general policies or standards to guide coastal development.

The Coastal Management Program has established 31 coastal districts (as of February 1991) which have developed approved coastal management programs. All the programs are based on state standards. The VDCMP includes all areas within the Valdez municipal boundaries up to 1,500 feet in elevation, and all marine waters with in the city limits.

The VDCMP has established a series of policies regarding coastal development. The stated policies are used as a basis for "consistency determinations" by Federal and state agencies and the Coastal Coordinator. The plan's policies apply to all lands and subject uses and activities in the Valdez District. Under the provisions of 6 ACC 50, the State of Alaska is required to make a determination of consistency for certain permits and other activities requiring approval with the Alaska Coastal Management Program. The list of permits that are subject to coastal consistency determination has been divided into three groups: Categorical Approval, General Concurrence, and Individual Project Review. The proposed TAGS Project falls into the Individual Project Review category and as such, is subject to state and local review. It would also be considered to be a "major" project.

3.9.2.3 Valdez Comprehensive Development Plan

In 1991, the City of Valdez completed a draft update to the existing 1971 Valdez Comprehensive Development Plan. The update has not been approved by the City Council as of this date, so the 1971 plan is still valid. As part of the update, a survey of approximately 10 percent of the city's population was conducted in 1990 to, among other things, help determine development goals for the City of Valdez.

Based on the survey, several goals and objectives were included in the plan that could relate to the proposed project. The second stated goal in the plan concerns economic development, and encourages the development of a broadbased economy. Objectives of the economic development goal include: encouraging placement of a gas pipeline terminus in Valdez; development of an associated petrochemical industry; marketing the Port of Valdez as a commodities port facility for gas and oil pipelines; and striving to create an atmosphere in the community conducive to commercial and industrial development.

Other goals and objectives in the plan that could have an impact on the project include: the separation of incompatible land use; the prohibition of locating structures in environmentally sensitive areas; providing buffers between industrial and other land uses; controlling undesirable air and water emissions from industrial land use; providing adequate access to shorelines and public lands and water; and establishing development standards for lands that require special physical or environmentally sensitive areas.

In addition to the stated goals and objectives, the plan has a number of planning recommendations that could pertain to the TAGS Project. They include avoiding potentially adverse impacts on fish and wildlife and their habitats, and on water quality and vegetation. Where industrial activities would cause significant adverse visual or noise impacts, the developer would be required to provide adequate screening or buffers. Where feasible, a 100-foot buffer of natural vegetation would be maintained.

3.9.2.4 Chugach National Forest Land and Resource Management Plan

The current Land and Resource Management Plan for the Chugach National Forest was adopted in 1984 and was designed to guide management for a 10-year period. The plan will next be revised in 1995 or 1996 (Behrends, 1992). The forest is managed under the multiple use concept and has developed nine Management Areas which are composed of various Analysis Areas. The Analysis Areas have specific management goals, practices, standards, and guidelines for their identified resources.

The project buffer abuts Management Area 7 (Gravina). The Chugach National Forest land adjacent to the project is designated as a "timber production" analysis area, and as such has three primary management goals. The goals are to: 1) improve marine-oriented recreation opportunities, 2) maintain wildlife habitat, and 3) improve fish habitat. Four identified resources in the timbered sideslopes analysis area are recreation, wildlife and fish, timber, and minerals and geology.

3.9.2.5 Alaska Statewide Comprehensive Outdoor Recreation Plan

The ADNR is responsible for outdoor recreation planning by virtue of Alaska Statute 41.20.020. The ADNR prepares an updated recreation resource assessment and policy plan every 5 years that sets forth goals, assesses recreation needs, and analyzes issues, policies, and land use affecting recreation opportunities.

The project site is located in the Southcentral Region, where 62 percent of the state's population lives. Many existing recreation sites in the Southcentral Region are overcrowded. The 16 proposed additions to the state park system that are located in the region contain 84 percent of all the acreage in the entire state recommended for addition to the state park system. Proposed marine parks in Prince William Sound total 3,000 acres.

3.9.3 Recreational Resources

The proposed project is located in the northeast corner of Prince William Sound, which is a major state recreational resource due to its outstanding scenic and natural resources, and accessibility to more than half the state's population. Prince William Sound has over 2,700 miles of coastline, 4.4 million acres of National Forest, three major ice fields, islands, mountains, streams, and rivers (Prince William Sound Tourism Coalition, undated). Recreational activities available in the Prince William Sound area tend to focus on natural features and include sightseeing, fishing, hunting, camping, backpacking, boating, kayaking, and photography.

3.9.3.1 City of Valdez

Federal, state, and municipal lands are available throughout the Valdez area for various types of recreation. Figure 3.9.3-1 depicts the location of existing and proposed recreational facilities throughout the City of Valdez. The following subsections discuss developed facilities and services available in the City of Valdez area as well as dispersed recreation.

Developed Facilities and Services

Chugach National Forest lands within the municipal boundary are classified by the FS as "timber production," but are being currently managed to maintain scenic value and recreational use (City of Valdez, 1986). There are no developed FS facilities within the project area or city. The closest developed FS facility is a recreation cabin at Jack Bay, southeast of Anderson Bay (Behrends, 1992).

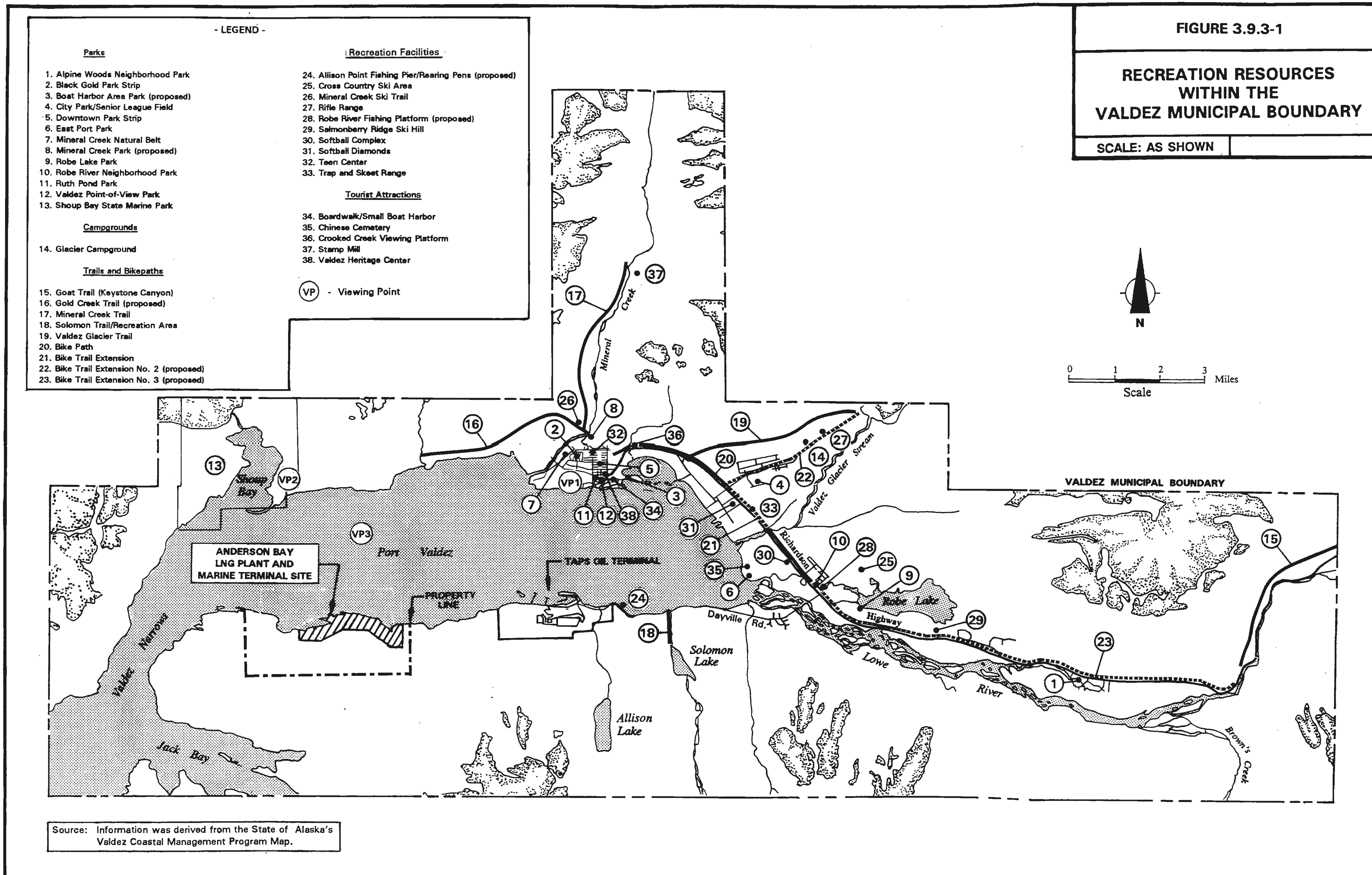


FIGURE 3.9.3-1
RECREATION RESOURCES WITHIN THE VALDEZ MUNICIPAL BOUNDARY
SCALE: AS SHOWN
- LEGEND -
Parks
1. Alpine Woods Neighborhood Park
2. Black Gold Park Strip
3. Boat Harbor Area Park (proposed)
4. City Park/Senior League Field
5. Downtown Park Strip
6. East Port Park
7. Mineral Creek Natural Belt
8. Mineral Creek Park (proposed)
9. Robe Lake Park
10. Robe River Neighborhood Park
11. Ruth Pond Park
12. Valdez Point-of-View Park
13. Shoup Bay State Marine Park
Campgrounds
14. Glacier Campground
Trails and Bikepaths
15. Goat Trail (Keystone Canyon)
16. Gold Creek Trail (proposed)
17. Mineral Creek Trail
18. Solomon Trail/Recreation Area
19. Valdez Glacier Trail
20. Bike Path
21. Bike Trail Extension
22. Bike Trail Extension No. 2 (proposed)
23. Bike Trail Extension No. 3 (proposed)
Recreation Facilities
24. Allison Point Fishing Pier/Rearing Pens (proposed)
25. Cross Country Ski Area
26. Mineral Creek Ski Trail
27. Rifle Range
28. Robe River Fishing Platform (proposed)
29. Salmonberry Ridge Ski Hill
30. Softball Complex
31. Softball Diamonds
32. Teen Center
33. Trap and Skeet Range
Tourist Attractions
34. Boardwalk/Small Boat Harbor
35. Chinese Cemetery
36. Crooked Creek Viewing Platform
37. Stamp Mill
38. Valdez Heritage Center
VP - Viewing Point
N
0 1 2 3 Miles
Scale
VALDEZ MUNICIPAL BOUNDARY
ANDERSON BAY LNG PLANT AND MARINE TERMINAL SITE
PROPERTY LINE
TAPS OIL TERMINAL
Port Valdez
Shoup Bay
Valdez Narrows
Jack Bay
Mineral Creek
Valdez Glacier Stream
Richardson Highway
Robe Lake
Dayville Rd.
Solomon Lake
Allison Lake
Lowe River
Brown's Creek
Source: Information was derived from the State of Alaska's Valdez Coastal Management Program Map.

The only state land within the municipal boundary of Valdez specifically designated for recreation is Shoup Bay State Marine Park. It is located on the north side of Port Valdez, approximately 3 miles to the northwest of the proposed site. There has been no development of facilities at the park, and there are no immediate plans to develop it. The Alaska State Parks Department will devise a facility and development plan when there is funding (Bingham, 1992). The Jack Bay State Marine Park is located in the City of Valdez south of Valdez Narrows. As with Shoup Bay, it has not been developed to date.

The Valdez City Parks and Recreation Department is responsible for municipal recreation facilities and activities in Valdez. The city manages a number of parks, several trails and bike paths, a campground, a softball complex, a trap and skeet range, a boat harbor, and other facilities (see figure 3.9.3-1). Three gymnasiums and an indoor swimming pool located at Valdez schools are used by the Parks Department for community recreation (Robb, 1993). The campground (which is leased to the City of Valdez from the state) has 102 camp spaces, and is the only developed public camping facility in the Port Valdez area. The city also operates the Valdez Boat Harbor, which has 513 slips.

A number of commercial recreation and tourism oriented businesses operate in the Valdez area. They include commercial bus tour operators from Anchorage that include Valdez on their tours; three luxury cruise lines that stop in Valdez; two large tour boat operators based in Valdez; 1-day cruise boats; and private guides and rental boats. Popular destinations for tour operators include Columbia Glacier, Shoup Glacier, and the Alyeska Marine Terminal. There are 3 private RV parks and 27 charter boat operators listed in the 1991-92 Facilities and Services Directory (Valdez Convention and Visitors Bureau 1991-92, undated).

Recreational activities in the Port Valdez area, as in the rest of Alaska, tend to be outdoor oriented. Fishing, tent camping, hunting, motorboating, and hiking are the five favorite outdoor recreation activities for residents of the southcentral Alaska region according to the ADNR (ADNR, undated). Visitors have similar interests, but also include sightseeing as one of their favorite activities.

Fishing is a popular activity in the Port Valdez area. In 1984, it was estimated that 18,620 fishing days occurred in Port Valdez. Of the various types of offshore fishing available, salmon fishing is the most popular. Offshore areas near Anderson Bay and Seven Mile Beach are popular with anglers (Valdez Fishing Facts, undated). Other fishing activities in Port Valdez include crabbing, shrimping, and fishing for rock fish. Streams in the Port Valdez area are closed to salmon fishing, so stream fishing efforts are directed primarily to fishing for Dolly Varden char (City of Valdez, 1986).

Big game hunting in the Valdez area is not well documented. Hunting activities have concentrated on mountain goat, black bear, brown bear, and moose. Waterfowl and upland game bird hunting also occurs in the area, but is undocumented (City of Valdez, 1986).

3.9.3.2 Project Site

Anderson Bay was evaluated by the ADNR for inclusion in the Alaska Marine State Park system. Although it was not included in the system, it was considered to have high recreational potential (City of Valdez, 1986).

There are no developed facilities near the proposed site although western Port Valdez is a "major recreation resource of Valdez" (City of Valdez, 1986). A lack of road access, facilities, and steep, rugged terrain, limit upland use of western Port Valdez. Beaches near the project site do receive some usage such as occasional boat landings and camping (City of Valdez, 1986). Seven Mile Beach is used for landbased activities such as picnics and weddings (Janka, 1992).

Most recreational activities occurring near the site, occur offshore. Boating and fishing are popular near the site, particularly during the summer. Anderson Bay is protected from wind and used by boaters for recreational purposes. It is also a refuge when bad weather prevents small boats from crossing Port Valdez to the city harbor. As mentioned previously, Anderson Bay and the area off Seven Mile Beach are popular sites for salmon fishing.

3.10 VISUAL RESOURCES

Visual Characteristics

Port Valdez is the northeastern-most section of the Valdez Arm of Prince William Sound. The narrow, deep fjord extends approximately 14 miles from the Valdez Narrows on the west, to the Lowe River delta on the east. Port Valdez is approximately 3 miles wide, and is surrounded on the north and south sides by steep rocky slopes, which rise to elevations of 4,500 feet above mean sea level. The mountainous terrain surrounding Port Valdez has been heavily glaciated, and consists of horns, aretes, cirques, U-shaped valleys, and rock basin lakes. Diversity in this rugged landscape is created by relatively level delta outwashes formed from the Lowe and Robe Rivers, Mineral Creek (Shoup Bay), and the Valdez Glacier (ADNR, 1988).

Anderson Bay is a shallow, well-defined bay, approximately 1 mile wide near the western entrance to Port Valdez. The steep rocky shoreline of the proposed site is composed of cliffs that rise from 30 to 40 feet in height above the shoreline. From benches adjacent to the cliffs, the terrain rises steeply to the southern boundary of the project area and reaches an elevation of approximately 300 feet above sea level. Beyond the southern boundary, are the Chugach Mountains, which form a backdrop to the site with elevations up to 13,000 feet. Below the rocky cliffs surrounding Anderson Bay, are several narrow beaches at the outlets of Seven Mile, Nancy, and Short Creeks, a small rocky island, and well-defined tidal wetland areas that appear as "meadows" depending upon tidal conditions.

Dense virgin coastal spruce and hemlock forests are found along much of the south side of Port Valdez and the project area. Hemlock and spruce on lower slopes give way to shrubby alpine vegetation at higher elevations. Understory vegetation is thick and consists of various species of alder and willow, salmonberry, devils club, blueberry, and other woody shrubs. The dense forest is virtually unbroken as it follows the shoreline from west of the Alyeska Facility, to the western end of Port Valdez.

Anderson Bay and the project site can be seen from the City of Valdez, from Shoup Bay State Marine Park, and to boat and plane traffic passing the site. Visibility of the site depends upon a number of factors such as weather, sun angle, and light. Low clouds and fog often cover vast sections of Valdez Arm, and obscure views of the project site from many areas of Port Valdez.

Forest Service Visual Management System

Although the project area is not located on FS lands and is not subject to National Forest visual standards, it is surrounded on the three land sides by Chugach National Forest. The FS has established a Visual Management System (VMS) that is used in multiple use resource planning and decision making processes. The VMS has established measurable standards for the visual resources of National Forest lands. A set of premises relating to landscape character, view expectations, number of viewers, viewer duration, and management objectives underlie the VMS (FS, 1974).

Because the project site is located on state lands, rather than on FS-administered lands, the project site was not inventoried as part of the VMS. FS land adjacent to the site, however, was inventoried and classified. The lands adjacent to the project site were assigned a landscape variety class rating of B ("common") rather than a rating of A ("distinctive") or C ("minimal").

Viewers

Port Valdez receives considerable use by water craft passing through the area on the way to or from Valdez. Many of the vessels are used by tourists and other recreationists to view attractions in the Port Valdez area and to access recreation areas. Destinations in the Port Valdez area that are popular with residents and tourists alike and require passing by the project site from Valdez include: Shoup Bay (which is directly across Port Valdez from the project site), Sawmill Bay, and Jack Bay. In addition, summer boat tours and cruises from Valdez go past the project site on their way to and from the popular Columbia glacier. Approximately 28,000 passengers on cruise ships and 660 passengers on charter boats passed by the site in 1992 (Anacker, 1993). In addition, the Alaska Marine Highway System cited 13,757 disembarking passengers and 13,974 embarking passengers on ferries that would have passed by the site in 1991.

3.11 SOCIOECONOMICS

The Socioeconomic study area is the City of Valdez (270 square miles), located at the southern terminus of the Richardson Highway at the head of the east/west oriented Port Valdez in Prince William Sound. It is 305 road miles from Anchorage, Alaska and 45 miles northwest of Cordova (Darbyshire & Associates, 1991). The City of Valdez is a scenic, tourist port town with short, mild summers and long, cold winters.

3.11.1 Population

The population of the City of Valdez in 1990 was 4,068 persons (table 3.11.1-1) (U.S. Bureau of the Census, 1990). This represents a 32 percent increase over the 1980 population of 3,079 persons and a 20 percent increase over the 1988 pre-Valdez oil spill population of 3,686 persons (Department of Finance, 1992). Beginning in March 1989, Valdez became the center for oil spill cleanup operations, precipitating a huge influx of people to the city. Although cleanup operations have ended, the city's population remains above pre-spill levels. In the period from 1970 to 1980, the TAPS pipeline and marine terminal construction led to a 206 percent population increase.

During the summer months of 1990, population was estimated at 4,653 persons. Additional employment in fish processing and new construction during the summer is responsible for the temporary increase in population (Department of Finance, 1992).

TABLE 3.11.1-1

Population and Selected Demographic Census Numbers

	Total Population	% Change Population	No. of Households	Per Capita Income
1990		1980 to 1990		
City of Valdez	4,068	32%	1,277	26,968
Alaska	550,043	37%	188,915	17,610
1980		1970 to 1980		
City of Valdez	3,079	206%	957	13,371
Alaska	401,851	34%	131,463	10,193
1970				
City of Valdez	1,005	NA	281	NA
Alaska	300,382	NA		NA

NA=Not available
Source: U.S. Bureau of the Census, 1970, 1980, 1990.

Population increases for the State of Alaska were 34 percent and 37 percent from 1970 to 1980 and 1980 to 1990, respectively (table 3.11.1-1). Population increase for the United States was 9.89 percent from 1980 to 1990, significantly lower than the growth rate of Valdez and Alaska.

3.11.2 Economy, Employment, and Income

Total employment for the City of Valdez was 2,200 persons in 1990 (table 3.11.2-1) (Alaska Department of Labor, 1992). The Valdez economy is heavily dependent on the Alaskan oil operations, tourism, Prince William Sound commercial fishing, and Federal and state government expenditures. In 1990, public administration (34.0 percent) and transportation, communication, and utilities (TCU) (25.6 percent) were the major employment sectors. The primary employer in the transportation sector is Alyeska, which is responsible for the transport of crude oil through the TAPS pipeline system to Valdez and then, by tanker to customers. Alyeska accounted for 40 percent of the Valdez TCU industry employment in 1990. An airline service, boat charters, shipping agents, stevedoring (i.e., loading and unloading ships), car rentals, and a bus and taxi service make up the remainder of the sector's employment. The 1989 Valdez oil spill created approximately 125 permanent transportation positions in Valdez, primarily through the establishment of the Ship Escort Response Vehicle System (SERVS), which is a subsidiary of Alyeska (Department of Finance, 1992).

The City of Valdez has experienced two spurts in employment growth in the past two decades. The first came with the construction of the Alyeska TAPS pipeline and oil terminal in the mid 1970s. This construction led to the tripling of employment levels in the city. When the pipeline and oil terminal were completed in 1977, employment fell by more than 50 percent

TABLE 3.11.2-1

Employment by Major Industrial Sector in the City of Valdez

	1980	1985	1988	1989	1990	1991
Construction	226	112	38	23	26	34
Manufacturing	9	171	206	261	247	288
TCU	449	416	388	1,129	563	655
Trade	105	155	175	237	265	228
FIRE	36	20	15	24	30	32
Services	242	251	294	462	346	306
Government	680	725	673	751	749	604
Total	1,746	1,850	1,789	2,887	2,200	2,146

TCU = Transportation, Communication, and Utilities
FIRE = Finance, Insurance, and Real Estate
Source: Alaska Department of Labor, 1991.

in Valdez. Employment levels did not fall below pre-construction levels because Alyeska became a major employer in the city.

In the period from 1980 to 1985, employment grew by just under 6 percent, but the Valdez economy was moving towards greater diversification. Pipeline revenues contributed to the construction of air and cargo port facilities as well as a civic center. Valdez became a major tourist attraction catering to cruise ships and visitors seeking hunting, fishing, and sightseeing opportunities. The fish processing business increased its presence in the local economy. Valdez offered road and air access, labor availability, and a dramatic increase in the Sound's salmon fishery.

The Exxon Valdez oil spill of 1989 dramatically increased employment levels in Valdez. The workforce nearly doubled within 2 weeks of the spill. Total employment reached 2,887 in 1989, with enormous gains in the transportation sector. Again, despite a fall-off in these jobs after spill cleanup, employment remains above pre-spill levels.

Manufacturing has consistently increased in importance in the Valdez economy, representing 11.2 percent of employment in 1990 compared to less than 1 percent in 1980. Increases in transportation and manufacturing are partly attributable to the increase in commercial fishing that has occurred in Valdez. On the other hand, construction employment has declined from 1980 levels of 226 persons to the 1990 level of 26 persons, an 88 percent decrease. Construction employment increased in 1992 when the Petro Star Refinery was built. In January 1993, the Petro Star Refinery construction was completed and the refinery now employees 25 persons with potential for future expansion (Griffin, 1993).

In 1990, per capita income in the City of Valdez was $26,968 compared to the state average of $17,610. This is due in part to the relatively high average wage earned by the Alyeska Terminal employees.

3.11.3 Housing

The 1990 U.S. Census indicated a total of 1,499 housing units in the City of Valdez with a 14.8 percent vacancy rate. There are approximately 583 single-family homes, 617 mobile homes, and 225 multi-family homes, and a total of 63 hotels, motels, and bed and breakfasts (Darbyshire & Associates, 1991). Nearly 45 percent of all vacant units in 1990 were mobile homes. Many of these mobile homes are considered poor quality housing (Smith, 1992). The vacancy rate for single-family units was 6.9 percent. In the past, the housing market has been tight. Construction of new homes is expensive, especially during the winter months because of the high cost and frequency of snow removal.

The vacancy rate for multi-family units was 22.9 percent in 1990. A number of bed and breakfasts rent rooms to offset the decline in tourism during the winter months. The rental market becomes tight during the summer with increased demand.

The average cost for a moderate house is $130,000 and average fair market rent for a two-bedroom apartment is $853 per month.

In 1992, the Cottonwood, Mineral Creek, and Winterpark subdivisions stimulated housing development. Cottonwood, located west of town off of Egan Drive across the Mineral Creek Bridge, currently has about 34 lots on 300 acres of land. Also located west of town, between West Egan and Pioneer near the elementary school, is Winterpark which has approximately 30 lots with an additional 50 or 60 acres available for development. Mineral Creek Heights is located on North Mineral Creek Drive, north of town. Additional areas for development include the Robe River subdivision, located 5.5 miles east of town and Alpine Wood, located 10 miles outside of town. These subdivisions use city water and either city or onsite sewer. There is adequate land to meet foreseen demand; however, sewer and water services may need to be expanded in certain areas (Dengel, 1993). Foreseen demand does not include construction and operation of the Yukon Pacific LNG facility.

3.11.4 Public Facilities and Services

The City of Valdez school programs and curricula have an excellent reputation statewide (Darbyshire & Associates, 1991). The school systems serve students in grades K-12. There is an elementary school with 583 students. The elementary school has a 650 person capacity. The junior high school has 154 students with a facility capacity of 125 students. Four new modules were constructed in 1991 to support the additional students. The high school has 232 students, with a facility capacity of 400 students. There are no immediate plans for expansion.

The pupil to teacher ratio is 15 to 1, and there is little teacher turn-over. The teacher pay schedule ranks in the top 3 of the 54 school systems in the State of Alaska. Facilities include libraries and gymnasiums, which are used for community events as well. Books and supplies are currently adequate (Tongen, 1992).

The Valdez Community Hospital is a 15-bed acute care facility managed by Lutheran Home Services Management Company. There are four doctors who practice out of the Valdez Medical Clinic located next to the hospital. The hospital has 34 employees, including 12 nurses, 6 nurses' aids, and 1 licensed practical nurse. The hospital is fully equipped and includes emergency room, surgical, and radiological facilities as well as a laboratory. In 1989 during the Valdez oil spill cleanup, additional doctors were brought into the hospital. Despite increased staffing, hospital services were overwhelmed by the number of persons seeking care at the hospital (Jacobs, 1993).

The police department has approximately 24 full-time employees, including the Chief of Police, 14 certified officers, 4 jail officers, and 5 dispatchers. Officers work 12-hour shifts with 7 days on and 7 days off. All police on the force must complete Alaska State Troopers Police Training. The department owns seven cars (Crystal, 1992). The jail can house 16 offenders. In 1991, the department assumed civil defense responsibilities in order to ensure the health and safety of the public during and after a civil or natural disaster (Darbyshire & Associates, 1991).

The Valdez fire department has 12 full-time employees including the Fire Chief, 3 captains, 3 lieutenants, 3 engineers, and 1 secretary. The department also has approximately 25 volunteer fire fighters from the community. Fire fighters work in 24-hour shifts, averaging 150 hours a month. In addition, the Alyeska Fire Brigade is available to assist during large-scale fires, including emergencies at the terminal. Alyeska's helicopter is routinely used by the fire department for search and rescue missions (Lundfelt, 1993).

The fire department trains fire fighters in fire fighting and emergency services. The department provides public safety programs in the area of fire protection, rescue, and emergency medical services (EMS). The fire protection program includes marine fire protection response and investigations, in addition to structural fire protection and training. The rescue program is designed to handle any reasonable contingency, including high angle mountain rescue, avalanche rescue, and swiftwater rescue (Darbyshire and Associates, 1991).

Equipment owned by the fire department includes five engines and two heavy tankers (McCollum, 1992). EMS personnel operate three fully equipped ambulances and a rescue truck, in addition to contracting for local aviation service when required. The fire department headquarters and main station are housed in the east north wing of City Hall. There are additional stations at the airport, the Robe River subdivision, and Alpine subdivision (Darbyshire & Associates, 1991).

Police and fire departments experienced unusually high demands during the Valdez oil spill cleanup. For the most part, existing staff met demands successfully, but both departments were strained and overworked. Currently, staffing and facilities adequately serve the community's needs.

The main public water system, Valdez Downtown, services the majority of the city. It consists of four wells with total usage of 1.5 million gpd. Total pumping capacity is 4.3 million gpd (3,000 gpm). There are two wells within the South Central Division System serving a small rural area. The Robe River Subdivision and Loop Road system each have one well (Schlitz, 1992). The Valdez Comprehensive Development Plan notes that any additional development, such as the Mineral Creek Subdivision, will require additional wells (Darbyshire & Assoc., 1991). The Valdez Sewage Treatment Plant operates at 60 to 70 percent capacity, taking in 1.75 million gpd (Schlitz, 1992).

3.11.5 Fiscal

The City of Valdez 1991 revenues were approximately $37 million, down 4 percent from the 1990 level of $39 million (table 3.11.5-1). Revenues for 1991 include approximately $18.8 million in taxes, $12.9 million in intergovernmental transfers, and $3.2 million in revenues from use of money and property. Taxes received based on the assessed value of oil-related facilities are the major revenue source, accounting for 90 percent of the local government's tax base. The assessed value of these facilities is decreasing at a rate of approximately 7.5 percent per year (Darbyshire & Associates, 1991).

The city expended $3.5 million on capital improvement projects during 1991. Debt levels are not excessive at $50 million, down $7 million from the 1990 level. There is no income or sales tax in the City of Valdez. The property tax rate was $19 per $1,000 of assessed value in 1992. A bed tax of 6 percent is charged by hotels, motels, and bed and breakfasts.

3.12 TRANSPORTATION

Roads and highways are administered by both the state Department of Transportation and the City Engineering Department. Other transportation facilities, including the port, harbor, and airport, are administered by the Municipal Dock/ Boat Harbor Department.

3.12.1 Highways

The Alaska Department of Transportation manages 34 miles of roads located within the city limits, including Richardson Highway connecting Valdez with Fairbanks, Anchorage and the lower-48 states. This is a two-lane highway with 6-foot shoulders that is in good condition. Other roads under state management include Mineral Creek Loop Road, Egan Drive, and Dayville Road, two-lane paved highways with no shoulders. Given current traffic patterns, Mineral Creek Road and Egan Drive, two heavily used roads, will need upgrading within the next 10 years.

The City of Valdez maintains 22.29 miles of roads. The age of the roads ranges from 6 months to 27 years old, and most are less than 15 years old (City of Valdez, 1992). Normally, roads within Valdez would have a 30-year life with proper maintenance and normal traffic.

In general, the city's infrastructure is well maintained and quite able to handle a population of twice its present size (Department of Finance, 1992). Heavy traffic is a problem on most roads during the summer months.

3.12.2 Marine

Valdez has a bustling port with two separate deep water docks, a city dock with a 2-acre staging area, and a container terminal with a 21-acre staging area (Darbyshire & Associates, 1991). In terms of activity level, the port is not overcrowded. Usual marine traffic consists of a number of Exxon vessels, cruise ships (averaging about 35 landings a summer), approximately 200 fishing boats, a general cargo barge, and several foreign freezer ships. Operational procedures that govern marine traffic in and out of Port Valdez are discussed in section 2.1.2.3.

TABLE 3.11.5-1

Fiscal Data for City of Valdez, Alaska

Combined Statement of Revenues, Expenditures, and Changes in Fund Balances
All Governmental Fund Types and Expendable Trust Fund

Year Ended December 31, 1991
With Comparative Totals for Year Ended December 31, 1990

	Governmental Fund Types			Fiduciary Fund Type	Totals (Memorandum Only)	
	General	Special Revenue	Capital Project	Expendable Trust	1991	1990
Revenues:						
Taxes	$18,798,480	--	--	--	18,798,480	19,332,389
Licenses and permits	94,973	--	--	--	94,973	61,464
Fines and forfeitures	30,370	--	--	--	30,370	36,373
Intergovernmental	6,034,005	6,871,487	648,083	--	13,553,575	12,991,224
Revenues for use of money and property	1,026,169	2,197,064	--	2,247	3,225,480	4,050,350
Charges for services	473,137	836,365	--	--	1,309,502	1,646,470
Other	--	208,278	34,375	--	242,653	799,791
Total revenues	26,457,134	10,113,194	682,458	2,247	37,255,033	38,918,061
Expenditures:						
Current:						
General government	2,970,348	--	--	--	2,970,348	2,943,707
Public safety	2,682,124	--	--	--	2,682,124	2,550,358
Public works	2,097,280	688,076	--	--	2,785,356	2,852,930
Public service	2,611,242	810,609	--	--	3,421,851	3,278,469
Other services	--	45,450	--	3,000	48,450	28,088,433
Education	--	8,346,372	--	--	8,346,372	7,915,064
Debt service:						
Principal retirement	5,030,000	--	--	--	5,030,000	4,710,000
Interest and fiscal charges	4,908,074	--	--	--	4,908,074	4,955,489
Capital projects	--	--	3,517,819	--	3,517,819	2,775,812
Total expenditures	20,299,068	9,890,507	3,517,819	3,000	33,710,394	59,990,262
Excess of revenues over (under) expenditures	6,158,066	222,687	(2,835,361)	(753)	3,544,639	(21,072,201)
Other financing sources (uses):						
Operating transfers in		3,791,258	1,871,523	--	5,662,781	6,255,385
Operating transfers out	(5,548,040)	(2,671,443	--	(36,608)	(9,256,091)	(9,642,825
Net other financing sources (uses)	(6,548,040)	1,119,815	1,871,523	(36,608)	(3,593,310)	(3,387,440)
Excess of revenues and other financing sources over (under) expenditures and other uses	(389,974)	1,342,502	(963,838)	(37,361)	(48,671)	(24,459,641)
Fund balances, January 1	5,652,271	22,104,184	2,255,947	37,361	30,049,763	54,509,404
Fund balances, December 31	$5,262,297	23,446,686	1,292,109		30,001,092	30,049,763

Source: Comprehensive Annual Financial Report of the City of Valdez, Alaska, 1992.

The Alaska State Ferry System provides ferry transportation to Valdez from Cordova during the winter and from Whittier during the summer. The winter schedule includes stops in Valdez about every 2 days, the summer schedule, beginning May 1, has scheduled stops 4 days a week.

The City of Valdez boat harbor provides boat moorage, amenities (such as showers, rest rooms, fresh water), and haul out services. There are 513 slips and a waiting list of 2 to 3 years for available space. During 1990, the harbor operations had revenues of over $350,000 and expenses of $315,000 (Darbyshire & Associates, 1991). There is a boat harbor expansion plan which is in the initial phases of development. It would increase the current number of slips to a maximum of 600.

3.12.3 Airport

The Valdez Airport, located east of the Valdez city center, is a relatively large and adequate airport for a city the size of Valdez (see figure 2.1.4-2). The runway is 6,700 feet long and well lit for nighttime flights. The airport normally handles 24 private planes and 7 commercial flights in and out per day (this increases to 8 or 9 flights during the summer months). Mark Air and ERA are the two major carriers. There are also two helicopter companies and a few cargo and charter planes. In 1989 during the Valdez oil spill cleanup, airport operations averaged approximately 400 to 500 flights per day. There is a waiting list for airplane hangars. Room is available to construct additional hangars, although none are currently planned (McAllister, 1992).

3.13 SUBSISTENCE

Projects proposed for the State of Alaska, which require Federal permits prior to construction and which are determined to potentially have significant effects on the human environment, are required to evaluate the effects of those projects on subsistence uses and needs under Section 810 of the Alaska National Interest Lands Conservation Act (ANILCA). ANILCA requires the preparation of an evaluation of effects of a project on subsistence use and needs, a finding of whether subsistence uses will be significantly affected, a public hearing with prior notification in the area, and an 810 Determination.

The subsistence use of resources has been traditionally and still is pursued as a way of life in much of Alaska. It is an integral part of the social structure, cultural traditions, and identity, as well as a source of nutrition for Alaska Natives. The foundation of their social and cultural systems is the utilization of the natural environment and its resources. Subsistence foods typically comprise a significant portion of their diet, particularly in smaller villages where imported foods are not readily available or are expensive to transport to the area. Much of Native Alaskan culture is centered around teaching subsistence methods to the young, activities to obtain subsistence foods, sharing and exchanging resources with others, and the religious and cultural gatherings in which the food is shared or eaten.

3.13.1 Overview of Resource Harvesting

Subsistence harvesting patterns are determined by the types of resources available, the proximity of those resources, the season, ease of travel and access, and historical uses of resources. Each community relies upon specific subsistence resources to varying degrees based upon these factors. Major subsistence resources include fish, invertebrates, marine mammals, deer, waterfowl, bird eggs, firewood, and house logs. Deer are the most commonly harvested resource. Goat hunting takes place above mountain timberlines, particularly in the eastern part of Prince William Sound.

Major subsistence harvesting activities occur year-round but harvesting of specific resources is highly seasonal. Salmon are primarily harvested from May through October; crab, shrimp, and halibut from April through October when boating is easier and the species are not in deep waters; shellfish from September through April; and deer are hunted after October when the cold weather drives them to lower elevations. Hunters usually do not harvest seal and sea lion during the pupping season.

Under current regulations, only Alaska Natives can legally hunt sea mammals. Seals are hunted throughout Prince William Sound, but most often in the western part of the sound.

3.13.2 Community Harvesting

Two communities exist in the project area, Valdez and Tatitlek, from which subsistence/personal uses are most likely to occur and that could potentially be affected by increased tanker and other vessel traffic and potential accidents. Subsistence/personal harvests are described below for each community. The primary sources of information concerning subsistence and personal use of resources are the ADFG (1988) and Rural Alaska Community Action Program (1981).

Valdez

Valdez primarily has a wage employment and cash economy. As a result, Valdez residents' hunting and fishing levels are considered low when compared to residents from elsewhere in the Prince William Sound/Copper River Basin region. In 1987, the Alaska Joint Boards of Fisheries and Game classified Valdez as a nonrural area and, as such, it would not receive priority hunting and fishing rights if subsistence resources were determined to be significantly limited. Thus, harvests by Valdez residents since 1987 have been classified as personal use or recreational, and are not considered to be subsistence.

Tatitlek

Tatitlek is the oldest remaining Native community on Prince William Sound. Tatitlek is a Chugach Eskimo community of 119 people (in the Tatitlek census designated place [CDP] for 1990; U.S. Bureau of Census, 1992) located on Prince William Sound, 16 miles south of Anderson Bay, and outside of Port Valdez. It is on a point surrounded by the Tatitlek Narrows and Boulder Bay, and across from Bligh Island. Access is primarily by boat and plane.

The village economy is primarily based upon commercial fishing and subsistence harvesting activities. Approximately 83 percent of the households rely upon fishing-related employment on at least a seasonal basis. In 1979, 43.8 percent of the Native households had a net annual income of less than $10,000, and over 60 percent were under $15,000. The majority of the cash appeared to be expended on fuel, groceries, and fishing equipment. Overall, income levels and the amount spent on food, expensively boated or air freighted in from Cordova and Valdez, indicated that residents rely heavily upon subsistence harvesting activities to meet their dietary needs (Rural Alaska Community Action Program, 1981).

Tatitlek residents focus summer (May through August) subsistence harvesting activities on salmon, berries and plants, and intertidal resources (i.e., clams, cockles, octopus, shrimp, sea cucumbers, and herring roe). Year-round subsistence harvesting occurs for halibut, seal, crab, ducks, octopus, cockles, clams, and chiton (gumboot). Harvest activities of residents tend to be oriented to use of the relatively close marine and coastal areas (Rural Alaska Community Action Program, 1981).

In 1979, at least 25 percent of Tatitlek residents harvested 39 of 113 subsistence resources available, 13 of these were fish. Three-fourths or more of the households harvested silver salmon, red salmon, and pink salmon. Fifty to 74 percent of the households harvested king salmon, chum salmon, and halibut. Twenty-five to 49 percent of households also harvested herring and red snapper. Salmon harvests annually averaged 113 pinks/household, 50 chum, 43 red, 38 silver, and 10 king salmon. Salmon were primarily harvested by use of gillnets in saltwater (Rural Alaska Community Action Program, 1981).

Game subsistence harvesting was slightly less pervasive than fish harvesting. Twenty-five percent or more of the households harvested 12 big game and bird resources. Fifty to 74 percent of the households harvested deer while 25 to 49 percent harvested black bear and goat. Fifty percent or more of the households harvested goldeneye, Canada goose, and bird eggs; and 25 to 49 percent harvested buffalohead, loon, mallard, common merganser, scaup, black scoter, and surf scoter (Rural Alaska Community Action Program, 1981).

Fifty to 75 percent of Tatitlek households harvested tanner crab, octopus, cockles, chiton (gumboot), and seaweed with herring roe. In addition, one-fourth to one-half of the households also harvested dungeness crab, king crab, butter clams, razor clams, and shrimp (Rural Alaska Community Action Program, 1981).

Three-fourths or more of the households harvested harbor seal and 50 to 74 percent harvested sea lion.

Over one-fourth of households harvested seven types of berries and plants. Three-fourths or more of Tatitlek households harvested salmonberry and highbush blueberrys; 50 to 74 percent harvested wild celery; and 25 to 49 percent cloudberry, highbush cranberry, and nagoonberry (Rural Alaska Community Action Program, 1981).

3.14 CULTURAL RESOURCES

Prehistoric/aboriginal site density in the Prince William Sound area is quite low in comparison with other Alaska coastlines, and only a few major site excavations have been carried out. No intact sites predating about 3800 BP have been found in the area, possibly because of tectonically induced shoreline changes. As a result, the culture history for the area is based mainly on extensive surveys and excavations at the Palugvik site in the early 1930s by de Laguna (1956). This site is located approximately 56 miles southeast of Anderson Bay on Hawkins Island in southern Prince William Sound. She defined four cultural stages for the area. These stages are based on diagnostic artifacts, presence or absence of European trade goods or skeletal evidence of European diseases, degree of shell and bone decomposition in middens, and the nature of trees growing on abandoned sites. The attributes of these stages (Hassen 1978 and Workman 1978, cited in Mobley et al., 1990) may be summarized as follows:

Older Prehistoric Period (before 1750 BP). Sites and components assigned to this period exhibit decomposed shell in midden; incised stone plaques; a relative abundance of planing adzes and smaller woodworking tools; a predominance of simple stemmed slate blades and slender, awl-like slate projectile points, over barbed slate blades; chipped ulu-shaped scrapers; socket pieces with bifurcated bases; a greater abundance of bone or shell beads; a scarcity of fire-cracked rock; and the absence of native copper.

Younger Prehistoric Period (undated). Sites and components assigned to this period exhibit less shell decomposition. In contrast to the Older Prehistoric Period, fire-cracked rock (interpreted as sweatbath refuse) is abundant, and native copper is present. Other attributes associated with this period are grooved splitting adzes, stone picks, very small adze blades or scrapers, small ground chisels, barbed slate points, socket pieces with plain bases, and war clubs.

Protohistoric Period (undated). Attributes of sites and components of this period are similar to those of the earlier Younger Prehistoric Period, with large blue "Cook type" beads (and presumably some iron).

Historic Period (after 1783). The start of this period is marked by the appearance of "Glacier Island" trade beads and other European goods associated with the beginning of Russian expansion into the region. Human bones from this period show evidence of introduced disease; Christian burial practices are used by the aboriginal population.

More recent archeological work in the Valdez area commenced in 1969 and 1970 in connection with the construction of the TAPS Project (Workman, 1970). No sites were found at that time. Subsequent work has consisted almost exclusively of surveys and inventories and the area sequence outlined above remains unchanged.

The most common types of sites found in the Prince William Sound area are rockshelters and villages. The latter are generally located close to shore in proximity to resource loci, primarily salmon streams and on protected waters with a beach suitable for landing water craft. A preference for locations near caves suitable for interment of the dead is also indicated. Yukon Pacific sponsored a cultural resources survey of the LNG Project area concentrating on locales possessing one or more of these characteristics (Hall, 1990). No cultural resource sites were located.

A check of the Alaska Heritage Resource Survey (AHRS) files identified eight non-aboriginal historic period sites around Port Valdez in the area stretching from Old Valdez in the east to Entrance Island in the west. Two additional sites were noted on the AHRS map in the same area. None of these 10 sites is located within the project area.

The Alaska SHPO has reviewed the report of the Yukon Pacific-sponsored cultural resources survey of the project area and concluded that no properties on or eligible for the NRHP are located in the project area.

3.15 ALTERNATIVE CONSTRUCTION CAMP SITE AND ACCESS ROAD

After examining several potential sites for the location of the construction camp site, one alternative offered sufficient merit to be carried forward for further assessment. This alternative, as described in section 2.3.1, would have the construction workforce housed in Valdez at the existing, but upgraded, camp site adjacent to the airport. This camp site is owned by Arctic Camps Limited, a commercial operation which operates a 700-person camp on its 7.5-acre property. About half the site is occupied by its buildings which include 7 two-story dormitories and a cafeteria/dining room that can seat 250. The remainder of the site, which is located on the gravel outwash downstream from the Valdez Glacier, supports grass and shrub vegetation and there are no waterbodies or flowages. Arctic Camps just recently purchased an adjacent 10-acre parcel of land which has a 100 foot by 130 foot steel warehouse building which the company intends to rent to outside agents. It also intends to construct a new camp.

Arctic Camps has temporary camps at other locations for construction and other purposes. Its current inventory of modular structures is sufficient to expand its Valdez facilities to accommodate the projected peak Yukon Pacific workforce of 4,000 (Purcell, 1993). From a scheduling point of view, the camp upgrades could be put in place well in advance of the main construction, making a floating camp at Seven Mile Creek unnecessary.

With this camp site alternative, it would be necessary to construct road access to the Anderson Bay site. This would require a total of 1 mile of new, off-right-of-way road extending from the end of the existing Alyeska site road (figure 2.3.1-2) west to the pipeline right-of-way at Salmon Creek. From there, 2.5 miles westward to the Anderson Bay site, the road would follow the pipeline alignment which generally follows the shoreline at the 100 foot contour. The road would require the clearing of an estimated 9 acres of forest over and above the clearing requirements of the pipeline right-of-way. This forest type is spruce-hemlock, interspersed with alder and is typical of the region and is similar to what currently exists at the LNG plant site.

Although no wetlands have been identified from the available aerial photographs, some small ones can be expected to occur along the 3.0-mile alignment. These would have to be filled to prepare the road bed.

This access road would also cross Sawmill, Salmon, and Seven Mile Creeks. The latter two crossings could be paired with that of the pipeline. Each of these streams is known to support pink and chum spawning. Bears have been observed feeding at Sawmill Creek as well.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 GEOLOGY AND SOILS

During construction of the LNG facility, 3,018,000 cubic yards of overburden and 6,655,000 cubic yards of rock would be excavated. This process would involve grading, ripping, excavating, and movement of material by heavy equipment in addition to drilling and blasting. Approximately 70 percent of the generated material would be used for structural fill onsite. The remaining 30 percent of debris would be disposed of as discussed in previous sections. The excavated areas would consist of steep rockcut slopes and level benches which would be the primary sites for the facility.

4.1.1 Bedrock and Slope Stability

The stability of the surficial deposits and shallow bedrock would depend on the angle or slope of the cut, the nature and orientation of bedrock jointing, groundwater conditions, and the strength and weathering characteristics of the material. During site construction, major cuts would be made at the south edge of the site and along the access roads. The proposed angle of the slope is 50° and would be oriented approximately east-west. Slope cuts with angles 50° or greater would oversteepen the slopes and increase the potential for rock slides. The proposed 50° slope cuts would not oversteepen the bedrock slopes. The new cuts would, however, weaken the rock along existing foliation, bedding planes, and joints making downslope movement of rock and soil more likely. Yukon Pacific proposes to minimize this risk by using rock bolts to stabilize the cut slopes. These bolts would be at least 30 feet long and placed on 10 foot by 10 foot centers across slopes where unstable conditions are encountered. The bolts would substantially reduce the risk of bedrock slope failures. Instability of cut rock faces was encountered during the construction and operation of the Alyeska facilities. Stabilization of these walls using a combination of rock bolts and drains, and frequent monitoring was apparently successful. The planned maximum rock cut-slope height for the LNG site is 100 feet. If this height is exceeded during construction, then the slope would be benched. These height limits would minimize the potential for bedrock slope instability.

The presence of water on rock slopes also increases the pore pressure which facilitates ground movement. Yukon Pacific plans to dewater the rock slopes with the use of weepholes and toe drains. The proposed dewatering would greatly add to the slope stability. Draining this water would also reduce the effects of ice wedging during the winter months. Ice wedging results in the fracturing of rocks caused by the expansion of water upon freezing. The water collected would be channeled into the planned drainage and stormwater system.

For added safety, Yukon Pacific proposes to construct a permanent catchment area at the base of each slope. The catchment would have a minimum width of one-half of the slope height. This would be sufficient to catch all debris from minor rock falls that can occur during construction.

Thin deposits of glacial overburden are widespread throughout the site. The overburden is 0 to 15 feet thick and composed of silt, fine- to medium-grained sand, and gravel. Construction and movement of these materials by heavy equipment may result in localized slumping. During daily construction activities the available heavy equipment would be sufficient to remove these unstable deposits. Any unstable areas would be maintained on a daily basis so that slumping does not occur during nonconstruction periods. Maintenance of unstable areas would include grading the sites to a lower angle and installation of erosion control measures, if necessary.

4.1.2 Surface Erosion

The primary project-related impact on soils would occur during site excavation. This would include the removal of overburden soils down to bedrock and the placement of these soils in planned fill and disposal areas. The soils would be removed because their long-term stability beneath the permanent facilities cannot be ensured. Under the current construction schedule, excavation of the site would take place over three consecutive summers.

The total construction area subject to vegetative clearing and excavation would be 392 acres. This includes approximately 377 acres of forest and shrub and 15 acres of palustrine wetlands. Possibly not all of this area would be denuded and graded; however, this analysis assumes the project would impact the entire acreage. The soil overburden profile ranges from very thin on the ridges to as thick as 20 feet in the glacial troughs. Because the bedrock is so shallow on the ridges and is often covered with a layer of weathered and broken rock, the overburden material is expected to consist of organic soils, stumps, roots, glacial till, and rock. Approximately 3,018,000 cubic yards of overburden material would be generated during the excavation activities. It is estimated that up to 50 percent of this material would be organic soils.

The average annual precipitation at the site is about 61 inches which includes the water equivalent of 294 inches of snow. Under the current site conditions, the steep slopes and shallow soils result in an exceptionally high runoff rate (approximately 12 cubic feet per second per square mile). The drainages in the area are steep ravines that discharge into streams that flow directly into Anderson Bay. During the 3-year excavation period, portions of the construction site would be disturbed and exposed to potential water-related impacts before the soils would be relocated to the designated fill areas and the potential for soil loss and sedimentation due to rain runoff and snow melt would be high.

To reduce surface water related impact on soils, Yukon Pacific filed an Erosion Control Best Management Practices Manual (BMPM). The BMPM is not a detailed site-specific plan rather it describes general guidelines and erosion control techniques that are applicable to the non-permafrost conditions characteristic of the Valdez area. Yukon Pacific has indicated that a detailed site-specific erosion and sediment control plan that conforms to the BMPM guidelines would be developed prior to initiation of construction. This site-specific plan would be submitted to the Alaska Division of Governmental Coordination (ADGC) for review and approval. The ADGC, acting as the lead state agency, would coordinate its review with several other state agencies including the ADEC, Alaska Public Utilities Commission (APUC), ADNR, and ADFG (Barber, 1993).

The objective of Yukon Pacific's BMPM is threefold. First, it provides guidelines for stabilizing soils and controlling hydraulic erosion processes to minimize erosion-related damage to natural terrain and earth structures. Second, it recommends methods to decrease the potential for siltation of streams and other bodies of water that receive runoff from the proposed site. Finally, it emphasizes the importance of maintenance of the installed erosion control structures during and following construction.

Five major topics are addressed in the BMPM: site preparation; slope stabilization measures; channel control structures; sediment retention structures; and revegetation measures. For each of these five topics the BMPM provides several best management guidelines that either could or would be implemented to minimize disturbance to the local environment. A brief summary and analysis of effectiveness of the best management practices for each of the five topics are discussed below.

Site Preparation

Clearing activities would be restricted to areas marked on the ground prior to initiation of construction. Trees would be felled within the permitted clearing boundaries. Any felled trees or other debris which accidentally enters a stream would be removed from the water within 48 hours. The BMPM specifies that any borrow sites which would be used should be worked in phases to minimize the amount of exposed surface area at any one time. It also suggests that these borrow sites would be located away from groundwater seepage zones and floodplains to the extent possible. The BMPM indicates that surface runoff upslope of the borrow areas should be diverted away from the borrow areas by diversion ditches, while surface runoff from the borrow areas should be collected in settling ponds.

Temporary erosion and sediment controls would be installed on the downhill side of construction work areas prior to any earthwork. Temporary drainage ditches would be constructed prior to major ground disturbance work to facilitate offsite drainage through the work area until permanent drainage structures could be installed. Temporary control structures would be designed for a 10-year storm and permanent control structures would be designed for a 50-year storm. Cut and fill slope angles would vary based on the composition and erodibility of the fill material. Steeper slope angle would be allowed for coarse-grained, less erodible material than for fine-grained or high moisture soils.

Slope Stabilization

Slopes would be stabilized by constructing structures to direct surface runoff away from erodible slopes and by revegetating disturbed areas. Diversion terraces and interceptor dikes would be installed or cut into slopes to channel runoff laterally away from erosion-sensitive areas to stable erosion-resistant channels. Diversion levees may also be installed along the top of slopes to prevent runoff from crossing erosion-sensitive slopes. These diversion structures would be cleaned periodically to prevent the buildup of sediment and debris. Benches or flat terraces may be built to stabilize steep cut and fill slopes. These benches would be constructed across the slope and would be engineered to convey water along the bench to stable drainage outlets. Slope drains would be installed where necessary to carry runoff from diversion ditches and levees. The BMPM recommends that slope drains should be lined with rock or some other erosion-resistant material. In some cases these slope drains may outlet into rock aprons or stilling basins to dissipate energy.

Channel Control

Runoff through the facility site would be controlled by culverts, drainage ditches, and/or channel liners. Culverts would be installed to provide stream crossings of roads and other work areas. The BMPM specifies that culverts should be aligned to maintain the stream's natural gradient. Where flow from the outlet of the culvert is excessive, construction of stilling basins or other energy dissipation structures may be required. Other culvert features also may be required including debris deflectors upstream of the culverts to prevent obstruction of flow, thaw cables to prevent culverts from freezing, and markers to identify the inlet and outlet of the culverts during periods of deep snow cover.

Drainage ditches may be used to control runoff. Where necessary temporary ditch checks or check dams would be installed in ditches to reduce flow velocity and erosion until the ditches could be lined with an erosion resistent material such as rock riprap, erosion control fabric, gabions, timbers, or concrete blocks.

Sediment Retention

Sediment retention would ultimately be accomplished through revegetation of disturbed areas. Prior to reestablishment of a vegetative cover, sediment would be controlled using a variety of structures. Silt fence would be installed in upland areas along the toe of slopes and along streams to prevent sediment from reaching waterways. Periodic inspections would be required to check silt fences for tears and accumulation of sediment. Excess sediment would be removed as necessary. Sediment basins may be installed in drainages to help remove sediments from runoff. The BMPM specifies that several factors should be considered in sediment basin design including the rate of flow, desired retention time, and particle size of the suspended sediment. Sediment traps constructed of stone, brush, or hay bales may be used to retain sediments in small channels.

Revegetation

Disturbed areas that are prone to erosion would be revegetated as soon as practical after final grading is completed. In the event that final grading is delayed for a prolonged period of time, temporary seeding may be required. The BMPM recommends revegetating with native plants and grasses. The optimum period for seeding would be between May 15 and June 20. Fertilizer and mulch may be applied in some areas to control erosion and promote seedling growth. In areas of high soil moisture erosion control fabric may be installed instead of mulch.

Stormwater Control

In addition to developing the detailed site-specific erosion and sediment control plan referenced above Yukon Pacific would develop a stormwater discharge plan as required under the EPA's application requirement for stormwater discharges associated with industrial activity (40 CFR Part 122.26). This plan would incorporate many of the sediment control measures specified in the BMPM and would also include measures to control pollutants in stormwater discharges during and after construction. The plan would include an estimate of the runoff coefficient from the site (fraction of total rainfall that will appear as runoff) and the increase in impervious area after construction is completed.

Yukon Pacific's BMPM describes general guidelines and measures that could or would be utilized during construction, but it does not provide detailed information regarding where a particular mitigation measure would be employed or who would be responsible for its implementation. Furthermore, although a variety of erosion and sediment control structures are discussed, the BMPM does not specify the number, size, or, most importantly, the placement of these structures. However, we believe the BMPM does provide a foundation for the development of a detailed site-specific erosion and sediment control plan that would be capable of reducing erosion and sedimentation to acceptable levels. To ensure adequate permanent and temporary erosion control at the project site, **we recommend Yukon Pacific prepare a site-specific erosion control and sedimentation plant that:**

1) **provides detailed procedures for controlling sediment from access road construction including the roadbed, cut and fill materials, culvert installation, and bridge installation;**

2) **provides detailed drawings that show the number, size, and placement of erosion and sediment control structures on the site;**

3) **provides detailed drawings which show the areas that would be revegetated and include a description of the seedmix, seeding methods, soil amendments, and mulching methods that would be used; and**

4) **should be filed, together with comments of the appropriate state agencies (ADGC, APUC, ADNR, and ADFG), with the Secretary of the Commission (Secretary) for review and approval by the Director of the Office of Pipeline and Producer Regulation (OPPR) prior to initiation of construction.**

4.1.3 Snow Avalanche Impacts

A preliminary snow avalanche hazard evaluation prepared for Yukon Pacific (Fesler and Fredston, 1991) identified five potential avalanche paths, primarily at the west end of the site. No portion of the main LNG processing or storage facilities, nor the plant or terminal facilities, would be exposed to potential snow avalanche hazard. However, the haul road connecting the facilities could be affected by snow avalanches at two locations, paths No. 4 and No. 5. In both cases, the snow avalanche potential is small and the likelihood of an event infrequent; consequently, normal road clearing operations would suffice to maintain winter use of the access road.

Only facilities located at the south edge of the construction dock area, which will become the cargo/ferry personnel dock, would be within the range of snow avalanche path No. 3 and could be potentially affected. A major avalanche (i.e., approximately a 200-year event) along this path could reach the compound and bury vehicles, break windows, and possibly cause structural damage to buildings. To avoid the potential for damage to facilities located in this area, **we recommend that further field evaluation of avalanches on path No. 3 be undertaken prior to the development of final design in order to determine the need for mitigation.** Simple mitigation measures such as enhanced building strength, the absence of windows on the south side of buildings, or a barrier at the south end of the compound at the base of the avalanche path should minimize danger from snow avalanches.

4.2 SEISMICITY

This section briefly discusses the results of the FERC staff's review of Yukon Pacific's analysis of the earthquake hazards and its proposed design measures to mitigate earthquake-induced damage to the facility. In conducting its review, the FERC staff was assisted by staff of the NIST and the USGS, collectively referred to as FERC staff. The December 23, 1992 report of the NIST/USGS review is entitled "Review Comments on the Design Criteria for the Anderson Bay Terminal of the Trans Alaska Gas System" (see appendix A).

It is important to note that the intensity of earthquake shaking is only one of many matters of great significance in the seismic design of the proposed facility. The structural and geotechnical parameters governing the response of the plant structures and equipment to ground shaking are of equal or greater importance. The quality and type of materials and equipment selected and delivered, and the quality of the workmanship in the actual construction of the facility are of critical importance. The quality of the constructed facility will depend largely on implementing a sound program of equipment qualification.

It is also important to note that the design of the proposed facility is still in a preliminary phase. The seismic design criteria have been proposed, as required by Federal regulation, but there are many details and significant decisions involving professional engineering judgements yet to be made. Consequently, it is not appropriate for us to recommend specific conditions at this time to address certain issues such as design spectra, damping, and ductility. The recommendations presented in this section of the EIS form the basis for the staff's conclusions on the proposed design criteria, the acceptable level of risk for the LNG plant, and the fundamental assumptions regarding the seismicity of the site area. Subsequent reviews and approvals of seismic design plans would be done through the Director of OPPR's clearance letter process. Since many of these decisions will not be made until the FERC certificate is issued and final design plans are prepared, **we recommend that all final seismic design plans and specifications be filed with the Secretary for review and approval by the Director of OPPR. The seismic design measures should take into account the specific recommendations and results of studies specified below.**

Compliance with DOT Requirements/NFPA Standards

The DOT regulations require the project sponsor to determine the most critical ground motion with a yearly probability of exceedance of 10^{-4} or less. The input values are determined on the basis of the seismic source characterization discussed below and in section 3.2 of this EIS.

The FERC staff believes that the scope of the geoseismic information presented by Yukon Pacific satisfies the seismic investigation requirements of the DOT regulations and the NFPA Standards. Also, sufficient evidence has been provided to demonstrate that the site is suitable for construction of LNG storage tanks and their impounding systems under the criteria of § 193.2061(f). The data do, however, allow for alternative interpretations on the parameters for detailed design as discussed below.

Seismic Source Characterization

One of the important conclusions of the Yukon Pacific seismic hazard studies is that during the service life of the facility as projected by Yukon Pacific (approximately 30 years), the chance for a repeat of a great subduction zone earthquake in the Prince William Sound area comparable to the 1964 event (M_w 9.2) is extremely remote and thus can be discounted with respect to the seismic design of the LNG plant. A great subduction zone earthquake is judged possible in the Yakataga region (the "Yakataga Gap"), approximately 60 miles to the east of the Anderson Bay site. A lower-magnitude earthquake—the so-called "intracycle event"—on the Aleutian megathrust beneath the site, is considered by Yukon Pacific to be a more credible event than a repeat of the 1964 earthquake. Yukon Pacific estimates the magnitude of the intracycle event as M_w 7.75.

Based upon its geologic studies, and a new proposed explanation of how tectonic strain is partitioned between the megathrust and other faults in the region, Yukon Pacific's estimate of the earthquake exposure at the LNG plant site includes the assumption that the strain accumulated on the megathrust prior to 1964 was completely released in the 1964 event. This assumption is significant with respect to earthquake recurrence on the megathrust and the maximum magnitude of the intracycle event.

Yukon Pacific used a number of approaches to evaluate the repeat time for 1964-type earthquakes in the Prince William Sound area. These approaches were based on recent and historic seismicity, plate tectonic data, and geologic (paleoseismic) evidence. However, there is a large discrepancy between estimates of return period (RP) for 1964-type earthquakes derived from paleoseismic studies (RP 600 to 950 years) and from plate tectonic studies (RP 175 to 333 years). This discrepancy is a long-standing issue of discussion in the research community, and the lack of definitive data assures that the issue will not be resolved quickly.

The paleoseismic studies are subject to several difficulties, including: obtaining sufficient samples over a broad region, constraining ages of events, correlating events between samples over large distances, and knowing that all events have been sampled. Given these difficulties, it is not a simple matter to draw reliable conclusions about the repeatability of 1964-type events. While available data may be consistent with the conclusion that such events have repeat times of 600 to 950 years, alternative interpretations are also possible. The possibility of shorter repeat times cannot be ruled out.

While Yukon Pacific presented evidence to support its conclusion that the possibility of a great subduction zone earthquake in Prince William Sound can be disregarded, we believe the Yukon Pacific scenario is not the only credible one that can be deduced from the available data.

Yukon Pacific's analysis of the maximum intracycle earthquake is based on comparisons of the 1964 source zone to other subduction zones that have generated $M_w \geq 9.0$ earthquakes. That comparison may not be appropriate because the tectonic setting of the 1964 zone is much more complex than that of the southern Chile and Kamchatka zones with which it is compared.

That issue notwithstanding, we note that in the western Aleutian zone, which may be equally analogous to the Prince William Sound area, a M_w 8.0 earthquake in 1986 occurred in the rupture zone of the 1957 M_w 8.6 earthquake; only 29 years after that great earthquake. Unless this type of rapid reoccurrence can be ruled out in the Prince William Sound area, the occurrence of an earthquake of $M_w \geq 8.0$ on the megathrust zone below the site during the projected life of the facility must be seriously considered.

We also note that at the projected rate of gas production, the service life of the facility could be much longer than 30 years. Since, with each passing year of low seismic activity, the probability of a major earthquake increases, the maximum likely magnitude for the intracycle event goes from M_w 7.6 in 1995, to M_w 8.2 in 2025. **Therefore, we recommend that the intracycle earthquake specified for facility design purposes be set at M_w 8.2.**

Seismic Design Motions/Criteria

Design Accelerations - Yukon Pacific proposes to apply a dual-level earthquake concept to the seismic design considerations for the LNG plant. We concur with this general approach.

Input values for effective acceleration are proposed to be 0.4g for the OBE, and 0.55g for the MDE. These values would be applied as input parameters to design response spectra. However, Yukon Pacific's supporting documentation for the ground acceleration analysis indicates that the MDE value of 0.55g corresponds to a "reasonable estimate". The same analysis cites 0.62g as a "conservative estimate" and 0.72g as an "upper bound estimate" for zero period accelerations. In that regard, and in consideration of our previous recommendation that the intracycle earthquake be set at M_w 8.2, **we recommend that the MDE value for the effective acceleration be at least 0.6g.**

Design Spectra and Hydrodynamic Effects/LNG Sloshing - DOT regulations also require that the most critical ground motion with a yearly probability of 10^{-4} or less be specified in terms of both horizontal and vertical design response spectra determined from the mean plus one standard deviation of a free-field horizontal elastic response spectrum. In practice, there are a number of different ways to specify design spectra, all involving considerable engineering judgement. The spectra proposed by Yukon Pacific were derived using fixed ratios between controlling values of effective acceleration, velocity, and displacement as proposed by Newmark and Hall in 1982. In the case of the Anderson Bay site a great earthquake in the Yakataga Gap region, 60 miles from the project site, must be considered in the design of the facility. The low frequency components of such an earthquake would not be significantly attenuated and therefore must be considered in the long period range of the design spectrum.

The effect of long period vibrations is a significant consideration in analysis of the tank wall stresses, and the hydrodynamic response (i.e., liquid sloshing) of the LNG in the tanks and the required amount of tank freeboard—the space between the liquid level and the top of the tank. **We therefore recommend that Yukon Pacific evaluate the adequacy of the long period levels of the proposed design response spectra using seismological modelling analyses to estimate directly the long period ground motion from postulated critical design earthquakes on the Aleutian megathrust and in the Yakataga Gap. A report on the methods, assumptions, and results should be filed with the Secretary. The results of that analysis would be incorporated into the seismic design, as appropriate.**

Vertical Acceleration - The level of vertical acceleration proposed by Yukon Pacific is two-thirds of the horizontal acceleration. The DOT regulations state that for source distances less than 10 miles, horizontal and vertical acceleration should be assumed equal. While it is true that the postulated distance of the design earthquake on the megathrust is 12 miles, as opposed to 10 miles, the focus of the design event would potentially be directly below the site.

The DOT regulations are not clear on whether the "source" distance should be measured from the hypocenter—the actual location of the earthquake with a depth below the surface component—or, from the epicenter—the vertical projection of the hypocenter on the earth's surface. Vertical acceleration is likely to be at its maximum in the epicentral area, especially for thrust-type faulting. **On that basis we recommend that the vertical acceleration be set as equal to the horizontal acceleration for design purposes.**

Subsurface Conditions - We also note that Yukon Pacific's proposed design spectra are for structures founded directly on bedrock. Since even relatively small depths of fill or soil deposits can result in significant ground motion amplification, **we recommend that, for all structures not directly supported by rock, design spectra for "competent soil conditions" as recommended by Newmark and Hall (1982) should be used.**

Duration - An important consideration in the damage potential of an earthquake is the duration of strong ground shaking. This factor is particularly important for major earthquakes of the size that occur along the southern coast of Alaska. Yukon Pacific has presented no explicit discussion or estimate of the duration of shaking to be considered in the seismic design of the facility. In its response to a data request on this issue Yukon Pacific stated that the proposed broad-band design spectrum adequately accounts for duration effects. That may or may not be true for this particular situation. **We recommend that Yukon Pacific conduct a specific analysis of the duration of strong ground shaking likely to be experienced at the site as a result of the design earthquake, and document that the structures are designed to accommodate the ductility demand associated with the duration of the shaking. A report on the methods, assumptions, and results should be filed with the Secretary. The results of that analysis would be incorporated into the seismic design, as appropriate.**

Damping and Ductility - As previously noted, the FERC staff recommends that the occurrence of a M_w 8.2 near-source earthquake during the service life of the facility be considered in the plant design. In a great earthquake the duration of shaking would be longer, and the cyclic strength degradation and ductility demand would be more severe than in the proposed M_w 7.75 magnitude design earthquake. The proposed MDE design spectrum assumes a damping value of 7 percent of critical. According to Yukon Pacific, this represents the lower bound of recommended values for prestressed concrete with no prestress remaining. While this damping value seems reasonable for the stated condition of the structure, we question the ability of a prestressed concrete tank to contain LNG without a major spill if this condition were allowed to develop, particularly in the case of a great earthquake where the duration of shaking would be relatively long.

Yukon Pacific's proposed use of a ductility ratio of 1.2 should also be examined for the case of the longer duration earthquake. The selection of a ductility ratio carries with it the need to ensure that it actually is achieved reliably through proper selection of materials, proper structural detailing, and reliable quality assurance procedures, and that the deformations associated with this ductility ratio do not cause failure. Allowable deformations of LNG tanks in the MDE must be predicated on the premise that an LNG spill would lead to failure, even if it is not triggered by total structural collapse.

Combined Loads/Structural Details - While the load criteria and structural details are incomplete and/or uncertain at this time, deficiencies and inconsistencies must be identified so that they are taken into account in the final design criteria. We have identified areas where we have design concerns that are in addition to those Yukon Pacific has recognized need more work. **Consequently, we recommend that Yukon Pacific file with the Secretary a discussion of each of the following issues, as the design of the facility progresses:**

- **Unless there is clear and convincing justification for lesser values, the load combination factors specified in ASCE 7-88 (1990) should be used.**

- **Use of the calculated flat-roof snow load of 169 pounds per square foot in conjunction with earthquake loads appears to be conservative. This snow load corresponds to a mean recurrence interval of approximately 100 years and does not account for any load reduction due to snow slide-off on the steeper roof slopes. If the ASCE 7-88 (1990) load combination factors are used, then the design snow load with a 50-year recurrence interval could be used in conjunction with earthquake loads.**

- **The design load criteria should account for the possibility of combined seismic and impounded fluid loading for the outer tank. This load combination could be critical for the so-called "double integrity" tank designs.**

- **Since snow load is one of the controlling design factors, the design basis for snow load should be consistent with that for earthquakes. Therefore the design for maximum snow load should use an annual failure probability of 10^{-4}.**

- **For the double integrity tanks, the secondary containment is not isolated from the primary containment, thus creating the potential for collapse of the outer tank as the inner tank fails. There does not appear to be a structurally independent impounding system.**

- **The detail for the joint between the floor of the double concrete wall tank needs additional development to assure proper function under strong ground shaking and possible differential movements and settlement of the tank footing.**

- **The behavior of the circumferential prestressing for the double concrete wall tank is unclear in the event of a wire failure due to corrosion or "missile" impact.**

- **Weathering effects on the bedrock formation could affect the rock anchors for the tank foundation and rock slopes in the project area.**

Earthquake-Related Phenomena

As discussed in section 3.2 of this EIS, the most significant earthquake-related hazard to the LNG plant, other than ground shaking, is the potential effects of damaging waves resulting from seismically induced subsea landslides in Port Valdez. Such waves can occur due to moderate-sized earthquakes as well as great earthquakes and are therefore quite likely to occur during the life of the project. Potential sources of subsea generated waves are shown on figure 4.2-1 while potential locations of wave runup at the Anderson Bay site are shown on figure 4.2-2.

The postulated severe case scenario would involve a wave generated from a large subsea slide on the Shoup Bay delta during high tide. Yukon Pacific estimates that such a wave could attain a height of 13 to 26 feet and result in peak runup on the site of approximately 93 feet. Properly constructed energy dissipation devices could reduce the peak runup to approximately 67 feet. Yukon Pacific proposes the following mitigation measures:

- Use a combination of seawalls and other energy dissipation devices.

- Locate all important plant components above the 75-foot elevation.

- Reduce peak runup potential at the plant site by placing large amounts of fill in the runup-prone areas.

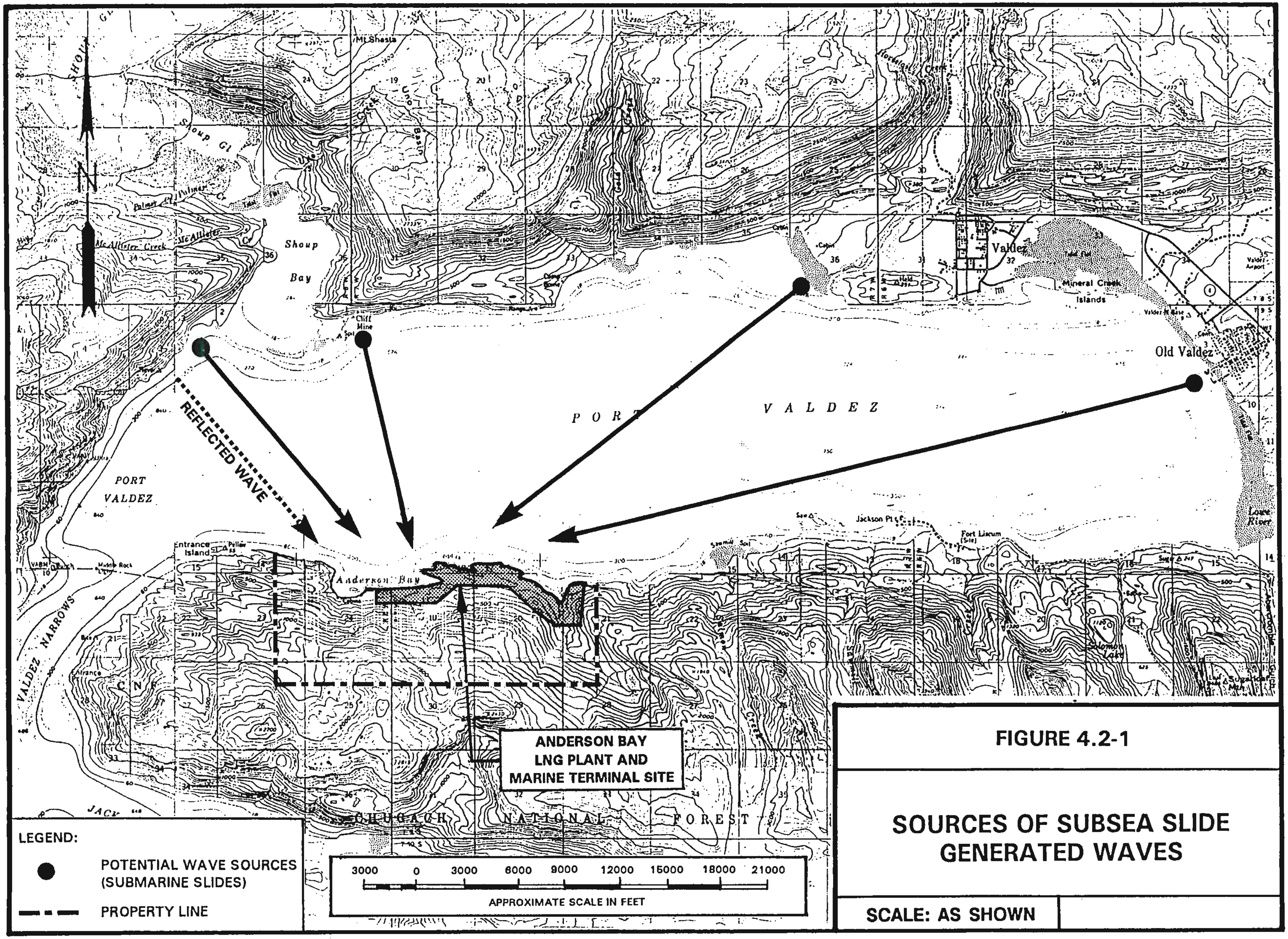


FIGURE 4.2-1

SOURCES OF SUBSEA SLIDE GENERATED WAVES

SCALE: AS SHOWN

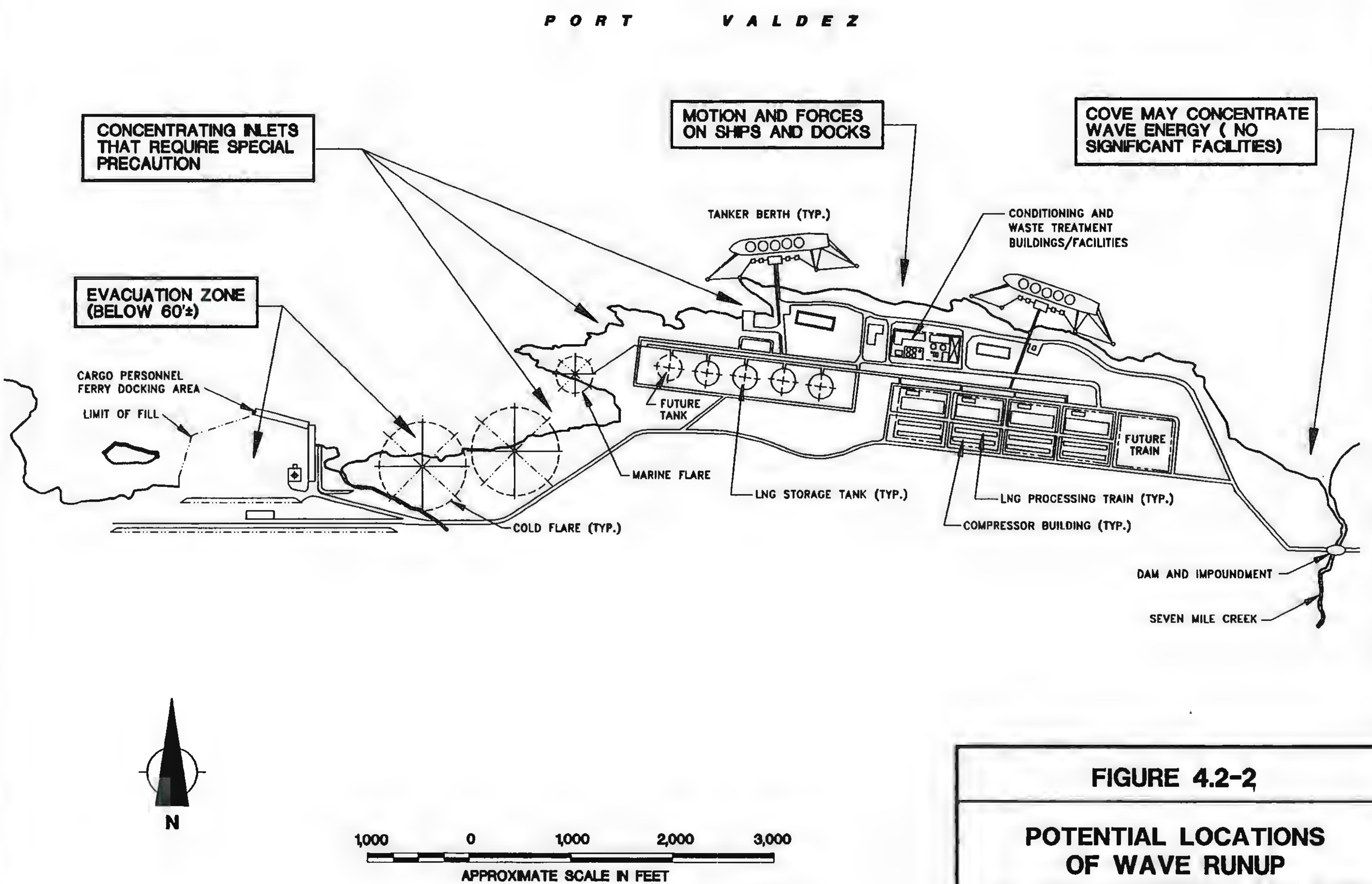


FIGURE 4.2-2

POTENTIAL LOCATIONS OF WAVE RUNUP AT THE ANDERSON BAY SITE

SCALE: AS SHOWN

DWG FFRGZ23

The FERC staff believes that for the shore-side facilities these measures are appropriate and reasonable. However, with regard to the marine terminal, LNG tankers, and tanker berthing facilities, such waves would be a significant threat. Plant personnel would have less than 1-minute warning from the time the wave is generated to the time it hits the marine terminal. Serious consideration of the wave hazard must be addressed in the plant design and operation plans. As with many other details of the proposal, our conclusions regarding the adequacy of the proposed mitigative measures must await more final design and operation plans. **We recommend that Yukon Pacific develop plans to consider and mitigate, to the maximum practical extent, the effects of damaging waves (especially those resulting from subsea landslides) on the marine terminal facilities and on tankers at berth.**

The steep terrain on the plant site, the heavy annual snow accumulations, and the major excavations and earth-moving that would take place when the facility is built, could have a significant effect on rock slope stability and avalanche potential. This hazard needs to be more fully evaluated as the design and construction progresses. **We recommend that Yukon Pacific conduct an analysis of rock slope stability and potential effects of snow avalanches on the plant, especially under seismic conditions, and incorporate appropriate mitigative measures into the plant design and operation plans.**

4.3 FRESHWATER ECOLOGY

4.3.1 Water Resources

Water would be required during construction and operation of the LNG facility. During construction, water would be obtained from Seven Mile Creek and Nancy or Short Creeks for one concrete batch plant, the construction camp, and various industrial uses including dust control. It is anticipated that one concrete batch plant would be required; however, a second small backup plant may also be used. Water usage estimates during construction are 13,917 gallons per hour (gph) average (4,200 gph average from December through April), and 25,833 gph maximum year round assuming that maximum flows for the concrete batch plant and the construction camp coincide. While Seven Mile Creek is anticipated to supply most of this water, Nancy or Short Creek may be utilized to supply water for the batch plant, which would require an average of 125 gph from December through April and an average of 417 gph from May through November. Maximum withdrawal for the batch plant has been estimated at 3,333 gph year round.

During operations, the primary water source would be Seven Mile Creek with backup provided by the desalination plant and barge water from Valdez. Water for operations is not anticipated to be provided by Nancy and Short Creeks. Year round withdrawals from Seven Mile Creek are expected to be 4,500 gph (average) to 12,000 gph (maximum) during operations. Approximately 48,200 gph (average) to 150,600 gph (maximum) would be withdrawn from Port Valdez for the desalination plant; however, about 90 percent would be returned to Port Valdez. The maximum withdrawal rate for operations is the design rate required to supply the sum of the individual peak demand rates.

A comparison of estimated water supply and water requirements was conducted by Yukon Pacific (R&M Consultants) to determine if sufficient water is available onsite to satisfy both short- and long-term project needs. R&M Consultants estimated water requirements of 13,320 gph from May through November and 4,560 gph from December through April during construction and 4,560 gph during operations year round. These water requirements from the creeks are similar to the average requirements given above. To these water requirements, total water requirements were estimated by the addition of 5,400 gph (0.20 cfs) year round for estimated minimum flow requirements, bringing the total to 18,840 gph (0.70 cfs) during construction from May through November and to 10,020 gph (0.37 cfs) during operations and for the rest of the year during construction. These average total water requirements were compared to estimated water flows from Seven Mile Creek (table 4.3.1-1). Flow estimates are being verified during a 1992/1993 monitoring project to provide site-specific flow data for Seven Mile Creek and Nancy Creek.

TABLE 4.3.1-1

Water Needs During Construction Compared to Flow in Seven Mile Creek

Month	Mean Monthly a/ (cfs)	7Q10 a/ (cfs)	Needed b/ (cfs)	Surplus c/ (cfs)	Deficit d/ (cfs)
January	4.4	0.2	0.37		0.17
February	4.5	0.3	0.37		0.07
March	3.0	0.2	0.37		0.17
April	7.4	0.6	0.37	0.23	
May	30.8	6.2	0.70	5.5	
June	65.5	26.9	0.70	26.2	
July	61.7	14.8	0.70	14.1	
August	45.9	6.0	0.70	5.3	
September	41.5	4.2	0.70	3.5	
October	22.6	1.9	0.70	1.2	
November	13.3	0.9	0.70	0.2	
December	4.8	0.3	0.37		0.07

a/ Estimated by HYDMET, Inc.

b/ Assumes in-stream flow requirement of 0.20 cfs. Actual in-stream flow requirements have not yet been set.

c/ Calculated by R&M Consultants (1992).

d/ Deficit based on averages. Peak usage deficit would be greater.

Flow comparisons are used to ensure that sufficient water would be available for facility construction and operation, while also ensuring that stream flow rates do not fall below minimum flow rates to be set by the State of Alaska. Minimum flow rates are required for both water quality and the support of salmon spawning within the streams and would be set following the collection of 2 years of flow monitoring data in Seven Mile Creek and Nancy Creek and the evaluation of minimum flow studies (Brna, 1992b). Based on the relative water requirements for the facility and the estimated water flows in Seven Mile Creek, insufficient water would be available from December through March during low flow years (table 4.3.1-1). This deficit would be even larger during peak water usage.

As a possible remedy to the water supply shortage, a 40-foot-high, in-stream rockfill dam with a central concrete core has been proposed to provide the required storage. Located 400 feet upstream of the waterfall on Seven Mile Creek, the dam would produce a reservoir approximately 3.5 acres in area (see figure 2.1.4-3). In addition, storage tanks would be constructed to buffer the impact of periodic low flows. A 400,000-gallon tank would provide an average of 40 days water for the concrete batch plant. An 800,000-gallon tank would provide potable water for 2.5 days during construction from May through November and for 7.3 days for construction during the rest of the year or during operations year round.

Supplemental flow from Nancy Creek has also been considered to supplement water requirements for concrete batch plant usage during low flow periods. Similar to Seven Mile Creek, following the 1992/1993 flow monitoring period, minimum flow requirements will be determined for Nancy Creek as well. Short Creek has also been considered as a supplemental source. However, its use is not recommended since flows within Short Creek are expected to be much less than in Nancy or Seven Mile Creek (table 3.3.1-2). Supplemental sources from offsite as well as from groundwater were also reviewed by Yukon Pacific. Groundwater has not been selected as a possible water supply source, and the offsite source would be limited to potable water barged from Valdez.

There are several issues of concern relating to water supply. The basis for facility water requirements during operation has not been adequately supported by a design water balance; the basis for Yukon Pacific's estimates is lacking detail. In addition, the constrained construction window recommended for fisheries' requirements during spawning season may increase construction supply requirements during the fall and winter months (although certain activities are severely constrained by weather conditions). Finally, given typical stream morphology and the unique setting of Seven Mile Creek, the in-stream flow requirements may exceed the original estimate of 5,400 gph. Monthly variations should also be used to approximate requirements; during spring/summer periods of higher flow, minimum stream flow requirements would be higher. Given the above concerns, we believe that water supply requirements may be understated and that a water supply shortage for the proposed project could occur. To clearly demonstrate water supply requirements for the proposed facilities, **we recommend that Yukon Pacific prepare, in consultation with the ADFG, and file with the Secretary, a detailed water balance and design supply analysis, prior to initiation of construction.**

In addition, regardless of what the actual facility water requirements may be, **we recommend that Yukon Pacific, in coordination with the ADFG and in conjunction with preparation of the detailed water balance and design supply analysis, conduct an in-stream flow study to determine the minimum flow requirements to minimize impact on spawning fish (see sections 4.3.3, 4.4.3, and 4.5.4) and maintain flow through Seven Mile Creek above the minimum levels. The results of this study should be filed with the Secretary and the ADFG for review and approval of the results and consideration of additional flow regulation mitigation.**

4.3.2 Water Quality

Stream water quality in the proposed project area could be adversely affected during construction and operation of the LNG facilities. During construction, activities in streams, damming of stream flow, grading of shoreline, rechanneling of streams, and release of contaminants from construction activities and road deicing could adversely affect stream water quality. During operation of the LNG facility, stream water quality could be affected through emissions, spills, road use, and outfall discharges directly into streams or into areas with significant tidal exchange. Groundwater quality could be affected by recharge from contaminated surface waters as well as by spills and by leakage from any onsite tanks or landfills.

4.3.2.1 Stream Quality

In order to provide for a stable water supply, a dam has been proposed for Seven Mile Creek (see figure 2.1.4-3). Based on the relative flow and water requirements, the dam would be required to supply water for construction and operation activities. When flowing water is dammed, the physical and chemical characteristics of the water may be altered both at the dam site and downstream. The extent of alteration is primarily a function of the residence time of water behind the dam. In small dams, the water is generally only detained for a few hours or days, the flushing rate is high, and the physical and chemical characteristics of the water are not significantly changed.

However, even with small dams, sediment, temperature, and nutrient transport within the stream can be altered. In the short term, construction of the dam would result in increased turbidity within the stream due to construction activities. Elevated turbidity levels would be expected to remain for only a short time following the construction period, and to affect a relatively small area (Dehoney and Mancini, 1984). Short-term increases in sediment may violate the Alaska Water Quality Standards for (A) Water Supply (i) drinking, culinary, and food processing, under which the area streams are classified by default. The regulations require no increase in the concentration of sediment, including settleable solids, above natural conditions. However, the state, at its discretion, may grant a short-term variance for a one-time, temporary activity associated with the placement of dredged or fill material affecting a specific waterbody. The applicant must demonstrate that the activity would be conducted in a manner to mitigate water quality impacts, using methods found by the ADEC to be most effective, and must show that the activity, once completed, will not cause a long-term, chronic, or recurring violation of the water quality standards.

In the long term, however, dams may serve as sedimentation ponds, resulting in a decrease in turbidity downstream from the dam. However, based on visual observations, very little sediment is transported in Seven Mile Creek, and according to R&M Consultants (1992), most of this sediment may be carried through the dam via the outlet works. The dam may serve as a beneficial water flow regulator for low flow periods, provided sufficient water is available for operators during those periods. The effects on nutrient transport and stream temperature are expected to be insignificant in the long term due to the relatively short detention time of the dammed reservoir. As a result, the proposed dam is not expected to have a significant impact on the water quality of Seven Mile Creek, assuming minimum flows can be maintained.

Significant alterations in coastal morphology and stream discharge have been proposed to construct the LNG plant facilities (figure 2.1-4). Grading and stream rechanneling activities would significantly impact water quality within Nancy, Terminal, Strike, and Short Creeks during construction and restoration. In addition, Seven Mile Creek may be impacted, as grading is proposed below the falls near the creek. Grading and fill activities may significantly increase turbidity near the mouths of the streams, but would not affect water quality upstream beyond tidal influences. Short Creek would be rechanneled from its present course to discharge as outfall No. 6. Terminal Creek (and its pond) would be eliminated. Strike Creek would be rechanneled and would discharge from outfall No. 1. The long-term effects of rechanneling Short Creek should be minimal with respect to water quality provided Short Creek flows into a concrete channel to minimize turbidity effects from the creation and flow over a new streambed. However, short-term water quality degradation may occur through leaching of concrete. Mitigation for the destruction of Terminal Creek and its pond is discussed in section 4.4.3.

Construction and use of roads in the facilities may also increase the turbidity in the streams. In addition, chemicals, such as road deicers in the wintertime, increase the potential for contaminant entry near the mouths of Nancy and Short Creeks. Best management practices for erosion control during construction and along the roadways must be followed to minimize any adverse effects from the roads, especially since the soils in the project area are highly erodible organic soils or erodible mineral soils following alterations to the overlying duff layer (see section 4.1.2).

Outfall Nos. 5 though 8 discharge into Anderson Bay, while the remaining outfalls discharge into nearshore Port Valdez. Several of the outfalls include stream discharge as a major component (along with site runoff) and discharge at the mouth of streams (figure 2.1-4). Thus, depending on the location of other discharges and tidal influence within the stream, site runoff and other discharges could affect the water quality of the stream. Affected outfalls include Nos. 1, 6, and 7. Strike Creek would discharge from outfall No. 1, rechanneled Short Creek would discharge from outfall No. 6, and Nancy Creek would discharge from outfall No. 7. Since natural streamflow would dominate the outfalls, the water quality from these outfalls should be heavily influenced by the water quality within these streams (section 3.3.2.1). Furthermore, site runoff should not significantly alter the outfall water quality since: 1) drainage from upslope is routed around or channeled through the plant site, and 2) water from areas on sites at which contamination might occur (such as diesel fueling) is collected and sent to the wastewater treatment plant. Water from the concrete batch plant could also affect water quality within outfall Nos. 6 and 7. Water runoff from the batch plant site, potentially high in fines and colloidal material, would be either pumped back into the water tank or allowed to drain to a permitted outfall following containment in the sediment ponds.

Site runoff could affect the water quality from outfall Nos. 1, 6, 7, 9, and 10. Site runoff water quality predictions based upon limited area stream water quality are presented in table 4.3.2-1 and compared to estimated desalination source seawater water quality and stream water quality standards (drinking water standards as given in 18 AAC 80 apply). The standards may be applicable at outfall Nos. 1, 6, and 7 since site runoff and other sources appear to discharge directly into the streams near the mouth. Outfall Nos. 9 and 10 do not directly discharge into the streams, and thus the freshwater standards would probably not be applicable. Instead, marine water quality criteria would apply.

Assuming the applicability of strict freshwater standards (i.e., no mixing zones, variances), maximum concentrations of iron, arsenic, cadmium, and lead may fail state water quality standards (table 4.3.2-1). However, since none of the projected average concentrations exceed the standards, it is unlikely these constituents would violate the standards. However, actual discharge water quality should be sampled during plant operation to ensure compliance with Alaska State Water Quality Standards. If standards are not met, mitigative measures such as treatment may be necessary.

TABLE 4.3.2-1

Estimated Site Runoff and Seawater Water Quality

Water Quality Parameter	Unit	Site Runoff, Average	Site Runoff, Maximum	Desalination Source Seawater	Freshwater Standard (18 AAC70 & 80)
Temperature (winter)	°F	36	40	38	< 59
Temperature (summer)	°F	50	60	52	< 59
pH		7.5	8.5	8	6.5-8.5
BOD	mg/L	2	5		60 a/
COD	mg/L	3	7		
TSS	mg/L	20	200		45 a/
Ammonia (N)	mg/L	0.15	0.15		
Oil/grease	mg/L	1	5		no sheen, taste, or odor 10 a/
Fecal coliform	mg/L b/	16	200		< 1 per 100 mL (18 AAC80); 14/100 mL a/
Nitrate (N)	mg/L	1	3		10
Phosphorus	mg/L	0.01	0.02		
Copper	mg/L	0.01	0.29	0.066	1
Iron	mg/L	0.2	2.0	0.092	0.3
Nickel	mg/L	0.01	0.70	0.019	
Zinc	mg/L	0.02	5.00	0.044	5
Arsenic	mg/L	0.002	3.600	0.001	0.05
Cadmium	mg/L	0.0002	0.9000	0.0001	0.010
Lead	mg/L	0.02	0.50	0.001	0.05
Mercury	mg/L	0.0003	0.0020	0.0003	0.002
Hydrocarbons	mg/L	0.1	0.2	0.6	no sheen, taste, or odor
BTEX	g/L				1.3 (summer) - 5.0 (winter) a/
Benzene	g/L	0.1	0.1	0.2	
Chlorobenzene	g/L	0.1	0.1	0.2	
Ethylbenzene	g/L	0.1	0.1	0.2	
Toluene	g/L	0.1	0.1	0.3	
Xylenes	g/L	0.2	0.2	0.6	

a/ Maximum discharge specified on Alyeska's NPDES permit (12/14/90).

b/ Real units should be no. of colonies/100 mL.

Contamination of streamwater through the introduction of oils, grease, and fuel during the construction and operation activities is possible. The residence time of these materials within the stream would be dependent upon the amount introduced, the persistence of the chemical, the flow conditions, and the mineralogical and organic matter content of the stream sediments. Accidental spills of chemical reagents and fuels may also introduce hydrocarbons and other chemicals to streamwater. **We recommend that Yukon Pacific, prior to commencing construction, develop and file with the Secretary for review and approval by the Director of OPPR a Spill Prevention, Containment, and Control Plan (SPCC Plan) that would describe the preventive and mitigative measures it would employ to minimize the impact associated with such occurrences. These measures should include but not be limited to: requiring all fueling and lubricating to be done in areas designated for such purposes, with such areas to be located at least 100 feet away from all waterbodies; specifying collection and disposal procedures for wastes generated during vehicle maintenance; requiring each construction crew to have on hand sufficient supplies of absorbent and barrier materials to allow the rapid recovery of any spills; and development of standing procedures regarding excavation and offsite disposal of any soil materials contaminated by spillage. In addition, we recommend that Yukon Pacific ensure that construction contractors are able to demonstrate to environmental, local, or state inspectors their ability to implement the SPCC Plan. The SPCC Plan should also identify the types and quantities of hazardous materials that would be stored or used on the construction site.**

The impact of contaminants may also occur through the application of deicers on nearby roads. These would be proportional to the quantity and frequency of material application during both construction and operation of the proposed facility. To document compliance with Federal and state stormwater discharge requirements, **we recommend Yukon Pacific develop a stormwater monitoring plan. This plan should be developed in conjunction with the new NPDES stormwater permit requirements that will be imposed under Section 402 of the CWA (40 CFR Part 122.26(c)(ii)). This plan should be prepared in conjunction with the site-specific Erosion and Sediment Control Plan and should provide a detailed description of the stormwater collection and treatment process, including best management practices to control pollutants in stormwater discharges during both construction and operation. These plans should be filed with the Secretary, and provided to the EPA as part of the documentation with the NPDES permit application.**

4.3.2.2 Groundwater

Based upon preliminary borehole results, groundwater flow within the project area has an upward gradient. Although this flow pattern results in seeps, bogs, and springs, which could complicate grading operations and drainage from the site, these flow conditions should prevent serious groundwater contamination from any spills or leakage that may occur onsite. Contaminated groundwater would be expected to surface instead of recharging and contaminating large volumes of groundwater in the area. Although groundwater has not been proposed as a possible water supply, it should be emphasized that the grading operations would impact the surficial unconsolidated aquifer which may result in decreased flow in area streams. A french drain network may be required in the project area for drainage purposes based on experience with similar sites (Lawson, 1992).

Provisions to contain and treat spills and leakage will be outlined in the SPCC Plan. Possible sources of onsite contaminants include leaching from waste rock, spills, treatment plant waste solids, and garbage dump piles. An onsite permitted landfill has been proposed to dispose of ash from the incinerator and possibly to house spent molecular sieves. Although no hazardous waste would be incinerated, ash from the incinerator must be tested for toxicity using the toxic compound leaching procedure to determine if the ash is hazardous since flyash from municipal incinerators is frequently hazardous (Tillman, 1991). If any of the incinerator ash is hazardous, the landfill must permitted under the Resource Conservation and Recovery Act (RCRA) or that portion of the ash must be shipped offsite to a permitted hazardous waste facility.

The spent molecular sieve is not expected to be hazardous and may be landfilled directly onsite or shipped offsite for regeneration or disposal. The composition of the molecular sieve has been projected as 75 to 85 weight percent zeolite; 23 to 15 weight percent magnesium aluminosilicate; and 2 to 0 weight percent quartz. It is assumed that the spent activated carbon from the Mercury Guard Vessels will be disposed of offsite. This carbon may be considered hazardous waste according to the mercury content (up to 16 weight percent).

4.3.3 Freshwater Fisheries

Construction of the Anderson Bay LNG facility would have direct and indirect impacts on five of the eight identified streams on the facility site. The primary direct impacts include altering the channels of Terminal, Short, and Strike Creeks; the crossing of Nancy Creek approximately 1,200 feet upstream of the stream mouth by the main access road from the cargo dock area; and grading the banks and intertidal area of Seven Mile Creek. Construction of water withdrawal structures on Nancy Creek, a dam on Seven Mile Creek, and a temporary construction camp along the banks of Seven Mile Creek may directly impact the surface waters.

There were no resident fishes present in Terminal, Short, and Strike Creeks during surveys conducted by ADFG personnel. This was attributed to high gradient, poor habitat, or the presence of barriers to fish movement (ADFG, 1992; Thompson, 1992). Therefore, alteration of these creek channels would not impact resident fish resources in these streams.

Pink and chum salmon are the only anadromous fish utilizing creeks on the proposed site. The steep gradient of the area limits their distribution to the lower reaches and intertidal areas of Seven Mile, Nancy, and Henderson Creeks where spawning occurs during late summer. Fry emerge in the spring and immediately migrate out of the stream. Therefore, the ADFG has proposed a construction window of May 1 to July 15 when no salmon are present in the system (Brna and Stackhouse, 1993).

Henderson Creek is on the edge of the site and would experience no direct impacts from plant construction or operation. The main access road from the cargo dock area, however, would cross Nancy Creek approximately 1,200 feet upstream from its mouth. In-stream construction of the road crossing may disturb fish habitat. Runoff from the equipment road may increase the delivery of fine sediments into the stream. To prevent potential disturbance of the limited anadromous and resident fish habitat in this stream, we **recommend the road crossing be made above a small falls which may currently be acting as a fish barrier (Brna and Stackhouse, 1993). To minimize impacts due to siltation of spawning gravels and redds from construction and from road runoff, we recommend any in-stream construction be limited to the period between May 1 and July 15 when there are no spawning fish or incubating redds present and that sediment traps be placed along the road to prevent fines from running off into the stream. To prevent loss or disruption of habitat, we further recommend there be no other in-stream construction activity or in-stream equipment crossing**

or fording the streambed at any time. Any temporary crossing structures should be limited to portable construction bridges or crushed, clean rock and culvert bridges.

There were no resident fish found in the reaches of Seven Mile Creek above the falls (ADFG, 1992), but spawning pink and chum salmon utilize the area below the falls as spawning and nursery habitat. The hydrology of this area is not well understood; however, there is apparent upwelling of subsurface water through the gravels near the stream mouth which is probably critical to salmonid spawning and redd survival. In addition, the gravels and incubating redds are sensitive to siltation and disturbance. To minimize potential impacts, we **recommend no construction equipment or in-stream activity occur in the area below the falls and any in-stream construction or activity which may cause siltation (above and below the falls) be scheduled between May 1 and July 15 when there are no salmon or incubating redds present in the stream (see section 4.1.2 for discussion of Erosion and Sediment Control Plan).** As a mitigation measure, Yukon Pacific has proposed to increase spawning habitat and incubation success by maintaining higher stream flows in Seven Mile Creek during the winter low flow period. However, there are no data at the present time to indicate that spawning habitat in Seven Mile Creek is limited by flow. To determine the existing conditions in this area and to avoid impacts on spawning salmon or incubating redds due to reduced flows or an altered hydrograph caused by the proposed 40-foot dam, water withdrawal structure, and 3.5-acre reservoir, we have recommended Yukon Pacific conduct an in-stream flow study as directed by the ADFG (see section 4.3.1).

The proposed location of the construction camp is along both banks of Seven Mile Creek. Yukon Pacific has developed a construction plan that requires considerable grading (figure 2.1.4-3) which would eliminate riparian vegetation. In addition, working the banks in this steep canyon area would likely cause rockfall into the streambed and an increased runoff of fines. Grading the banks and eliminating riparian vegetation may result in increased sedimentation in the stream and loss of downstream spawning habitat. **We recommend that Yukon Pacific prepare a revised site plan that avoids grading and clearing the riparian zones within 100 feet of the streambanks along Seven Mile Creek above the proposed dam. The revised plan should also avoid grading and clearing to preserve the gorge area surrounding the water falls and the associated intertidal shoreline area located on either side of the confluence of Seven Mile Creek and Anderson Bay. The revised plan should be filed with the Secretary for review and approval by the Director of OPPR.**

Fuels, lubricants, and other chemicals spilled during plant construction and operation would negatively impact water quality if allowed to run off into the streams. Leachates from disturbed soils and decaying vegetation could also negatively impact water quality and affect fish utilizing the streams. To minimize impacts caused by runoff of spills or leachate, we have recommended Yukon Pacific develop a SPCC Plan using best management practices (see section 4.3.2.1).

Overall, there would be minimal impacts on resident fish resources because of their limited distribution on the site. Anadromous fish resources spawning in Nancy Creek would not be significantly impacted if disturbance to the streambed is avoided or minimized and the runoff of fine sediments is controlled. The impacts on anadromous fish spawning in Seven Mile Creek are less clear because the flow patterns are not well understood. Once an in-stream flow study has been completed, we have recommended that Yukon Pacific coordinate with the ADFG and FERC staffs to determine a flow regime to minimize impacts on spawning fish (see section 4.3.1). Grading and clearing the banks would cause some disturbance of the streambed and increased runoff of fine sediments. If the disturbance and runoff are minimized by careful construction and adequate sediment and erosion control, the impacts would not be significant.

4.4 TERRESTRIAL ECOLOGY

4.4.1 Wildlife

4.4.1.1 Waterfowl

Impacts on nesting waterfowl are expected to be minimal as a direct result of the construction and operation of the LNG plant and the marine facilities due to a general lack of waterfowl nesting habitat at the Anderson Bay site. Although few waterfowl occur in the Port Valdez area during winter (Hogan and Irons, 1988), large concentrations of overwintering Barrow's goldeneyes and surf scooters may occasionally feed in the intertidal areas of Anderson Bay. Both species would be impacted from both the loss of approximately 35 acres of intertidal and subtidal habitat due to construction of the LNG plant and marine facilities.

The LNG tankers, unlike conventional oil tankers, would have entirely segregated ballast tanks that would not be exposed to either LNG cargo or petroleum products. Furthermore, the ballast discharge procedures require changing all ballast water at sea during the 36-hour period prior to entering Prince William Sound.

Foraging waterfowl might also be impacted by potentially lethal shock waves emanating from proposed submerged blasting in Anderson Bay. Impacts on birds might be minimized by hazing waterfowl from the blast zone of influence prior to blasting (see section 4.5.6.2 Marine Mammals). In general, the overall impacts on waterfowl from construction and operation of the LNG plant and marine facilities would not be significant if all proposed precautionary measures are fully implemented.

4.4.1.2 Shorebirds

The intertidal zones of Anderson Bay provide limited foraging habitat for shorebirds compared to elsewhere in the Port Valdez region due to a lack of mudflats and other shallow water areas. What foraging habitat does occur, however, would be impacted by the infilling of intertidal zone at the east end of Anderson Bay during rock and overburden fill and disposal (see section 2.3.2). Potential operational impacts on the intertidal habitat remaining after construction by hydrocarbon contamination from marine facility washdown and small fuel spills would be minimized by onsite collection and treatment of runoff and wastes. In general, although the proposed construction dock and spoil disposal site would severely reduce the intertidal zone of Anderson Bay, the impact on Port Valdez shorebirds would not be significant.

4.4.1.3 Raptors

The project may adversely affect raptors by disturbance or destruction of existing nest sites. (These issues as they relate to peregrine falcons are addressed in section 4.6.) Perhaps the greatest issue concerning raptors is the number of active bald eagle nests which could potentially occur within and near the project site. The Bald and Golden Eagle Protection Act (16 U.S.C. 668 (1988)) strictly prohibits the disturbance and/or destruction of bald eagle nests. In previous years, three bald eagle nests have been recorded within the project site and an additional two nests within a mile. A nest site at Nancy Creek is known to have blown down in 1989, and no nest sites were recorded in the vicinity of Anderson Bay by FWS and ADFG personnel during surveys in June of 1991 and 1992. Bald eagles could, however, reestablish nesting territories within the project area at any time and the existence of a bald eagle nest would have an impact upon project scheduling and/or activities. **Consequently, we recommend that Yukon Pacific conduct surveys for bald eagle nest sites during the year prior to the commencement of site activities and each year subsequently, to determine nesting activity at the site. If active nests are found, Yukon Pacific must consult with the FWS and ADFG to ensure the project does not violate the Bald and Golden Eagle Protection Act.**

4.4.1.4 Large Mammals

A variety of large ungulates and large predatory mammals occur within the Port Valdez area (Morsell, 1979; Roberson, 1986). Many of these species occur in such low numbers in the vicinity of the proposed project area, however, that adverse impacts would not be expected. The exceptions are mountain goats, brown bears, and black bears.

Mountain goats are considered abundant only in the steep mountainous terrain east of Valdez Arm (BLM and COE, 1988) with the nearest goat habitat of importance occurring at Abercrombie and Sulphide gulches, 10 to 14 miles east of Anderson Bay. The construction and operation of the project would not directly impact mountain goats. However, mountain goats could be indirectly impacted by increased human disturbance and hunting pressure from the expected additional 4,000 construction workers living at the construction site and the City of Valdez. Many of the Valdez area goat populations are accessible to humans, including the kidding areas at Abercrombie and Sulphide gulches, regulating or limiting human access to goat areas may be necessary to minimize impacts. Since Prince William Sound goat populations presently appear to be depressed (Abbot, 1992), additional pressures on them may need to be controlled by the ADFG.

Although black bear densities are considered to be low to moderate and brown bear densities low in the Anderson Bay area (Griese, 1991), several brown bears and a black bear were observed in June 1991 (Stackhouse, 1992a). As is the case at nearby Jack Bay (Yukon Pacific, 1991), bears may concentrate in the Anderson Bay area during the late summer to feed on spawning pink and chum salmon in Nancy and Henderson Creeks and nearby Seven Mile Creek (Thompson, 1992).

Since personnel with the ADFG have at times observed large numbers of bears in the vicinity of the project (Brna, 1992a), the potential for bear/human conflicts is potentially great with the construction and operation of the LNG plant and terminal. The LNG Project could impact bears in three ways: 1) the project facilities would block travel access along the Port Valdez shoreline potentially deflecting bear movements through areas of high human activity, 2) food and garbage odors could attract bears to human high use areas, and 3) increased disturbance and excessive hunting pressure (legal and illegal) could reduce the numbers of bears using the region. Bear/human contact frequently leads to killing of the bear. For example, at least 13 "problem" grizzly bears were killed during the construction of the Trans Alaskan Pipeline (Herrero, 1986). Human habitations, like salmon streams, will attract several bears from great distances if the animals anticipate food. These sites are called "population sinks" (Knight et al., 1988), and when they involve man-made attractants, often result in human contact with subsequent death or injury to bears. At Yellowstone Park and its vicinity, the second major cause of grizzly bear deaths is controlled removals of "problem" bears (Knight et al., 1988). The first is illegal hunting. The anticipated peak workforce of 4,000 construction workers would most likely increase the possibility of bear/human conflicts. To reduce the potential conflict with bears at the site, **we recommend that Yukon Pacific develop and file with the Secretary, for review and approval by the Director of OPPR prior to initiation of construction, a mitigation plan which details procedures for avoiding bear/human conflicts. This plan should stress implementation of an education program for workers, in addition to methods of bear-proofing the site, especially the waste disposal area.**

4.4.1.5 Small Mammals and Furbearers

Construction of the LNG plant and marine facilities would result in the loss of habitat for several species of small mammals, especially the forest-dependent red-backed vole. However, this is probably the most abundant small mammal in the Port Valdez region (Morsell, 1979), and no small mammal species are known to occur at the project site for which significant losses in habitat or population can be expected.

The greatest impact that the construction and operation of the LNG plant would have on furbearers would result from the loss of coniferous forest habitat for pine martens and the loss of shoreline habitat for mink. The significance and extent of these impacts are insignificant from a regional population scale.

4.4.2 Vegetation

Construction of the proposed LNG facility would require the clearing of approximately 365 acres of mature coastal spruce and hemlock forest and 13 acres of alder shrub. Overall, this clearing represents a relatively minor impact since both forest and shrub vegetation types are common and well represented in the areas of Anderson Bay surrounding the proposed LNG site. All vegetation clearing would be conducted in accordance with a state-approved site-specific erosion and sedimentation control plan (Braden, 1993) (see section 4.1.2). This plan would be developed by Yukon Pacific prior to construction and would include specifications that define the physical limits of clearing activities; detail timber salvage and brush disposal operations; and outline acceptable methods for blasting, erosion control, and revegetation of areas that would not be used for siting of permanent aboveground facilities (Braden, 1993).

The proposed clearing activities could result in several secondary effects, including increased soil erosion potential (see section 4.1.3), elevated soil temperatures, and permanent loss and alteration of wildlife habitat (see section 4.4.1). The clearing of forest could also affect uncleared forest vegetation growing along the edges of the cleared areas. Some edge trees would be exposed to elevated levels of sunlight and wind, which could increase evaporation rates and the probability of wind throws. The proposed clearing also could temporarily reduce local competition for available soil moisture and light and may allow some early successional species to become established and persist on the edge of the uncleared areas adjacent to the site. In general, however, all of these secondary impacts, with the possible exception of loss of wildlife habitat, would be minor and would not require any additional mitigation that has not already been proposed or recommended by us or Yukon Pacific.

Yukon Pacific's BMPM indicates that buffer strips of uncleared, native vegetation may be left between construction areas and natural waterbodies to minimize erosion and sedimentation. However, no such buffer strips are shown on Yukon Pacific's rough grading overall site plan. Instead, these plans indicate that the entire site would be cleared and graded to the waterline of the of the bay and streams. We believe that the maintenance of such buffer strips would minimize the risk of sedimentation. **Therefore, we recommend that where feasible Yukon Pacific should maintain a natural, uncleared vegetative buffer strip at least 50 feet wide between construction areas and waterbodies. Yukon Pacific should indicate the location and size of these buffer strips on its final site plans that would be filed with the Commission prior to construction. Where Yukon Pacific believes maintenance of a 50-foot-wide buffer strip would be infeasible, Yukon Pacific should file with the Secretary for review and approval by the Director of OPPR prior to construction a detailed explanation of why the required buffer strips cannot be maintained, and should include with this explanation a description of alternative sediment control measures that would be employed on a site-specific basis instead of maintaining the vegetative buffer strip.**

4.4.3 Wetlands

Approximately 49 acres of estuarine and palustrine wetlands are located within the construction limits of the proposed site. For this analysis we have assumed that all of this wetland area would be affected by site development. Yukon Pacific has proposed a wetland mitigation plan, in accordance with the President's Council on Environmental Quality Guidelines, to compensate for wetland losses and adverse wetland effects associated with the proposed construction. Yukon Pacific's wetland mitigation plan is based on a numerical accounting of the physical and geomorphic characteristics and functional values of the potentially affected wetlands on the site. Each wetland was evaluated and given a relative functional value score based on a wetland evaluation technique that was developed by the Wetland Evaluation Working Group (WEWG) in June 1992 as a modification of the FWS National Wetlands Inventory (NWI). The WEWG is made up of staff from various state and Federal agencies, including the ADFG, FWS, COE, and EPA, and representatives from Yukon Pacific. The functional value scores for each wetland type except subtidal wetlands (E1UBL) are listed in table 3.4.3-1. Yukon Pacific did not evaluate the functional values of subtidal wetlands because it contends that adverse effects on these wetlands would not require mitigation. Of the wetlands that were evaluated, the highest functional values per acre were given to the estuarine intertidal emergent and unconsolidated shore wetlands between Terminal Island and the mainland. The lowest functional values were assigned to the inland palustrine scrub-shrub and emergent wetlands.

Yukon Pacific's wetland mitigation plan was designed to offset the construction-related loss of wetland functional values. The plan has three components: 1) rectification of wetland impacts through repair, rehabilitation, restoration, or enhancement of specific wetland sites; 2) reduction or elimination of wetland impacts over time through recovery and maintenance of wetlands over the life of the project; and 3) compensation for impacts through onsite and/or offsite replacement or substitution of resources and habitats. In-kind and onsite mitigation was developed for wetland types that were determined to have valuable ecological characteristics. Mitigation for other wetlands involved either creation of new, more valuable wetland types or enhancement of existing low functional value wetlands, both on and offsite. Proposed onsite mitigation includes re-meandering the surface discharges of Short and Terminal Creeks; rehabilitation and creation of intertidal and shallow subtidal salt water habitats in the rock disposal area of Anderson Bay; and flow regulation enhancement at Seven Mile Creek. Proposed offsite mitigation includes enhancement and creation of intertidal seepage-fed pond/channel complexes in the area of the Old Valdez townsite; and creation of a freshwater pond/channel complex behind the Old Valdez townsite docks.

Onsite Marine Mitigation

Most of the impact on estuarine intertidal wetlands would be mitigated by onsite rectification and reduction of impacts, and by compensation through replacement or substitution of affected wetlands. Yukon Pacific proposes to fill an area of approximately 16.9 acres in size at the east end of Anderson Bay near the mouths of Short and Terminal Creeks (see section 2.3.2). This area, referred to as spoil fill Site B', currently comprises estuarine, subtidal and intertidal, unconsolidated bottom wetlands. These existing wetlands would be filled during construction. Following construction, Yukon Pacific proposes to grade down the western portion of this area and return it to intertidal and shallow subtidal habitat. This mitigation would require that some excess rock and soil be pushed out into the deeper water at the east end of Anderson Bay, creating at least 10 acres of new shallow subtidal wetland habitat to the west of the proposed disposal site. While this reconfiguration of spoil fill Site B' is discussed in the wetland mitigation plan filed on October 13, 1992, it is not reflected on any site plans currently on file.

Onsite Freshwater Mitigation

Several emergent wetlands, one scrub-shrub wetland, and one unconsolidated freshwater wetland, would be filled or adversely affected by construction. Yukon Pacific proposes to mitigate this impact through compensation of wetlands in the vicinity of Short Creek, Terminal Creek, and Seven Mile Creek. Following construction, Yukon Pacific would re-meander Short and Terminal Creeks. In addition it would create at least 5 acres of small, irregularly shaped, open water ponds fringed by emergent and rooted aquatic vegetation along the Terminal Creek corridor, and would construct one larger 2-acre pond from the upland areas surrounding Terminal Creek. The remainder of freshwater wetland impact would be mitigated by regulating the water flow of Seven Mile Creek. Yukon Pacific contends that the low winter streamflow of Seven Mile Creek and the frequency and duration of tidal inundation of spawning redds are two factors which limit the survival and production potential of pink and chum salmon that spawn in the creek. Yukon Pacific believes that by releasing water from the proposed Seven Mile Creek reservoir and increasing downstream flow during winter it can increase the reproductive success of these salmon. However, Yukon Pacific has not presented any construction plans or a water budget analysis which indicates that this mitigation can be implemented. See sections 4.3.3 and 4.5.4 for a more detailed discussion of salmon redds in Seven Mile Creek.

Offsite Mitigation

The proposed offsite mitigation involves construction of several acres of intertidal and freshwater pond/channel complexes within the intertidal flats along the shore south of the Old Valdez townsite and the area behind the Old Valdez townsite docks. This area is predominantly flat, unconsolidated, and sparsely vegetated ground with little habitat or other functional value. The proposed pond/channel complex would be created by constructing several irregularly shaped shallow depressions, 1 to 4 feet deep, with interconnecting channels and slightly elevated margins. This would result in a mix of vegetated and open water wetland types.

Plan Comments

Yukon Pacific's wetland mitigation plan has been reviewed by the Alaska offices of the COE, EPA, and NMFS. These agencies expressed several concerns regarding the plan in recent letters to the FERC. The EPA believes that more field studies are needed to collect additional wetland information, particularly for the intertidal wetlands at the east end of Anderson Bay (EPA, 1993a). The COE, EPA, and NMFS do not agree with Yukon Pacific's presumption that no mitigation would be required for the subtidal marine areas (E1UBL) that would be affected by site development. Both the COE and NMFS indicated that mitigation may be required to offset impact on or loss of these areas (COE, 1993; NMFS, 1993a). Another concern of the COE and EPA is that the wetland mitigation plan lacks sufficient site-specific details regarding how it would be implemented.

The COE generally agreed with the functional value scores given to specific wetlands and approved of Yukon Pacific's efforts to match the losses of particular values with appropriate mitigation. However, the COE was dissatisfied with the level of effort regarding review of alternatives that would avoid the destruction of shallow intertidal areas and also the lack of information regarding the successes and failures of other similar mitigation plans that have been implemented in the same geographic area. The COE also indicated that a precise mathematical offset of losses and gains of wetland functional values has not been required in past practice and is not of great concern to the COE (COE, 1993).

In general, we agree with the comments of the other agencies and share similar concerns regarding Yukon Pacific's wetland mitigation plan. The plan does not provide mitigation for any of the subtidal areas that would be affected. Further, although it proposes various rectification, reduction, and compensation for most of the affected wetland functions and values, it provides no design plans or details as to how the proposed mitigation would be implemented and monitored, or whether the mitigation is likely to be successful. In addition to the concerns raised by other agencies, we have a concern regarding Yukon Pacific's proposed onsite marine mitigation. We believe that the proposal to grade excess rock and soil further out into the deeper water of Anderson Bay following construction of the LNG facility would result in sedimentation of marine waters that could potentially harm marine organisms. If not properly mitigated, this action would present an additional unnecessary impact on the waters and wetlands of Anderson Bay.

It is generally believed that wetland replacement can be an effective method of mitigation if properly implemented. Research suggests that soils, plants, hydrology, and elevation are key factors that influence the success or failure of wetland construction projects (COE, unpublished paper). A study of eel grass transplantation projects in the Pacific Northwest found that substrata, elevation, current or wave disturbance, light energy, scale or size of plots, salinity, and temperature were all factors influencing the success of eel grass transplants (Thom, 1990). Several of these factors as well as timing of construction have been cited as critical aspects to be considered in planning and implementing tidal marsh creation and restoration in other areas of the United States (Broome, 1990). In view of this information, we believe that additional information about Yukon Pacific's wetland mitigation plan is necessary. **Therefore, we recommend that Yukon Pacific file with the Secretary for review and approval by the Director of OPPR prior to construction a revised wetland mitigation plan that contains the following:**

- **identification of, and proposed mitigation for, all the subtidal wetlands that would be affected by the site's development;**

- **a detailed literature review of the other wetland mitigation projects that have been conducted in the Pacific Northwest, including a summary of the successes and failures of these projects;**

- **site-specific construction plans that incorporate information learned from the literature review regarding how the proposed mitigation would be implemented including detailed information regarding the key factors that are known to influence the success of wetland construction (e.g., elevation, substrate, hydrology);**

- **details regarding how the proposed wetland mitigation would be monitored and evaluated following construction to ensure its success; and**

- **written comments from the JPO, COE, NMFS, and EPA on Yukon Pacific's revised wetland mitigation plan.**

4.5 MARINE ECOLOGY

Marine impacts include impacts from the LNG facility upon Anderson Bay, Port Valdez, and the shipping lane through Prince William Sound. This section addresses the potential for impacts within these waterbodies.

4.5.1 Bathymetry and Circulation

Due to fill and blasting operations, the bathymetry of nearshore Anderson Bay would be significantly altered, and at least 35 acres of intertidal habitat would be destroyed. An 18-acre area would be graded to 30 feet elevation by filling the intertidal areas between the shore and the adjacent island and extending beyond the island several hundred feet into Anderson Bay, and about 17 acres near and including the intertidal lower reach of Short Creek would be filled.

Approximately 3,018,000 cubic yards of overburden soils down to bedrock and 735,000 cubic yards of rock would be removed and placed in planned fill and disposal areas. In addition to disposal of waste rock and overburden, an additional 1,400,000 cubic yards of structural rock fill would be used as fill to construct a cargo dock. Disposal of the overburden material, which includes stumps, roots, organics, till, and broken bedrock, can affect water quality and is discussed in section 4.5.2.

Circulation within Anderson Bay would be affected by rock and spoil disposal resulting in the filling of 16 acres of its east end, and circulation in nearshore Port Valdez may be affected by thermal discharge. Decreased stream flow would result from the use of Seven Mile Creek, Nancy Creek, or Short Creek to provide water supply for construction and operation of the facilities (section 4.3.1) and may alter the salinity structure within Anderson Bay and nearshore Port Valdez. Thermal discharge would primarily arise from desalination plant and HRSG blowdown discharge during operation (table 4.5.1-1). High temperature discharges can impact marine habitat and alter the circulation in the vicinity of discharge and should therefore be minimized.

TABLE 4.5.1-1

Location, Volume, and Temperature of Discharge from Proposed Outfalls

Outfall	Discharge Volume (gpm) a/, b/	Temperature °F	Comments
Desalination Plant LE-1	Average: 657 Maximum: 1,503	Mean: 100 Minimum: 100 Maximum: 100 Edge of mixing zone c/: seawater + 1.8	See text
HRSG/Boiler Blowdown d/ LE-2	Average: 4 Maximum: 6	Mean: 230 Minimum: 230 Maximum: 230 Edge of mixing zone c/: seawater + 1.8	See text
Wastewater Treatment Plant LE-3	Average: 30 Maximum: 120	Mean: 48 Minimum: 35 Maximum: 60	
No. 1	Average: 667 Maximum: 7,900	Ambient	Mouth of Strike Creek
No. 2	Average: 317 Maximum: 34,400	Ambient	Combined wastewater plant discharge
No. 3	Average: 183 Maximum: 17,250	Ambient	
No. 4	Average: 167 Maximum: 1,417	Ambient	
No. 5	Average: 183 Maximum: 15,283	Ambient	
No. 6	Average: 417 Maximum: 20,683	Ambient	Mouth of rerouted Short Creek
No. 7	Average: 3,700 Maximum: 144,383	Ambient	Mouth of Nancy Creek
No. 8	Average: 117 Maximum: 12,617	Ambient	
No. 9	Average: 367 Maximum: 19,033	Ambient	Near mouth of Seven Mile Creek
No. 10	Average: 667 Maximum: 6,917	Ambient	

a/ The desalination plant volumes reported do not include strainer and pressure filter backwash volumes.

b/ The average discharge volumes from the outfalls are based upon average annual precipitation. The maximum discharge volume from the outfalls is based upon the 100-year return storm event with the duration/intensity chosen to yield the maximum instantaneous discharge volume.

c/ Assumes 50 to 1 dilution at edge of mixing zone (see text).

d/ The temperature of the wastewater treatment plant effluent is expected to be around 35°F to 45°F in the winter and around 50°F to 60°F in the summer. The temperature reported is the arithmetic average of the minimum and maximum temperatures.

HRSG blowdown effluent and desalination discharge effluent share the same discharge piping. The NPDES and state receiving water quality standards require that weekly average temperature increases be limited to no more than 1 degree Celsius at the edge of the mixing zone; maximum rate of change shall not exceed 0.5 degree Celsius per hour; and normal daily temperature cycles shall not be altered in amplitude or frequency. The desalination discharge volumes are expected to be much larger than the blowdown volumes, although the blowdown temperature may be much higher. Therefore, in sizing and evaluating the mixing zone, the relative discharge rate and temperature of both effluents must be considered.

Yukon Pacific has estimated a maximum differential temperature of 55°F to 65°F above ambient seawater for desalination plant discharge. For this temperature differential range, dilution to assure compliance with a 1°C or 1.8°F temperature increase would be 30-36 parts seawater to 1 part discharge or less than 50 to 1 dilution (55-65/1.8 = 30-36). A standard diffuser design would probably provide dilution in excess of 50:1. Dilution models may be utilized to incorporate information on water depth, local currents, salinity, temperature and volume of discharge, and seasonal stratification in order to calculate site-specific dilution for mixing zone allowances. Due to the high temperature of the discharge, **we recommend that Yukon Pacific use a dilution model to design the diffusers for the high temperature of the desalination and HRSG/Blowdown discharges, and determine the vertical extent of the mixing zone so that the surface and bottom thermal layers of Port Valdez are not subject to periodic surges of hot water.**

The worst-case difference in temperature between blowdown and ambient water would be about 195°F (230°F blowdown temperature relative to 35°F seawater temperature). To meet criteria, and in the absence some initial cooling, slightly greater than a 100:1 dilution would be necessary within the mixing zone (195/1.8 = 108). Again, dilution models would be required to determine the mixing zone necessary to sufficiently dilute this low volume, high temperature discharge and will be conducted before discharge is permitted by state agencies.

The actual size and shape of the mixing zone must comply with Alaska Water Quality standards 18 AAC 70.032 which state the cumulative linear length of all mixing zones intersected on any given cross section of an estuary, inlet, cove, channel, or other marine water measured at mean lower low water may not exceed 10 percent of the total length of that cross section, nor may the total horizontal area allocated to mixing zones in these waters exceed 10 percent of the surface area measured at mean lower low water. Temperature discharge must not have an adverse impact on anadromous fish spawning or rearing or form a barrier to migratory species. Although the state has some latitude in assigning limits, mixing zones are receiving more scrutiny and more evidence is being requested by the state.

Mixing zones of 600 feet to 600 feet (183 m) have been predicted for desalination plant discharge and assumed to meet the mixing requirements for blowdown discharge. Mixing zones of this size are within the normal range (Sturdevant, 1993). Before permitting, Yukon Pacific must apply for a mixing zone with the ADEC, and run models to assess the temperature of water at the edge of the mixing zone (Kawabata, 1992). If the size of the allowable mixing zone is not sufficient to meet the water quality standards for temperature, Yukon Pacific must cool the water before discharge into Port Valdez. Cooling measures, if necessary, could include cooling periods in sedimentation ponds or the installation of a small air cooler.

The location of the desalination discharge would not be determined until detailed design, but would be chosen so that its mixing zone allowances do not overlap with adjacent allowances (i.e., for the wastewater treatment plant discharge). The location of the combined desalination and boiler discharge shown on figure 2.1.4 sheet 2 is at the Port Valdez shoreline immediately north of the source water treatment (desalination) area. The location shown for the discharge from the wastewater treatment plant is based upon the assumption that the discharge would flow into Sediment Pond No. 1, ultimately leaving the site via outfall No. 2.

4.5.2 Water Quality

Possible impacts on marine water quality in the project area include increased turbidity from construction, grading, and blasting, loss of wetlands as buffers, disposal of fill, outfall discharge, ballast water exchange, and accidental spills. This section discusses the impacts of these activities upon nearshore water quality in Anderson Bay and Port Valdez as well as the shipping lane through Prince William Sound.

4.5.2.1 Anderson Bay and Nearshore Water Quality

Increases in turbidity in Anderson Bay and nearshore Port Valdez may arise from construction activities. We have recommended that Yukon Pacific prepare and submit a detailed erosion control and sedimentation control plan (see section 4.1.3) to delineate appropriate leaching, runoff, and erosion control measures from site surface excavation and uncontrolled or diverted runoff during construction activities. This plan would include control methods such as retention basins, berms, revegetation, and straw bales as appropriate.

Underwater blasting would be required in most areas of the leveling operation. Blasting would not occur until a detailed blasting test program has been conducted to determine the limits for charge size, charges per delay, and total charge weight for Anderson Bay. The blasting plan would be covered in the ADNR state permit (TAGS Right-of-Way Lease Stipulation Number 2.11) and COE Section 10 and Section 404 permits, and it would be reviewed by the NMFS, ADFG, COE, and FWS. Blasting would be expected to increase turbidity within the water column, thus blasting during the spring season should be avoided. In addition, blasting is likely to change water quality in the vicinity of the blast location. Only short-term turbidity impacts are anticipated, assuming the bathymetry of important tidal areas is not changed significantly.

Placement of fill within Anderson Bay could adversely affect water quality in Anderson Bay through increased turbidity during placement and subsequent leaching. The fill would contain all sizes of excavated rock, organics, concrete, and glacial till. According to a study conducted by Dames and Moore (1991) and Steffen Robertson and Kirsten, Inc. (1991), however, placement of onsite rock should not result in the formation of acids which would favor the leaching of metals from the rock. This conclusion was reached following a procedure known as static acid-base accounting using a total of 92.8 percent of onsite bedrock types from over the entire Anderson Bay plant site, including those with the highest acid-generating minerals (sulfides). Paste pH tests were also run on each sample to determine if acid generation had already begun. None of the rock demonstrated any potential for acid generation, and thus the potential for metals leaching from fill disposal appears to be minimal. As a further deterrent to leaching, all disposal areas would first be isolated from Port Valdez by containment dikes composed of mineral soil or rock.

The material used to construct these initial containment dikes would be relatively free of organic soils (less than 5 percent) and would not contain stumps or large roots. Organic material, which would be present in the overburden, could adversely affect water quality through the introduction of nutrients, metals, and turbidity. When complete, the surface of the disposal areas would be plated with clean rock to provide a trafficable surface for equipment and for the storage of construction materials. Following construction, the western portion could be graded down and returned to intertidal and shallow subtidal salt water influence according to the proposed wetland mitigation plan submitted by Yukon Pacific (see section 4.4.3). This would temporarily result in increased levels of turbidity within an uncontained area of Anderson Bay. To protect the water quality and habitat of Anderson Bay from unnecessary impacts, we have recommended that Yukon Pacific provide greater detail on its wetland mitigation plan to the Director of OPPR for review and approval, along with comments from the JPO, COE, NMFS, and EPA.

Although long-term leaching is not expected to be a problem, placement of the fill in the nearshore environment is expected to result in short-term violations of state water quality standards (e.g. turbidity). However, the state, at its discretion, may grant a short-term variance for a one-time, temporary activity with the placement of dredged or fill material affecting a specific waterbody. The petitioner must demonstrate that the activity would be conducted in a manner to mitigate water quality impacts, using methods found by the Department to be most effective, and must show that the activity, once completed, would not cause a long-term, chronic, or recurring violation of the water quality standards.

As discussed in section 4.5.1, 10 outfalls and effluent from the desalination plant, HRSG/boiler blowdown, and the wastewater treatment plant would discharge into Anderson Bay and nearshore Port Valdez. The 10 outfalls would contain stream water and controlled site drainage from developed areas. There would be no uncontrolled site drainage except for drainage from the shoreside perimeter of the site. To minimize uncontrolled runoff, we have recommended that a vegetative buffer strip 50 feet wide be maintained along all shoreline areas, where possible (see section 4.4.2). Grading and restoration requirements for the shoreside perimeter areas would be reviewed during detailed design by the FERC staff prior to construction and by other state and Federal agencies as it relates to the site-specific erosion and sedimentation control plan (see section 4.1.2).

Table 4.5.2-1 presents predicted water quality from the desalination plant and HRSG/boiler blowdown. Water quality estimates for the desalination plant, HRSG/boiler blowdown, and the wastewater treatment plant were compared to state water quality regulations. Desalination discharge composition was estimated based upon a concentration factor of 10/9 seawater assuming 90 percent of water withdrawn from Port Valdez is returned to Port Valdez. No violations were evident in the predictions with the possible exception of total dissolved solids (TDS) in the desalination plant discharge. However, dilution in the mixing zone is predicted to bring TDS into compliance by the edge of the mixing zone (from 50,000 to 30,932 mg/L). The HRSG/boiler blowdown composition was estimated based on an assumed operational limit of 3,000 mg/L total dissolved solids. The composition of the blowdown would be the composition of the desalination plant effluent concentrated by the ratio of TDS in the effluent to a TDS of 3,000 mg/L plus any corrosion or scaling inhibitors. The addition of these inhibitors would have to be approved through the NPDES permit process before discharge would be allowed.

TABLE 4.5.2-1

Liquid Effluent Compositions and Pollutant Mass Rates Desalination Plant Effluent and HRSG/Boiler Blowdown

		Desalination Source Seawater	Desalination Discharge, Average, in the Pipe	Desalination Discharge, Daily Maximum, in the Pipe	Desalination Discharge, Daily Maximum, Edge of Mixing Zone a/	HRSG/Boiler Blowdown, Average & Daily Maximum, in the Pipe b/	HRSG/Boiler Blowdown Average & Daily Maximum, Edge of Mixing Zone a/	Desalination Discharge, Rate of Pollutants Average (lb/hour) c/	Desalination Discharge, Rate of Pollutants Maximum (lb/hour) d/	HRSG/boiler Blowdown, Rate of Pollutants Average (lb/hour) c/	HRSG/boiler Blowdown, Rate of Pollutants Maximum (lb/hour) d/
Temperature e/			100F	100F	seawater+1.8F	230F	seawater+1.8F				
Discharge flow											
Average, gph			39,420			240					
Maximum, gph			90,180			360					
Salinity	ppm	30,000	33,333	50,000	30,392						
pH		8	8	8	8	8.2	8.2				
Hydrocarbons	mg/l	0.6	0.67	1.00	0.61			0.219	0.753		
Benzene	ug/l f/	0.2	0.2	0.2	0.2			0.000	0.000		
Chlorobenzene	ug/l f/	0.2	0.2	0.2	0.2			0.000	0.000		
Ethylbenzene	ug/l f/	0.2	0.2	0.2	0.2			0.000	0.000		
Toluene	ug/l f/	0.3	0.3	0.3	0.3			0.000	0.000		
Xylenes	ug/l f/	0.6	0.6	0.6	0.6			0.000	0.000		
Copper	mg/l	0.066	0.073	0.110	0.067			0.024	0.083		
Iron	mg/l	0.092	0.102	0.153	0.093			0.034	0.115		
Nickel	mg/l	0.019	0.021	0.032	0.019			0.007	0.024		
Zinc	mg/l	0.044	0.049	0.073	0.045			0.016	0.055		
Arsenic	mg/l f/	0.001	0.001	0.001	0.001			0.000	0.001		
Cadmium	mg/l f/	0.0001	0.0001	0.0001	0.0001			0.000	0.000		
Lead	mg/l f/	0.001	0.001	0.001	0.001			0.000	0.001		
Mercury	mg/l	0.0003	0.00033	0.00050	0.0003			0.000	0.000		
Chloride	mg/l	12,000	13,333	20,000	12,157	1,648	11.,97	4,386.2	15,051.4	3.301	35.442
Sulfate	mg/l	2,700	3,000	4,500	2,735	232	2,652	986.9	3,386.6	0.465	7.966
Bicarbonate	mg/l	150	167	250	152	12	147	54.8	188.1	0.024	0.443
Bromide	mg/l	70	78	117	71	6	69	25.6	87.8	0.012	0.207
Sodium	mg/l	10,000	11,111	16,667	10,131	922	9,822	3,655.2	12,542.9	1.847	29.508
Magnesium	mg/l	1,300	1,444	2,167	1,317	111	1,277	475.2	1,630.6	0.222	3.836
Calcium	mg/l	400	444	667	405	35	393	146.2	501.7	0.070	1.180
Potassium	mg/l	390	433	650	395	33	383	142.6	489.2	0.066	1.151
Strontium	mg/l	13	14	22	13	1	13	4.8	16.3	0.002	0.038
TDS	mg/l	30,000	33,333	50,000	30,392	3,000	29,471	10,965.6	37,628.6	6.009	88.538

a/ Assumes 50 to 1 dilution at edge of mixing zone.
b/ HRSG/boiler system will be operated to maintain 3,000 TDS.
c/ Calculated as the product of average flow and average concentration (mass rate is that of the pollutants in the raw seawater feed).
d/ Calculated as the product of maximum flow and maximum concentration.
e/ Mean, minimum, and maximum temperatures are the same for desalination plant discharge and blowdown.
f/ Actual values are less than the estimated values shown.

The two-step wastewater treatment system would be designed to bring the significant amounts of oil and grease, grit and other settleable solids, and organic and inorganic suspended solids into compliance with state regulations. Table 4.5.2-2 presents a typical estimate of effluent quality for the wastewater treatment plant based upon similar plant effluents (Metcalf and Eddy, 1979) and Yukon Pacific's experience with similar facilities. Predicted maximum biochemical oxygen demand (BOD) and total suspended solids in the wastewater treatment plant effluent are equal to values identified in a nearby NPDES permit (Alyeska's Treatment Plant) and are thus near the permitted limit. Fecal coliform predictions for the wastewater treatment plant effluent are in incompatible units with the standards (mg/L predicted versus #/100 mL regulated), and thus could not be directly compared. Alyeska is also required to periodically monitor nearby sediment to check for accumulation of organic contaminants within and outside of their designated mixing zone. While the wastewater effluent concentrations for Yukon Pacific are predicted to be in compliance, periodic water quality analyses for selected constituents may still be required in the NPDES permit.

All ballast water from the LNG tankers would be exchanged during the 36-hour period prior to entering Prince William Sound in order to ensure that foreign organisms do not enter the Sound. In addition to the 36-hour period, **we recommend that Yukon Pacific require ballast water discharge/exchange occur at least 10 kilometers south of Hinchinbrook Entrance in order to protect against any waiting or slow travel scenarios.** Therefore, ballast water exchanged at the facility should be relatively clean water based on its source and its recent change. In addition, the ballast storage system in LNG tankers is designed to isolate ballast water from the cargo and thus to prevent hydrocarbon discharge with the ballast water. Therefore, we do not believe impacts from discharge of this ballast water would be significant. Bilge discharges into nearshore waters from vessels moored at the site would not be allowed.

Other impacts that could potentially affect marine water quality in the project area include air emissions from the plant operations as well as accidental spills. Air emissions should not significantly impact marine water quality due to the high buffering potential of seawater. However, spills could result in significant effects, and thus appropriate precautions would be detailed in a SPCC Plan and followed accordingly. Such precautions include the placement of booms around tankers during loading as well as spill containment for any petroleum storage tank.

4.5.2.2 Prince William Sound and Offshore Water Quality

All ballast water from the LNG tankers would be exchanged during the 36-hour period prior to entering Prince William Sound to ensure ballast discharge (with foreign organisms) does not enter into Prince William Sound. Bilge water may be dumped in offshore waters because its discharge would not be allowed in Port Valdez. According to MARPOL regulations 73/78, bilge water must contain less than 100 ppm total petroleum hydrocarbons (TPH) if discharged over 50 miles from the coast, and must contain less than 15 ppm TPH if within 50 miles of the coast.

As identified in section 4.15.4, the worst scenario for Prince William Sound would involve release of LNG cargo due to a serious grounding or collision of a tanker. If LNG were released, it would either evaporate rapidly forming a flammable cloud, or ignite and burn. In either case, a LNG spill would not affect water quality.

TABLE 4.5.2-2

Liquid Effluent Compositions and Pollutant Mass Rates Wastewater Plant Effluent / Outfall No. 2

		Wastewater Treatment Plant Average	Wastewater Treatment Plant Maximum	Site Runoff Average	Site Runoff Maximum	Combined Discharge, Outfall No. 2 Average a/	Combined Discharge, Outfall No. 2 Maximum b/	Wastewater Treatment Effluent Average (lb/hr) c/	Wastewater Treatment Effluent Maximum (lb/hr) d/
Flow e/	gph	1,800	7,200	19,000	210,000	20,800	217,200		
Temp. (winter)	F	35	45	36	40	35.9	40.2		
Temp. (summer)	F	50	60	50	60	50.0	60.0		
pH		7.5	8.5	7.5	8.5	7.5	8.5		
BOD	mg/l	30	45	2	5	4.4	6.3	0.451	2.704
COD	mg/l	45	60	3	7	6.6	8.8	0.676	3.605
TSS	mg/l	30	45	20	200	20.9	194.9	0.451	2.704
Ammonia (N)	mg/l f/	0.5	1	0.15	0.15	0.2	0.2	0.008	0.060
Oil/grease	mg/l f/	5	10	1	5	1.3	5.2	0.075	0.601
Fecal Coliform	mg/l f/	16	200	16	200	16.0	200.0	0.240	12.017
Nitrate (N)	mg/l f/	10	20	1	3	1.8	3.6	0.150	1.202
Phosphorus (P)	mg/l f/	3	6	0.01	0.02	0.3	0.2	0.045	0.361
Copper	mg/l f/	0.05	0.05	0.01	0.29	0.01	0.28	0.001	0.003
Iron	mg/l f/	0.2	1.5	0.2	2.0	0.2	2.0	0.003	0.090
Nickel	mg/l f/	0.01	0.01	0.01	0.70	0.01	0.68	0.000	0.001
Zinc	mg/l f/	0.05	0.05	0.02	5.00	0.02	4.84	0.001	0.003
Arsenic	mg/l f/	0.001	0.001	0.002	3.600	0.002	3.481	0.000	0.000
Cadmium	mg/l f/	0.0002	0.0002	0.0002	0.9000	0.0002	0.8702	0.000	0.000
Lead	mg/l f/	0.05	0.05	0.02	0.50	0.02	0.49	0.001	0.003
Mercury	mg/l f/	0.0003	0.0003	0.0003	0.0020	0.0003	0.0019	0.000	0.000
Hydrocarbons	mg/l f/	0.1	0.2	0.1	0.2	0.1	0.2	0.002	0.012
Benzene	ug/l f/	0.1	0.1	0.1	0.1	0.1	0.1	0.000	0.000
Chlorobenzene	ug/l f/	0.1	0.1	0.1	0.1	0.1	0.1	0.000	0.000
Ethylbenzene	ug/l f/	0.1	0.1	0.1	0.1	0.1	0.1	0.000	0.000
Toluene	ug/l f/	0.1	0.1	0.1	0.1	0.1	0.1	0.000	0.000
Xylenes	ug/l f/	0.2	0.2	0.2	0.2	0.2	0.2	0.000	0.000

a/ Average combined discharge characteristics reflect a mass balance of effluent and runoff at average flow rates and concentrations.
b/ "Maximum" combined discharge characteristics reflect a mass balance of effluent and runoff at maximum flow rates and concentrations.
c/ Calculated as product of average flow and average concentration.
d/ Calculated as product of maximum flow and maximum concentration.
e/ Peak runoff to the Sediment Pond is 34,400 gpm; the equalized rate for discharge was assumed to be 3,500 gpm.
f/ Actual values are less than the estimated values shown.

4.5.3 Sediment Quality

Sediments throughout the entire Port are slightly contaminated with polynuclear aromatic hydrocarbons (PAHs) from past activities. However, the extent of the most highly impacted sediment near the Alyeska terminal, does not appear to extend beyond 1-2 miles from the terminal and, therefore, does not significantly affect the sediments in the vicinity of Anderson Bay. At a station 1 to 2 miles west of Anderson Bay in the middle of Port Valdez, the most concentrated PAH, phenanthrene, has a mean concentration of 38 ppb (Shaw, 1992). Since the sediments in Port Valdez have such a low organic content, very low amounts of contamination are noticeable, even though the sediments do not have a high affinity for the organic contaminants. Cumulative impacts do not appear to be of concern at this time. However, possible sediment accumulation could arise from discharge from the outfalls, and the accumulation of small spills. The exchange of ballast water should not be of major concern.

4.5.4 Marine Fisheries

Construction of the Anderson Bay facility would impact the marine environment in several ways. Estuarine spawning areas at the mouths of Seven Mile and Nancy Creeks are used by pink and chum salmon. These areas would be highly sensitive to changes in the flow regime and alteration due to the proposed grading of the shoreline near the mouth of Seven Mile Creek. Salmon fry utilize protected, shallow intertidal areas in Anderson Bay. There is a proposed loss of approximately 35 acres of this habitat. There would be changes in the rocky intertidal and subtidal areas in the tanker berthing area and along the face of the cargo dock area. The release of heated water from the desalination plant and HRSG/Boiler blowdown may impact the marine environment. This section reviews these impacts and potential mitigation measures to minimize the negative effects on marine fish resources.

Pink salmon fry exiting Port Valdez migrate along the south side of the port and use Anderson Bay as a nursery area. Chum salmon fry have also been observed in Anderson Bay. The construction of bulkheads and docking facilities for the cargo dock and the spoil disposal area would eliminate approximately 35 acres of productive, protected, shallow water areas which provide cover and food for salmon fry. The fill disposal area in the eastern corner of Anderson Bay would cover an eel grass bed which is a highly productive marine habitat and is limited in Port Valdez. Yukon Pacific has proposed to create shallow intertidal habitat in the fill disposal area following construction when this location is no longer needed as a laydown area. We believe this mitigation plan would be inadequate (see sections 4.4.3.1 and 4.4.3.3). The salmon stocks in Port Valdez have 2- to 5-year life cycles and construction is scheduled to take place over 5 years. Eliminating critical habitat for the entire life cycle of the species of concern could negatively impact the entire stock as opposed to impacting an isolated year-class. In addition, attempts to create eel grass habitat in the northwest U.S. and Canada have generally met with poor success (Thom, 1990).

Although salmon fry have been observed in this area, the importance of this area relative to other parts of Port Valdez and other habitat types has not been documented; therefore, it is difficult to determine if there are real negative impacts and the degree of the impacts. **We recommend that Yukon Pacific, in conjunction with the ADFG and FERC, develop and conduct a salmon fry utilization study, designed to determine the importance of the nearshore areas affected by plant construction relative to other areas in Port Valdez. This study along with proposed mitigation should be submitted to the ADFG and filed with**

the Secretary for review and approval to determine if the proposed mitigation would be effective or whether additional mitigation is required.

Shock waves from underwater blasting may injure or kill fish which occur in the area. To minimize impacts from blasting, **we recommend that Yukon Pacific prepare a blasting plan that considers (1) scare charges and/or bubble curtains to move resident fish away from the area prior to blasting, and (2) coordination with the ADFG and the Solomon Gulch hatchery personnel to schedule blasting activities when no adult or juvenile salmon are in the area.**

Intertidal and subtidal construction and blasting may cause changes in the algal community which in term could cause changes in spawning patterns for herring which have been occasionally observed to spawn in Anderson Bay. Currently herring spawning in Port Valdez is sparse and does not occur on an annual basis. It is unlikely that changes in intertidal structure or the intertidal algal community would significantly impact herring spawning patterns.

The discharge of effluent water at a temperature of 100°F from the desalination plant and 230°F from the HRSG/blowdown may attract marine fish to the warm water in the mixing zone. If fish become acclimated to the warm water the removal of the warm water can cause mortality due to thermal shock. Once Yukon Pacific has determined the specific discharge volume, **we recommend that Yukon Pacific consult with the EPA, ADFG, and NMFS to determine the allowable location, frequency, and duration of warm water discharges into Port Valdez.**

4.5.5 Benthic Organisms and Algae

Intertidal and subtidal construction, and blasting in the tanker docking area would cause long-term physical changes in bathymetry, and available substrate. In the short term, it is likely that intertidal and subtidal organisms and algae would be damaged, covered, or killed. Disruption of the rocky intertidal zone due to ice scour and extreme weather is common in Port Valdez. The intertidal marine community has adapted to this and tends to recover quickly. The changes in substrate profiles and substrate types may cause changes in the benthic community, but there is a low species diversity in Port Valdez and it is unlikely these changes would be significant.

Construction of the cargo dock area, and use of the nearshore fill disposal area would cover shallow gravel, cobble, and sand/silt substrates. This would reduce the amount of interstitial spaces and soft substrate available to epiphytic, benthic, and burrowing organisms. Clams and crabs do not occur in significant numbers in Port Valdez and it is unlikely loss of this habitat would impact these populations. However, harpacticoid copepods have been found congregated in and on these habitat types and are an important salmon fry food resource. In addition, there is a documented eel grass bed in the fill disposal area. Yukon Pacific has proposed to create shallow intertidal habitat in this area after construction and abandonment of this location as a laydown area to mitigate for the loss of the shallow intertidal habitats. We are not confident in the viability of this mitigation. See section 4.4.3.3 for further discussion.

Fill placed in deep water marine disposal areas would cover and kill any established benthic organisms. The deep water benthic community in Port Valdez has adapted to chronic disruption due to deposition of high levels of glacial sediments. The benthic community would probably recover once fill disposal has been completed.

LNG, fuels, lubricants, and other chemicals spilled during plant construction and operation would negatively impact intertidal benthic organisms if allowed to run off into the marine environment or streams. In addition, fuels, lubricants, and other chemicals spilled from supply or transport vessels would negatively impact marine organisms. To minimize impacts caused by runoff of spills or leachate, we have recommended that Yukon Pacific develop a SPCC Plan using best management practices.

Finally, ballast water loaded in the LNG tankers from other geographic areas may contain exotic species of algae or organisms. Yukon Pacific would require that all ballast water be exchanged 36 hours prior to entering Prince William Sound. This would prevent the exchange of water from different global regions in the sound and would prevent exotic introductions.

4.5.6 Wildlife

4.5.6.1 Seabirds

Hogan and Irons (1988) listed 12 species of seabirds occurring in the vicinity of Port Valdez. This list is dominated by gulls and terns which nest at Shoup Bay directly across Port Valdez from Anderson Bay. These birds, along with marbled murrelets and pelagic cormorants, are the most common birds during the summer, while gulls and common murres are most common during the winter. Most of these birds will forage in the Anderson Bay area (BLM and COE, 1988). The LNG Project is expected to have little impact on seabirds mainly because most of these birds forage throughout Port Valdez and there are no nesting colonies within the immediate vicinity of the project area. However, as with waterfowl (see section 4.4.1.1), seabirds are highly susceptible to fouling by hydrocarbon discharges (Hogan and Irons, 1988). This is especially true with alcids such as murres and murrelets which spend most of their time on the water. Potential hydrocarbon discharges associated with the LNG Project include wastewater discharges. However, as mentioned previously, these potential impacts would be minimized by Yukon Pacific's proposed two-stage wastewater treatment system (see section 2.1.1.5) and our recommended SPCC Plan.

Seabirds may also be impacted by potentially lethal shock waves from the proposed submerged blasting at Anderson Bay. These impacts might be minimized by hazing seabirds from the zone of influence prior to blasting (see section 4.5.6.2 Marine Mammals below).

In general, the overall impacts on seabirds would not likely be great if all precautionary measures are fully implemented.

4.5.6.2 Marine Mammals

While several species of marine mammals have been recorded in Valdez Arm, only sea otters and harbor seals occur there on more than an occasional basis. (Endangered and threatened marine mammals are discussed in section 4.6). The importance of Port Valdez to these species is presently unknown, although both species were observed in Anderson Bay during surveys conducted by the ADFG during June 1991 (Brna, 1992a).

Probably the greatest potential impact on sea otters and harbor seals (and other marine mammals in the area) from the proposed LNG Project is the proposed submerged blasting operation. Submerged blasting can cause severe damage to marine mammals in two ways: 1) produced sharp noise pulses can impair hearing systems and 2) intense shock waves can physically disrupt internal tissues (Richardson et al., 1989). While there is no direct information on the effect of pulse noises on marine mammals (Richardson et al., 1989), Bohne et al. (1985) speculated that cochlear lesions observed in Antarctic seals were caused by explosions that had occurred in the area. Submerged blasting would probably not effect resting otters and seals because their heads are out of the water during these periods.

Intense shock waves created by underwater high explosions are a more serious problem. Studies conducted in association with the Amchitka Island underground nuclear tests indicated that shock waves with peak pressures of 100 to 300 psi were lethal or damaging to sea otters and harbor seals (Rausch *in* Fuller and Kirkwood, 1977). Pressures greater than 300 psi were lethal to sea otters (Wright and Allton, 1971). Hill (1978) and Wright (1982, 1985), following Yelverton et al. (1973), described procedures for calculating safe distances from explosions for marine mammals based on a combination of physical factors. Hill (1978) calculated that an 11 pound (5 kilogram [kg]) charge detonated at a depth of 16 feet (5 meters [m]) would not physically harm a ringed seal occurring 1,180 feet (greater than 360 m) away at depths greater than 82 feet (greater than 25 m). Correspondingly, Hill calculated that a 110 pound (50 kg) charge would not cause physical damage beyond 2,526 feet (770 m). However, these calculations for marine mammals were based upon terrestrial mammal data and do not take into account physiological and anatomical differences between terrestrial and marine mammals, causing Hill to suggest that the calculations may overestimate shock wave impacts on marine mammals. Nevertheless, in the absence of better data, the Yelverton/Hill procedure does provide a conservative approach to setting zone of physical influence boundaries. Additionally, Hill (1978) and Wright (1982) have suggested that calculated safe distances should be doubled in circumstances where explosions occur at or near rocky bottoms, such as at Anderson Bay, because shock waves may attenuate less rapidly than in open water.

Consequently, while proposed submerged blasting associated with construction of the LNG Project may have the potential to impact local marine mammals, Hill (1978) has provided a mechanism to develop a zone of influence for these impacts. **We recommend that Yukon Pacific include in its blasting plan measures, such as the use of spotters or lookouts, to ensure marine mammals are not present within the zone of influence prior to blasting.** If necessary, the zone of influence may be extended to take into account that marine mammal reactions to audible noises might occur at much greater distances than shock wave influences (Richardson et al., 1989).

4.6 ENDANGERED AND THREATENED SPECIES

4.6.1 Terrestrial Species

No federally listed or proposed endangered or threatened plant or wildlife species have been reported in the vicinity of the Anderson Bay project area (Stackhouse, 1992a; FWS, 1993). However, the federally endangered American subspecies (*Falco peregrinus anatum*) and federally threatened Arctic subspecies (*F. p. tundrius*) of the peregrine falcon may occasionally occur in the area as they migrate between their Arctic and Interior Alaska breeding areas to southern winter areas (Swem, 1993). Neither subspecies has been confirmed to nest in the Prince William Sound area, although Prince William Sound falls within the breeding range of the nonendangered Peale's subspecies (*F. p. pealei*) (Craig, 1986). Construction and operation of the Yukon Pacific LNG Project would not affect these species.

4.6.2 Marine Species

To assess the potential effects that the Yukon Pacific LNG Project could have on populations of endangered whales or Steller sea lion, and in accordance with Section 7 of the ESA, the staff prepared a Biological Assessment (BA) (see appendix C) and submitted it for review to the NMFS. This BA addressed four federally listed species that were identified by the NMFS as well as the endangered northern right whale.

Our assessment concluded that no direct impacts on the populations of the northern right, gray, humpback, or fin whales, or Steller sea lions would occur as a result of this project. Port Valdez is not documented as being important habitat or often used by any of these species. The potential increase in shipping would have little or no effect on marine mammals as existing, high use shipping travel lanes would be used for transport of LNG to market. There is no documented evidence that normal shipping activities have had any adverse effects on whales or sea lions in Prince William Sound.

In a letter dated March 17, 1993, the NMFS (NMFS, 1993b) responded to the FERC staff by concurring that there is presently no identified critical habitat for any of the four species of the whales of concern or for the Steller sea lion, although there are currently plans to designate specific Steller sea lion rookeries and haulouts in Prince William Sound as critical habitat. None of these rookeries or haulout sites occur in Port Valdez. Consequently, the NMFS agreed with the conclusion that construction of the LNG terminal would not have direct impacts on the species discussed above and has indicated that formal consultation is not required for this project, therefore concluding Section 7 consultation between the FERC and the NMFS.

4.7 AIR QUALITY

General Construction and Operational Impact

Construction of the proposed Anderson Bay facility would cause temporary reduction of local ambient air quality due to fugitive dust and emissions generated by construction equipment. The extent of fugitive dust generation during the construction phase would depend on the level of activity and on the moisture content and texture of the soils that would be disturbed. If appropriate dust suppression techniques are not employed, dry and windy weather conditions could create a nuisance for nearby residents. Blasting could also generate large amounts of fugitive dust, but would occur only once or twice a day.

The emissions from construction vehicles and equipment should have an insignificant impact on the air quality of the region. However, under certain meteorological conditions, high concentrations of pollutants might remain in the immediate vicinity of the proposed construction activities for short periods of time. Proper maintenance of construction vehicles and equipment as well as tugboats and ferries used to transport construction materials, would minimize impacts on local air quality.

During operation of the Anderson Bay facility, emissions of pollutants would be generated from power generation, the liquefaction process, the onsite incinerator, and from tugboat and LNG tanker traffic. Emissions from these sources would be predominantly NO_x and CO since most equipment would use natural gas fuel. However, there would also be SO_2 and PM_{10} emissions from the bunker-fueled boilers on the LNG tankers, the diesel-fired tugboat engines, and some of the power generation equipment with oil as a backup fuel. VOC would also be generated from all of these activities.

New Source Review

Whenever a new source of air emissions is proposed, the process for determining if the source would operate in compliance with Federal and state regulations is called the New Source Review (NSR). For any source, compliance with the NAAQS and the Alaska standards, as listed in table 3.7.2-1, is based on the sum of impacts from the existing sources, the proposed source, and the ambient background level.

Under the Clean Air Act, permitting procedures, including NSR, are different for sources in attainment areas (areas designated as complying with the NAAQS) versus non-attainment areas (areas with concentrations exceeding the NAAQS). Attainment designations are pollutant specific. For example, an area may be designated nonattainment for ozone (O_3), and attainment for NO_X and the other criteria pollutants. Valdez and the Anderson Bay area, in the South Central Alaska Intrastate AQCR, are designated attainment for all criteria pollutants.

The Federal NSPS (40 CFR Part 60, Subpart GG(C)) limit NO_x emissions in the exhaust gases from stationary gas turbines with a heat input greater than 10 million British thermal units (Btus) per hour (approximately 1,000 hp) to 150 ppmv based on 15 percent oxygen in the exhaust on a dry basis, and at a turbine heat-rate of 14.4 kiloJoule/Watt-hour (kJ/W-hr). Proportional increases in the 150 ppmv are permitted with higher efficiencies. Emissions from gas-fired engines are regulated through the state permitting process.

The Federal PSD regulations (40 CFR 52.21) require that any proposed facility with the potential to emit more than 250 tons per year (tpy) of any pollutant, be classified as a major stationary source and be subject to PSD review. PSD regulations for major stationary sources and major modifications include a review of the existing air quality, the use of a modeling analysis to demonstrate compliance with the NAAQS, an analysis of the incremental increase in air pollution levels, application of BACT, and an assessment of the impact of new emissions on the environment. Ambient concentrations from any new pollutant source emitting after the baseline date must not exceed increments that have been set for specific pollutants (see table 3.7.2-1). Compliance with these requirements is verified through the state permitting process.

A top-down approach to BACT is now required where an applicant must demonstrate the use of the best available technology in controlling emissions from major stationary sources and major modifications. This approach requires that the applicant first consider the most stringent controls available and either use this technology or demonstrate why it is not feasible to do so, considering economic, energy, or environmental impacts. The process is then repeated for the second most stringent control, then the third, etc., until a feasible solution is reached.

Dispersion modeling analysis is required for PSD review and some state permits to demonstrate that the new emissions would not result in impacts with a significant increase over existing ambient air quality and that the impacts of these would comply with the NAAQS and PSD Increments. The ADEC must approve the procedures and the input for the dispersion models to be used (primarily ISCST2 and COMPLEX 1). In granting an air emission permit and an open burning permit, the ADEC would decide any restrictions on operations required to ensure that the Yukon Pacific LNG facility does not have an adverse impact on local air quality. Regulations regarding both permits are given in the Alaska Administrative Code, Title 18, Chapter 50.120.

Emission Sources

Sources of emissions from the proposed LNG terminal excluding the waste incinerator are listed in table 4.7-1. These emissions are based upon vendor quotes and EPA air pollution emission factors for the equipment provided in Yukon Pacific's July 1991 data response. Some of the proposed equipment has changed since the TAGS FEIS (1988) will continue to change as the design of the facility evolves. Emissions used in any permit modeling would be determined after the actual equipment has been selected. However, the emissions in table 4.7-1 give a reasonable approximation for the various emission sources, and the relative size of one to another.

TABLE 4.7-1

Annual Air Emissions for LNG Plant and Marine Terminal

Source	Pollutant Emissions (tpy)				
	NO_x	CO	VOC	PM_{10}	SO_2
LNG Train A a/	572.5	170.8	51.6	57.0	4.2
LNG Train B	572.5	170.8	51.6	57.0	4.2
LNG Train C	572.5	170.8	51.6	57.0	4.1
LNG Train D	572.5	170.8	51.7	57.1	4.1
Power Generation b/	192.6	60.2	26.6	17.7	1.4
Package Boiler c/	6.1	4.9	5.5	0.3	0.0
Boil-off Compressors d/	30.3	9.0	2.7	3.0	2.1
Flares e/	4.6	22.2	3.9	5.4	0.4
Tankers f/	4.2	0.2	0.6	1.4	68.0
Leakage			128.3		
Total	2,527.8	779.7	374.1	255.9	88.5

a/ Each LNG train consists of three 39,500-hp mixed refrigerant gas turbine-driven compressors, one 39,500-hp propane gas turbine-driven compressor, and one 6,700-hp flash gas gas turbine-driven compressor.

b/ Power generated by seven 12,600-hp gas turbines operating at 57 percent load.

c/ A backup for Power Turbine #1 and its heat recovery steam generator.

d/ Three 6,700-hp gas turbine-driven compressors.

e/ Includes one flare for LNG Trains A and B, one flare for LNG Trains C and D, and one marine flare to handle upsets during ship loading.

f/ Based on tankers making 275 trips/year, but included emissions while docked at plant, not cruising and maneuvering emissions.

Emissions from the waste incinerator were not included in this emissions inventory due to lack of information on the operating characteristics. Yukon Pacific has assured that the control efficiency of the incinerator scrubber will comply with the Alaska Air Quality Control Regulations. The incinerator will be designed to handle less than a 1,000 lb/hr feed rate during both construction and operation phases. This feed includes approximately 250 maximum lb/hr of biological sludge and undetermined amounts of oils, greases, construction debris, and heavy hydrocarbon wastestreams. The State of Alaska regulations do not impose the stringent incinerator regulations on sources less than 1,000 lb/day. Incinerators below 1,000 lb/day capacity are regulated as general fuel combustion devices and would be listed on the facility permit.

In this emission estimate, each LNG liquefaction train was assumed to have four gas-fired 39,500-hp GE Frame 5 gas turbine-driven compressors powering the liquefaction process. While the GE Frame 5 turbine-driven compressor is considered suitable for the base case, excluding NO_x abatement, the final selection of the refrigerant compressor driver will need to consider NO_x abatement. Additionally, there would be a 6,700-hp gas-fired turbine-driven compressor for flash gas removed during the liquefaction process. Four LNG liquefaction trains are planned. There is one fractionation process which would be located in the main utility building and would operate from gas lines feeding from all four liquefaction trains. Three 6,700-hp gas turbine-drive compressors are planned to gather boil-off vapors and displaced vapors from ship loading with vapors from the four LNG storage tanks ventilation into the fuel gas header for combustion in the turbines.

Seven 8,840-kW generators driven by 12,600-hp gas turbines are planned for this facility, located in the main utility building. One of these generators would produce the required steam for the facility. Two of these units would be capable of firing diesel oil as a backup fuel. Electricity generated at this plant would be needed for lighting and to operate a large number of pumps. These pumps include those necessary to transfer LNG in and out of the LNG storage tanks (four 7,500-gpm pumps and one 500-gpm pump for circulation for each of the four 800,000-barrel LNG storage tanks and those pumps which are part of the wastewater treatment facility. Electricity would also need to be supplied to the motors which operate the hydraulic dock equipment.

Two flares are currently planned for relieving the liquefaction trains, and a marine flare to handle upsets from ship loading or from LNG storage. The flares would only operate under upset or transient conditions, such as startup. The pilot would operate continuously, as long as the LNG liquefaction trains are operational, and would mostly emit NO_x.

The emission estimates are based on 275 LNG tanker trips per year. This estimate is for emissions while two tankers are docked and burning bunker fuel. Estimates of emissions generated when the tankers are cruising and maneuvering with accompanying tugboats are not included.

Air quality dispersion modeling was conducted to estimate the effects of emissions from the LNG facility. Dispersion models provide a mathematical representation of the physical processes that govern the atmospheric behavior of emitted pollutants that would occur due to releases from specific sources. The dispersion analysis done for this project uses the COMPLEX 1 model with the emission estimates in table 4.7-1. Hourly meteorological data collected from a 10-meter tower at the Anderson Bay site from September 1, 1989 through August 31, 1990 were used to characterize wind speed and direction for the model simulations.

These meteorological data showed an extremely high frequency of calm conditions which may not be representative of true wind conditions. If not, the model would calculate higher pollutant concentrations than would actually occur.

Maximum pollutant concentrations predicted in these analyses are summarized and compared with applicable standards and increments in table 4.7-2. The modeled results show that all predicted ambient concentrations are well below both NAAQS and PSD increments; however, other source emissions plus ambient background concentrations would need to be included before the results could be compared with the NAAQS and Alaska standards. Refined air quality modeling, considering both NO_x emissions from the proposed project and other sources in Port Valdez, will be performed as part of NSR to ensure that the proposed project does not exceed the available PSD increment.

TABLE 4.7-2

Dispersion Modeling Results Compared with Applicable National Ambient Air Quality Standards and PSD Increments

Pollutant	Averaging Period	Existing Ambient ($\mu g/m^3$)	Predicted Maximum Concentration ($\mu g/m^3$)	Applicable NAAQS ($\mu g/m^3$)	Applicable Class II PSD Increment ($\mu g/m^3$)
SO_2	Annual	15.7	0.3	80	20
	24-hour	44.5	2.8	365	91
	3-hour	133.5	7.4	1,300	512
NO_2	Annual	9.4	17.9	100	25
PM_{10}	Annual	10.1	2.1	50	19
	24-hour	63.6	14.8	150	37
CO	8-hour	1031.0	113.3	10,000	N/A
	1-hour	3,550.0	173.4	40,000	N/A

At this stage of the project development, the plant design is preliminary and equipment parameters are based on typical components currently in use. When Yukon Pacific selects actual equipment and goes through the Alaska air emission permit process, it will need to conduct accurate dispersion modeling based on actual emissions and meteorology. Under the Clean Air Act, it is the ADEC, supervised by EPA Region X, that would decide and ensure compliance with any operating restrictions necessary to keep air impacts from Yukon Pacific's LNG facility from adversely affecting the local population and environment. The permitting process with the ADEC will ensure that the proposed project complies with all aspects of the PSD regulations, including BACT for each source of emissions.

Since equipment design and selection necessary to complete an emission permit application have not been made, **we recommend that Yukon Pacific file a copy of all air emission permit and open burning permit applications submitted to the ADEC with the Secretary. Additionally, when the ADEC grants any air emission permit or open burning permit to Yukon Pacific, a copy should be filed with the Secretary.**

4.8 NOISE

Construction of the proposed facilities would increase noise levels in the vicinity of the project area. Construction equipment would be operated on an as-needed basis during the 9-year construction period. Diesel generators would be used to supply power for the temporary construction facilities at various locations throughout the jobsite. Operation of construction equipment, the diesel generators, and transporting materials to the jobsite would increase noise levels in the Anderson Bay area by large amounts; however, the remote location would minimize any impact on the general population's activities. Typical noise levels (in dBA at 50 feet) of the 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; trucks, 68 to 96 dBA; and the pile driver used in offshore construction, 92 dBA. Of all the construction activities, rock blasting would produce the greatest noise impact, although the duration of the noise impact would be the shortest, occurring at most twice per day, once at the noon hour and, if necessary plus weather permitting, another later in the evening. At the nearest noise-sensitive area (NSA), a distance of 3.7 miles from the proposed main utility building, a sound level of 95 dBA would be attenuated by the air to a sound level of 43 dBA, which would not be disturbing.

Increases in noise during the operational phase of the project would include noise generated by power generation, the liquefaction and fractionation of natural gas, compressed air and nitrogen plants, LNG transfer facilities to pump the LNG into storage tanks and out of storage tanks and to the LNG tankers, wastewater treatment facilities, an onsite waste incinerator, and LNG tanker and associated tugboat movements. Principal noise sources in these operations would include gas turbine-driven compressors, gas turbine generators, pumps, gas driers, heat exchangers, flares, incinerator, motors to drive hydraulic machinery, and engines powering the LNG tankers, tugs, and ferries. Noise from the relief valves, blowdown stacks, and emergency electrical generation equipment would be infrequent. The amount of silencing required for the equipment and piping depends on the facility's location, size, and proximity to NSAs.

Regulatory Requirements

In 1974, the EPA published "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety." This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for state and local governments to use in developing their own ambient noise standards. The EPA has determined that in order to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an Ldn of 55 dBA. The Ldn is defined as the 24-hour equivalent sound level [Leq(24)] with a 10 dBA weighting applied to nighttime sound levels (10:00 p.m. to 7:00 a.m.) to prevent sleep interference. Further, an Leq(24) of 55 dBA has been identified as protecting outdoor activity interference where people spend <u>limited</u> amounts of time such as playgrounds and schoolyards. These criteria have been used by the FERC to evaluate the noise impact from pipeline operation and compressor station operation. Additionally, the EPA requested that the DEIS evaluate the number of residences/businesses where noise levels would increase by more than 10 dBA over existing noise levels.

Noise-Sensitive Areas

The Anderson Bay site is remote, with the closest permanent buildings being part of the Alyeska Marine Terminal. The closest area which could be considered a NSA is the Shoup Bay State Marine Park, a tidewater glacier that is a primary attraction for tour boats. As such, it is an outdoor area where people spend limited amounts of time. The mouth of Shoup Bay is approximately 3.7 miles northwest of the main utility building.

Another NSA is the parking area north of Dayville Road just outside the eastern gate of the Alyeska Marine Terminal, near the Valdez Fisheries Development Association Hatchery and the Fort Liscum site. This parking area is used as a public camping area, primarily by recreational vehicles and truck campers during the salmon fishing season, and is owned by the City of Valdez. Due to this area's proximity to the Alyeska Marine Terminal, the Valdez Fisheries Development Association Hatchery, and the Solomon Gulch Hydroelectric Project, it is currently a noisy area, which does not prohibit its use by those who choose to camp there. This area is approximately 5.9 miles east of the main utility building.

The nearest residences or businesses in Valdez to the Anderson Bay site are across Port Valdez, west of the Valdez marina. This NSA is approximately 6.1 miles northeast of the main utility building.

Construction and operation of the Anderson Bay LNG facility would generate noise which would impact local marine and terrestrial wildlife. However, given the site's proximity to the Alyeska Marine Terminal and the noise generated by its operation, local marine and terrestrial wildlife are already exposed to industrial noise levels, which should not greatly increase.

Predicted Noise Impact

The Yukon Pacific LNG Project as proposed is a large, industrial facility with equipment capable of generating noise. Fortunately, much of this equipment would be housed in buildings or enclosures, which provide noise reduction. Exact specifications on each building or enclosure involved have not yet been selected, and the amount of noise reduction would vary greatly depending on what types of insulation, building windows, building doors, and building ventilation are used. The major sources of noise are associated with the gas liquefaction process, power generation, LNG transfer facilities, the onsite waste incinerator, wastewater treatment facilities, and the LNG tanker plus associated tugboat traffic.

Power generation for the facility would be created by seven 9,400-kW gas turbine generators which would be housed in the 700 feet by 400 feet main utility building. The main utility building would also contain the compressed air and nitrogen plants. Specific equipment for the generators and compressors has not yet been selected.

The gas liquefaction process would be accomplished in four parallel LNG process trains. Each train would contain pretreatment and gas liquefaction equipment. Additionally, one refrigerant fractionation system would operate feeding gas from any of the four LNG process trains. In the main cryogenic heat exchanger, the refrigerant would be driven by three 37,000-hp gas turbine-driven centrifugal compressors, such as GE Frame 5 gas turbines. Additionally, there would be a 37,000-hp propane compressor and a 6,700-hp flash gas compressor in each LNG process train. Most of the specific equipment has not yet been selected nor has information regarding buildings housing this equipment. The LNG process trains would be located north and northeast of the main utility building.

The gas fractionation system for the plant would be located adjacent to the east wall of the main utility building. Equipment involved in this process include: a feed gas expander suction drum, a fractionation feed gas expander, a scrub column, a deethanizer column, a depropanizer column, and the refrigerated storage tanks. Specific equipment has not yet been selected.

Four 800,000-barrel storage tanks are planned, located north and west of the main utility building. Each storage tank would contain four 7,500-gpm submerged centrifugal LNG loading pumps and a 500-gpm circulating pump—all located in the tanks. Specific equipment has not yet been selected.

An onsite incinerator would be used to handle solid and liquid waste generated by construction and operation of the facility. The incinerator would operate with a feed rate below 1,000 lb/hr and would be enclosed. Wastewater treatment would be located in the main utility building and would treat oily wastewater from washdown and marine facilities and sanitary wastewater from personnel facilities. The treatment would involve an oil/water separator and a biological secondary treatment, with a mixed aeration tank followed by a settling tank. Primary noise sources from the pumps would be enclosed in the main utility building.

LNG tanker and tugboats would generate noise during the transit through Port Valdez and while loading cargo. No estimates of the amount of noise generated by these ships and boats is provided. However, because no other ships or boats would be moving at the time the LNG tanker and its associated tugboats are moving in Port Valdez, the noise generated would probably not exceed the noise generated currently by other marine traffic.

Noise control for plant equipment would be determined by each manufacturer at the time of equipment selection to meet the requirements of Yukon Pacific's Specification A-09, Specification for Noise Control. Specific sources of noise and noise control measures designed to reduce that noise are listed in table 4.8-1. Specification A-09 limits the maximum sound levels at 1 meter from the major abounding surface for furnaces, air fin coolers, gas valves, compressors, and piping systems to 89 dBA; for electric motors, to 90 dBA; and for liquid valves, pumps, and turbines to 92 dBA.

Since the project is in the preliminary design phase, Yukon Pacific has not selected the actual equipment it would use for its Anderson Bay LNG Terminal. As a result, actual manufacturer's noise-level data is not available. Instead, Yukon Pacific's July 1992 "Noise Level Prediction at Plant Boundary Limit," is based on the assumption that exhaust stack noise levels would not exceed 85 dBA at 10 feet and no other plant equipment would exceed a noise level of 85 dBA at 3 feet. We note that these assumptions do not agree with Noise Control Specification A-09. Yukon Pacific's noise analysis predicted an Leq(24) of 46 dBA at the site's eastern property line, approximately 0.9 mile from the assumed acoustic center. Predicted noise levels at the other NSAs are listed in table 4.8-2. Noise levels at both the plant property line and the mouth of Shoup Bay are below an Leq(24) of 55 dBA, and the camp and nearest residence in Valdez are below an Ldn of 55 dBA. Further, the predicted noise levels as all NSAs are unlikely to significantly exceed current background levels.

TABLE 4.8-1

Desirable Design Features for Noise Reduction

Equipment	Source of Noise	Design Features
Heaters	Combustion at burners	Acoustical air intake plenum
	Inspiriting of air at burners	Inspiriting air intake silencer Acoustical air intake plenum
	Draft fans	Air intake silencer or acoustical plenum
	Ducts	Lagging
Motors	TEFC cooling air fan	Acoustical fan shroud, unidirectional fan and/or intake silencer
	WP 11 cooling air openings	Absorbent-liner ducts
	Mechanical and electrical	Enclosure
Air Fin Coolers	Fan	Lower rpm (increased pitch) Tip and hub seals Increased number of blades Decreased static pressure drop More fin tubes
	Speed changer	Belts in place of gears
	Fan shroud	Streamlined air flow Stiffening and damping
Centrifugal Compressors	Discharge piping and expansion joints	Inline silencer and/or lagging
	Anti-surge bypass system	Quiet valves, reduced velocity and streamlining Lagged valves and piping inline silencers
	Intake piping suction drum Air intake/air discharge	Lagging Silencer
Screw Compressors (Axial)	Intake and discharge piping	Silencers and lagging
	Compressor and gear casings	Enclosure, constrained damping or lagging
Speed Changers	Gear meshing	Enclosures, constrained damping on case or lagging
Engines	Exhaust	Silencer
	Air intake	Silencer
	Cooling fan	Enclosed intake and/or discharge quieter fan
Condensing turbine	Expansion joint on stream discharge line	Lagging
Atmospheric Exhausts and Intakes	Discharge jet	Discharge silencer
	Upstream valves	Quiet valve or silencer
Piping	Eductors	Lagging
	Excess velocities	Limited velocities Smooth gradual changes in size and direction Lagging
	Valves	Limited velocities Constant velocity or other quiet valve Divided pressure drop
Pumps	Cavitation of fluid	Enclosure
Flares	Steam jets	Multiport nozzles on air injectors

TABLE 4.8-2

Noise-Sensitive Areas Potentially Affected by Project Operation

NSA	Distance and Direction from Proposed Main Utility Building (miles)	Predicted Leq(24) (dBA)	Predicted Ldn (dBA)
Southeast property line	0.9 E	46	-
Mouth of Shoup Bay	3.7 NW	34	-
Camping area north of Dayville Road	5.9 E	-	36
Valdez - residence	6.1 NE	-	36

Since Yukon Pacific's noise analysis is based on assumed equipment noise levels rather than actual manufacturer's data, and on noise levels which do not reflects its own Specifications for Noise Control, **we recommend that Yukon Pacific file with the Secretary a revised acoustical analysis of the Anderson Bay LNG site reflecting far-field sound data of equipment finally selected (from either the manufacturer or a similar unit in service elsewhere), manufacturer's specifications and attenuation data for the intake and exhaust silencers finally selected, and the actual noise control equipment, for review and written approval by the Director of OPPR before commencing construction of the compressor facilities.**

Due to the considerable amount of proposed horsepower and its ability to produce a substantial impact on the existing noise quality at the Anderson Bay LNG Terminal, **we recommend that Yukon Pacific file with the Secretary a noise survey of the Anderson Bay LNG Terminal no later than 60 days after placing the terminal in service. If the noise attributable to the operation of the facility exceeds Yukon Pacific's predicted property line noise level, additional noise controls shall be added to meet that level within 1 year.**

4.9 LAND USE AND RECREATION

4.9.1 Land Use

Development of the LNG facility at the Anderson Bay site would have direct and indirect effects on land use in the project area. The primary effect would be the conversion of approximately 377 acres of forest and shrub and 49 acres of wetlands (within the 426-acre construction limits) to an industrial use. Indirect effects would be use restrictions on a larger area resulting from Yukon Pacific's proposed buffer zone and an overlapping dispersion exclusion zone required by DOT regulations (see section 4.15.3).

Yukon Pacific's proposed buffer zone would involve transfer of 2,500 acres of land owned by the State of Alaska and accessible to the public, to Yukon Pacific for a use that would restrict public access. No Chugach National Forest lands would be used for construction. The 2,500-acre buffer zone would limit the public from accessing the project area from land (see figure 2.1-1 and 3.9.1-1). Because of the remoteness of the area, the buffer zone would not be fenced, but would be posted around its perimeter. Although access to the Chugach

National Forest lands surrounding the project site would still be possible, access via the 3.5 miles of coastline in the buffer zone would be restricted. Due to the site's remote location and rugged terrain, the number of people who presently use the uplands above the project area for recreational or subsistence uses is very low. The impact of restricting access to the upland areas adjacent to the site is therefore not expected to be great.

The dispersion exclusion zone would extend northward more than 13,000 feet offshore from the tanker loading docks into Port Valdez (see section 4.15.3). Outdoor areas occupied by 20 or more people during normal use, such as beaches, playgrounds, or other outdoor recreation areas would be prohibited in this zone. This could restrict non-project related uses, such as boating and fishing and use of Anderson Bay as an anchorage and could result in disruption to present uses. Before or as part of any final state right-of-way lease, Yukon Pacific must demonstrate to the ADNR there would be sufficient moorage available in Anderson Bay to accommodate small boat operators or help provide moorage facilities in some other nearby location that is a substitute for Anderson Bay locations. In order to demonstrate compliance with the dispersion exclusion zone requirements, Yukon Pacific will need to develop an outdoor activity usage plan to ensure that normal usage in these outdoor areas does not exceed 20 people. **We recommend that Yukon Pacific prepare and file with the Secretary for review and approval by the Director of OPPR an outdoor usage plan to ensure normal outdoor activity usage does not exceed 20 people within the dispersion exclusion zone but still provides for anchorage and recreational uses.**

The project would not conflict with any local comprehensive plans. Two of the plans specifically mention the project and identify its location. The Prince William Sound Area Plan states that the proposed Anderson Bay site is reserved for the TAGS LNG terminal, unless another terminal site is developed. The Valdez Comprehensive Development Plan also supports the project, numbering among its economic goals, the encouragement of a gas pipeline terminus facility in Port Valdez.

4.9.2 Recreation

The proposed project would not have significant short- or long-term negative effects on recreation in the Port Valdez area. Although the reported number of recreationists using the project area (particularly the uplands) is minimal, virtually all recreational activity that currently occurs within, or near the project site, would be impacted to varying degrees.

The noise, dust, and activity generated by construction of the project would discourage marine and land-based recreation in and near Anderson Bay for the duration of construction activity, particularly during the summer seasons. As a result, the numbers of recreationists who would normally be expected to use the site (primarily to fish) would be substantially reduced. Part of the 390 land acres that would be converted to industrial use would be approximately 30 acres surrounding Seven Mile Creek which has been proposed to serve as the site for worker housing. The Seven Mile Creek area, particularly the waterfall and beach area, is popular for activities such as picnics, weddings, and fishing.

During operation, use of the project area beaches, adjacent waters, and uplands by recreationists and others would be limited due to the extensive alteration of the shoreline and overlapping restricted use areas. Yukon Pacific's site buffer and dispersion exclusion zone would limit recreational use in upland areas. Use of the waters adjacent to the project site between Anderson Bay and Seven Mile Creek would be restricted. Marine activities, such as anchoring in the protected waters of Anderson Bay and fishing, while not eliminated, would be restricted to less than 20 people.

Most of the approximately 4,000 construction personnel working on the project at its peak would be housed at a construction camp that would be built on the project site (see sections 2.3.1 and 4.16). Recreational facilities and activities would be available to construction workers at the construction camp. Despite onsite activities and facilities, some workers would no doubt recreate by fishing (and possibly hunting) in the project and Port Valdez areas.

Temporary increased demand on recreational facilities in the City of Valdez from construction personnel would occur, but would not be great. Impacts on outdoor facilities such as skiing and hiking trails would be minimal (Robb, 1993). The greatest potential impact on city facilities would be to indoor facilities such as the three school gyms and one pool operated by the City of Valdez Parks and Recreation Department for public recreation. Since most workers would be housed at the project site, and the number of workers would be reduced during the winter by 70 percent when indoor recreational activity would be greatest, the impact from workers on indoor city facilities would not be significant.

4.10 VISUAL RESOURCES

The degree of visual impact has been evaluated considering the visually prominent features of the proposed facility, site visibility from sensitive viewing points, and number of potential viewers. In this case, the low number of possible viewing points and limited site visibility due to distance reduce the visual impact to less than significant in spite of severe landscape alteration. Figure 2.1-2 is an artist's rendering of the proposed plant from Port Valdez.

One of the most prominent visual features of the project involves site development down to the water's edge. The proposed project would permanently change the visual character of a 2-mile stretch of southern Port Valdez shoreline. The pristine rocky coastline of the project site would be replaced with a large, industrial facility, resulting in contrasting form, color, and texture with the adjacent natural, heavily forested landscape. Site development activities would change the existing topography of the site by creating a series of benches ranging from an elevation of 31 feet MLLW for the construction wharf, to an elevation of 175 feet MLLW for the LNG process trains. In establishing the series of benches, Yukon Pacific proposes to grade down to the water's edge for the majority of the 2 miles of shoreline within the construction site. In these locations the existing vegetation, road outcrops, and irregular shoreline would be replaced with a uniform riprap or waterside facilities such as the cargo docking area and tanker berths. While this plan probably represents an engineering and cost solution, it has a drastic visual effect on the quality of the existing landscape.

The other most prominent visual features are the four LNG storage tanks and the four liquefaction trains. The storage tanks would be located on a cut bench at an elevation of 75 feet MLLW immediately east of Anderson Bay. The outer tank walls would measure from 91 to 111 feet high, depending upon the type of tank selected, and would thus be at elevation 166 to 186 feet MLLW. The domed roof would be somewhat higher, but less visible than the walls. The four LNG process trains would be located on a cut bench at elevation 175 feet MLLW near the east end of the site. Each would occupy an area 600 feet by 550 feet.

LNG tankers would also be visually prominent when traversing Port Valdez, and while at the marine berths—about 18 hours turnaround. The typical tanker would be approximately 950 feet long, more than 140 feet wide. However, they would be a minor addition to the current tanker traffic in Port Valdez.

Viewers throughout Port Valdez would be able to see the major project facilities and some operational activities to varying degrees depending upon viewer distance and atmospheric conditions. The following describes the visual impact of the proposed project from representative viewing points (VPs) in Port Valdez which were considered visually sensitive points or where concentrations of viewers occur. The locations of VPs are shown on figure 3.9.3-1.

Valdez City Harbor (VP1)

The Valdez City Harbor would be a focal point for residents, tourists, and commercial marine operators. Because the project is 5.5 miles away from VP1, certain atmospheric and light conditions would be necessary for the project to be readily visible. While project features could be detected, distance would significantly mitigate the visual effect of storage tanks, ships, and nighttime lights. The project site constitutes a very small component of the viewed landscape. The site is further diminished in visual prominence by the magnitude of the surrounding mountains and expanse of water between the site and city harbor. The presence of the existing Alyeska Marine Terminal also acts to decrease the visual impact. We estimate the project would result in a low visual impact from this viewing point.

Shoup Bay (VP2)

The potential viewers at Shoup Bay would be recreationists on boats visiting the Shoup Bay State Marine Park. The primary attraction to park visitors is the large and impressive tidewater glacier at the north end of the bay. The mouth to Shoup Bay is located across Port Valdez about 3 miles from the plant site. The possibility of viewing the plant would diminish after passing inside the bay's entrance. Because the LNG plant would only temporarily be visible to those traveling to or from Shoup Bay and, at such a great distance would not be noticeable from the marine park, the project is expected to have a low visual impact on this viewing point.

Alaska Marine Route (VP3)

Existing and potential viewers from VP3 would include: ferry, cruise ship, and sightseeing passengers; recreational boaters; and commercial and recreational fishermen. Viewers on vessels passing the site would view the facility from a number of angles, and would have direct views for as long as it would take the vessel to pass the site. One mitigating factor is the visual presence of the Alyeska Marine Terminal which tends to become a larger detraction to the natural landscape at locations closer to the LNG plant. A moderate degree of visual impact could occur from some viewing points along this route.

In summary, the anticipated visual impact from the points evaluated is representative of the range of impacts we would expect to find. The few number of visually sensitive areas, relatively few numbers of viewers, and distance at which the proposed facility would be seen most of the time to a large extent offsets the visual effect of the proposed project on the generally distinctive landscape quality of the area surrounding the site. To reduce visual impact, **we recommend that Yukon Pacific file with the Secretary for review and approval by the Director of OPPR prior to construction a visual mitigation plan that includes:**

- **shoreline protection measures that provide a more natural appearance by preserving existing landform and mature vegetation at prominent features along the shoreline, developed in conjunction with the recommended 50-foot-wide vegetation buffer strips; and**

- **landscape and architectural treatments that reduce the contrast of the aboveground structures with the natural landscape.**

4.11 SOCIOECONOMICS

Socioeconomic impacts associated with the Yukon Pacific LNG Project would be related to the jobs it would bring to Valdez, the economic and population growth it would stimulate, and the increased demands on public and private services and facilities it would create.

4.11.1 Employment

Construction of the LNG plant would create construction jobs and supervisory and operational jobs on the site. These newly created jobs would impact employment levels for the City of Valdez. Direct employment would consist of those workers hired for construction and operation of the plant. An influx of persons employed at the site would increase the demand for goods and services in Valdez. Businesses in the City of Valdez would have to hire additional staff to meet demand. These jobs would constitute indirect employment resulting from construction of the LNG plant.

According to Yukon Pacific, LNG Project construction phase employment at Valdez would build up gradually during the first two project years. Project employment would reach an average of 1,300 persons in Year 3 and would reach an average of 2,000 persons and a peak of 4,000 persons in Year 5 (see table 4.11.1-1). Total construction would be completed by Year 9.

Yukon Pacific proposes to house most construction employees in camp facilities located along the banks of Seven Mile Creek. These facilities would have a 4,000-person capacity with kitchens, dining facilities, and recreation complexes. According to Yukon Pacific, operations employment would begin in Year 5 with 200 persons. It would continue at this level for the duration of the plant operation.

Indirect employment would begin in Year 1 with 125 persons. Indirect employment would continue to increase until Year 5, and then would decrease as the number of construction workers on the site decreased. In Year 9 and throughout the life of the plant, indirect employment would be approximately 100 persons.

Total average employment would peak at 2,460 in Year 5, including an average 1,800 workers directly involved in project construction, 200 persons involved in operation of the plant, and an average 460 additional people employed in other economic sectors. During the summer months of Year 5, construction employment could reach a peak of 4,000 persons.

TABLE 4.11.1-1

Yukon Pacific LNG Project Annual Average Employment and Population by Project Year for the City of Valdez

Project Year	Direct Employment: Construction Workers a/	Direct Employment: Operations Workers a/	Indirect Employment: Construction Related b/	Indirect Employment: Operations Related c/	Total Employment	Additional Family Members d/	Total Population e/
Year 1	625	0	125	0	750	31	781
Year 2	875	0	175	0	1,050	43	1,093
Year 3	1,300	0	260	0	1,560	65	1,625
Year 4	1,750	0	375	0	2,125	93	2,218
Year 5	1,800	200	360	100	2,460	390	2,850
Year 6	1,100	200	220	100	1,620	355	1,975
Year 7	400	200	80	100	780	320	1,100
Year 8	575	200	15	100	890	304	1,194
Year 9	0	200	0	100	300	300	600

a/ Includes construction and operations personnel employed by Yukon Pacific.

b/ Construction-related indirect employment = 0.2 direct construction employment.

c/ Operations-related indirect employment = 0.5 direct operations employment.

d/ Construction workers are assumed to maintain family residence elsewhere. Additional family members accompanying permanent operations workers are estimated to be equal to the number of jobs. Additional family members accompanying indirect employees are estimated at equal the number of indirect jobs resulting from project operations and 0.25 times the number of indirect jobs resulting from project construction.

e/ Includes direct and indirect workers plus family members that would move to the area with new direct and indirect workers.

Construction workers would likely work an 8 weeks on, 2 weeks off schedule. This would offer workers the opportunity to leave Valdez for their 2 weeks off. During the 8 weeks on, workers would probably remain in the camp or in Valdez on their days off.

4.11.2 Population

Population projections for the State of Alaska forecast an increase in population of 2.9 percent from 1990 to 1995 and 2.3 percent from 1995 to 2000 (Spatz, 1993). Valdez has probably experienced an increase in population of at least 50 persons (a 1.2 percent increase) since the 1990 census because of new employees (and their families) at the Petro Star Refinery, which began operation in 1993. However, possible future cutbacks at the Alyeska Terminal could limit growth or cause a net loss of population for the city. Given the uncertainty of employment at Alyeska and the relatively slow growth scenario for the state, a no growth forecast is assumed for the City of Valdez through the year 2000 in the absence of the proposed LNG project. The following impact descriptions assume the total workforce would increase the population of Valdez when, in effect, the majority of the workers would be living at the proposed construction camp.

Average population increases associated with construction of the LNG facility would peak at about 2,850 persons in Year 5 (table 4.11.1-1). This would include 1,800 construction workers, 200 operations workers, 460 workers in other sectors, and 390 family members which we estimate would accompany new workers to the area, including new direct and indirect workers. Maximum seasonal population could exceed this level, since potential peak construction employment would equal 4,000 persons. The greatest population increases on an average yearly basis would occur in Year 1 (+781 persons) and Year 4 (+593 persons from the previous year) and would begin to decline in Year 6 (-875 persons from the previous year) until Year 9 when the plant would no longer be in its construction phase.

An addition of 2,850 persons to the Valdez population of 4,068 persons (1990 population) represents a total population of 6,918, a 70 percent increase over the 1990 population by Year 5 of construction. This would be a significant increase in population. Additional workers associated with construction of the TAGS pipeline would be expected to be in the Valdez area during some portion of the plant construction period. These workers tend to be transitory, following along with pipeline construction with a relatively short duration in any one location.

Construction of the Alyeska terminal and pipeline and later Exxon Valdez oil spill cleanup also created a large influx of population in a short time period. During construction of the Alyeska terminal and pipeline, Valdez population peaked at 8,253 persons in 1976 (Darbyshire and Associates, 1991). During the Valdez oil spill cleanup operations in 1989, the July population estimate was 7,300 persons (Dengel, 1993). Some estimates are closer to 10,000 persons at one time. The city successfully handled the large population influxes. Proper planning and cooperation between Yukon Pacific and city officials would avoid some of the difficulties that have been experienced in the past.

During operation, the permanent population would increase by approximately 600 persons, including direct and indirect employment and the families of employees that would move to Valdez. The operational increase of 600 persons would produce a total population of 4,668, a 15 percent increase over the 1990 population. Some additional people moving to Valdez to seek work at the LNG plant would create additional upward pressure on total population. Population increases of this magnitude would stress city operations beyond capacity.

4.11.3 Economy and Income

Construction of the LNG Plant would boost economic activity in the City of Valdez. Some of Yukon Pacific's employment needs could be filled by local residents. Some construction materials and supplies could be purchased from Valdez businesses. The increase in population would increase the amount of goods and services purchased in the city. The city's tax base would rise, increasing property and revenue tax receipts. These revenues could be used to improve city facilities and infrastructure, promoting further growth and economic diversity.

Local businesses in Valdez, primarily construction, retail, and service businesses, would experience increased activity as a result of the LNG facility construction. Yukon Pacific has developed an estimate indicating the maximum amount of materials that could be purchased by Yukon Pacific for construction of the LNG facility (see table 4.11.3-1). The maximum value of locally purchased materials could be $15,000,000.

TABLE 4.11.3-1

Construction Materials that could be Purchased from Local Businesses by Yukon Pacific

Material	Value of Material a/	Value to Local Business a/, b/
Welding gases	$5,000,000	$1,000,000
Fuel, oil, and lube	$35,000,000	$7,000,000
Concrete and special aggregates	$5,000,000	$1,000,000
Hauling	$5,000,000	$1,000,000
Other	$25,000,000	$5,000,000
Total	$75,000,000	$15,000,000

a/ In 1990 dollars.

b/ Value assumes that all goods would be purchased from local businesses and that these businesses would realize a 20 percent sales margin.

Assuming construction workers would be paid an average rate of $22.86 per hour for the equivalent of 70 hours per week, working 8 weeks on and 2 weeks off, an annual salary would be greater than $67,000. Yukon Pacific estimates a rate of $6,500 per month for operations employees, with an annual salary totaling $78,000 per year. These estimates far exceed $27,000, the approximate 1990 per capita income level for Valdez. Some dislocation of employment would occur as Valdez employees seek higher wages in construction jobs for the LNG plant. Local employers could be forced to offer higher wages, creating wage inflation. However, the benefits of increased economic activity would offset some of the negative impacts associated with upward pressure on wages. The Yukon Pacific workforce's relatively high paying jobs would benefit the local economy. Construction workers could spend time in town on days off, eating at local restaurants and purchasing goods and supplies. Operational and supervisory staff, living outside the construction camp, would also create a demand on local businesses. Increased activity could attract additional business ventures, boosting local tax revenue.

Average per capita income levels for the City of Valdez would increase as a result of the facility construction, since income levels of temporary construction workers would be included in per capita income estimates for the city. In addition, increased economic activity and potentially higher wages would raise income levels.

4.11.4 Housing

Personnel for initial project mobilization would be housed in the existing camp facilities located near the airport. These facilities would be used during the duration of the project by a small number of personnel ranging from 150 to 250. These facilities have a current capacity of 700 persons. During the first season of construction while the main proposed construction camp (located on the banks of Seven Mile Creek) is being constructed, a floating camp would be established near the creek mouth. The main camp would eventually have a capacity of

4,000 persons. It would be developed in three modules, each with capacity to house approximately 1,300 persons.

Supervisory staff during construction and 200 operational employees would be located in Valdez with their families. Indirect employment would add another 100 persons who could move to Valdez with their families. The exact numbers of newcomers to Valdez would be dependent upon the number of jobs that would be filled by current Valdez residents. Newcomers would generally be interested in rental housing or in buying a home. The current housing stock would not be adequate to meet project-induced demands. As a result, housing prices could rise. Existing lots subdivided for development could be purchased by newcomers, or contractors could begin construction commenced in anticipation of an influx of home buyers. The supply of land currently appears adequate to meet an increase in demand.

In-migrating job seekers would probably stay at local hotels and bed and breakfasts. Demand would likely exceed supply of this temporary housing during the summer months when tourists would compete with job seekers for rooms. In addition, fish processing and construction employment increases during the summer months create even greater demand for temporary housing.

4.11.5 Public Facilities and Services

The number of children enrolled in Valdez schools would increase because Yukon Pacific employees and other indirect employees, and their family members would relocate to Valdez. In the 1990-91 school year, the average number of students enrolled in the Valdez school system was 782 (Clark, 1993). According to the 1990 census, the total number of households in Valdez was 1,277, with an average of 0.61 school age children per household.

In Year 5 of construction, Yukon Pacific employment could peak at 4,000 persons in Valdez. It is unlikely that this level of employment would be sustained for even a 6-month period; therefore, we assumed that indirect employment and the level of public services would not increase commensurate with this temporary employment level. Average employment during Year 5, the peak construction year, would be 2,460 persons, creating a total population increase of 2,850 persons during that year (all population and employment numbers for this section are presented in table 4.11.1-1).

By Year 5, an additional 390 workers would relocate to Valdez with their families. Based on the assumption that there are 0.61 school age children per family, an increase of 390 families implies that there would be 237 school age children. Assuming no other factors influence school enrollment, an increase of 237 students would bring total enrollment to 1,206 persons. This would slightly exceed capacity of the Valdez school system (1,175 persons). An additional 15 teachers would be needed given the current student to teacher ratio of 15 to 1. Additional supplies and books would also be needed.

During project operations, there could be 183 new school age children enrolled in Valdez schools. This number is based on 300 families permanently relocating to Valdez. Total students enrolled in the school system would be 1,152, slightly within capacity limits. But, as noted in section 3.11.4, excess capacity varies with grade level and new additions to the system could pose problems in grades that are currently at full capacity levels. An additional 12 teachers would be needed to maintain the current student to teacher ratio of 15 to 1. Additional supplies and books would also be needed.

The following estimates indicate additional public services that would be required as a result of construction of the plant. The estimates are based on population estimates for two scenarios—during peak average construction employment and employment during operations. These estimates are based on the assumption that current staffing levels are in line with current needs and that additional staff requirements would be proportional to the population increase.

Current hospital staffing equals 1 employee (currently 34 employees) for every 120 residents, 1 doctor (currently 4 doctors) for every 1,017 residents, and 1 bed (currently 15 beds) for every 271 residents. In the State of Alaska, there is 1 doctor for every 760 persons (McHardy, 1993). These numbers indicate that Valdez Hospital could use additional doctors to bring its representation up to the state average.

During construction, additional staffing needed to accommodate a temporary increase in population of 2,850 persons would be approximately 23 employees and 2 doctors. An additional 10 beds would be needed. Permanent additional staffing needed to accommodate an increase in population of 600 persons during operations would be approximately 5 employees and possibly 1 additional doctor. An additional two beds would be needed.

Generally, large influxes of population into a community results in an increase in criminal offenses. In 1989, the year of the Valdez oil spill, total officer responses for the year were 6,734; in 1991, as population returned to more normal levels, responses totaled 4,918 (Valdez Police Department, 1992). Increases in felony crimes, misdemeanors, accidents, and parking and traffic congestion could be anticipated because of project construction. Total arrests in 1989 were 673 versus 338 in 1991. Current police department staffing includes 1 employee for every 170 residents. During construction, additional staffing needed to service a temporary increase in population of 2,850 persons would be 16 employees. During operations, additional staffing needed to accommodate an increase in population of 600 persons would be approximately 3 employees. The 1990 records indicate that there is 1 public service policeman (including patrol officers, detectives, and supervisors) for every 410 persons in the State of Alaska (McHardy, 1993). Therefore, current levels could be adequate.

Fire department staffing currently equals 1 full-time employee (currently 12 full-time employees) for every 339 residents and 1 part-time employee (currently, 25 part-time employees) for every 163 residents. In the State of Alaska, there are 1,250 persons for every full-time fire fighter (McHardy, 1993). There are no numbers available for volunteer fire fighters.

During construction, additional fire department staffing needed to service a temporary increase in population of 2,850 persons would be 8 full-time employees and 17 part-time employees. Permanent additional staffing needed to accommodate an increase in population of 600 persons would be 1 full-time employee and 3 part-time employees.

Since the 1989 Valdez oil spill, Alyeska has consulted with local government and emergency personnel to create an emergency response effort that takes advantage of resources that are available within city services and the private sector. This has increased cooperation between the community and Alyeska. Alyeska has also benefitted from the resources and knowledge available in the City of Valdez.

Current city water supplies are adequate. Some additional wells or improvements on the existing system could be necessary as new subdivisions are developed in the city . Sewage treatment capacity appears to be adequate.

4.11.6 Fiscal Impacts

Demands on city services, including schools, infrastructure maintenance, and public safety would expand with increased population, traffic, and overall activity. Yukon Pacific has estimated potential cost increases associated with the LNG Project by taking current budgeted dollars for the affected services and determining the per capita cost of meeting these needs (see table 4.11.6-1). The per capita cost was then multiplied by an average peak workforce of 2,000 persons, indicating an additional $6,012,000 of city costs. Additional annual property tax revenues estimated at $23,000,000 during the construction period would eventually more than offset the increased costs for the city. Some of the city's costs would be incurred early in the construction phase of the project, before the city received any increased tax revenue.

TABLE 4.11.6-1

Estimated Cost of Services for the City of Valdez Without the Project and With the Project

Service	Without Project 1992 Budget a/	With Project Estimated Total Requirements a/	With Project Additional Costs a/
Schools	$6,800	$10,200	$3,400
Roads	$1,200	$1,800	$600
Port	$207	$311	$104
Public Safety	$2,500	$3,750	$1,250
Utilities	$1,315	$1,973	$658
Total	$12,022	$18,034	$6,012

a/ Amounts in thousands of dollars.

It is likely that the tax status of the LNG facility would compare to the tax status of the Phillips Petroleum Company natural gas plant located on the Kenai Peninsula which is not subject to state tax (Benson, 1993). The plant would be subject to property taxes for the City of Valdez. These taxes would be based on the assessed valuation of the plant. Assessed valuation is based on the replacement value of the plant, including the market rate for the property on which it is located, minus depreciation, plus or minus outside economic factors (Haerer, 1993). Outside economic factors include future estimated supplies of LNG, the future estimated market for LNG, and other variables that could affect the value of the plant. The City of Valdez would tax Yukon Pacific, on a yearly basis, according to the plant's assessed value and the city's tax rate for that year. The tax rate, or mil rate, is based on estimated future costs and revenues for the city for the entire year. The rate is determined by city officials according to estimated needs at the beginning of each year.

The city's revenue base would increase with the construction of the LNG plant through increased tax revenues. As a result, the city's mil rate would come down because these revenues could be used to offset costs. Persons and businesses paying property taxes in the City of Valdez could have a lower tax bill.

Yukon Pacific estimates that the assessed value of the plant, based solely on total estimated construction costs, would be $2.3 billion. Taxable construction would begin in Year 2 when working materials would be brought onto the site. For the following 7 years, taxes paid to the city by Yukon Pacific would be based on a percentage of total construction costs. During operation of the plant, taxes paid would be based on the mil rate for each year and the assessed value. Yukon Pacific estimates that property tax payments would be $46 million per year. This number assumes a mil rate of 20 which we believe is unrealistically high based on a current mil rate of 19.

The experience the City of Valdez has in coping with short-term explosive growth and the adequacy of its infrastructure in most areas would avoid any significant adverse socioeconomic effects. The potential also exists for the project to result in net positive effects through job creation, tax revenues, and careful mitigation planning.

Because the current economic, housing, and other community conditions are expected to change before the project would actually start, any specific mitigation should not be developed at this time. However, the ADNR has required Yukon Pacific, before or as part of any final state right-of-way lease, to develop and commit to mitigation measures that address manpower, socioeconomic, and local planning impacts of the TAGS project.

4.12 TRANSPORTATION

The highways, roads, port, marine highway, and airport in Valdez would be affected by an increase in traffic as a result of the proposed LNG project. Roads would be used to transport goods, supplies, and people for the construction site and for businesses within Valdez. The primary mode of transportation would be by water, including the movement of LNG, construction materials and other supplies, and people. Airport traffic would increase with the delivery of people and supplies.

4.12.1 Highways and Roads

Richardson Highway would experience increased traffic with the transport of supplies for construction, supplies for businesses within the City of Valdez, and workers into the Valdez area. This highway has a design capacity far in excess of current average daily traffic loads. Increases in traffic as a result of this project would not exceed capacity levels of the highway.

Roads linking Richardson Highway to the city dock and small boat harbor would experience increased use. The Valdez Airport Road would experience an increase in traffic leading to the airport as well as to the existing camp facilities located near the airport. In general, Valdez roads in the downtown center would experience increased traffic loads with the increase in population. This could pose a problem during the summer months when tourist traffic is high. However, the city dealt with high traffic loads during the Valdez oil spill cleanup. Roads leading to new homes or subdivisions could need expansion or additional maintenance to handle increased loads.

4.12.2 Marine

During the construction phase, materials and supplies would be transported to the Anderson Bay site by water. Yukon Pacific has no plans to build a road leading to the construction site; therefore, all supplies received by truck or plane would have to be loaded onto a boat and delivered by way of the Port of Valdez. An average of two trips per day by tug, barge, or roll-on, roll-off ramp is expected, although peak activity periods may require six trips per day. In addition, one or two small boats per day would transfer materials and personnel.

Yukon Pacific is considering the use of large prefabricated modules for plant construction. This would result in a single shipment of 10 to 15 ocean-going barges ranging in weight of from 500 to 4,000 tons. In addition, there would be one to two ocean going barges per construction season month for the first several years. Ocean-going barges would unload directly at the Anderson Bay cargo dock.

Cargo docking facilities have been proposed to accommodate all marine transport. A cargo/personnel ferry dock located on the west end of the LNG plant site would support plant operations, including the receipt of diesel oil, consumables, potable water, and other supplies for plant operation and maintenance. The cargo dock would have a fuel station for refueling small craft and floating equipment. The cargo/personnel ferry dock would provide permanent moorings for the service vessels and small craft employed by the plant.

During full capacity, Yukon Pacific estimates that it would use 15 tankers of 125,000 cubic meters capacity, making 275 loaded voyages per year. The tankers would dock at two LNG tanker berths located on the plant site (see figure 2.1-3). The LNG would be transported from Anderson Bay, through Valdez Narrows and Valdez Arm, across Prince William Sound. Operation would be governed by current Coast Guard operations and surveillance systems. For more detailed information on LNG tankers and transport see sections 2.1 and 4.15.4. Currently, port activity is not heavy. However, proper precautions would need to be taken to ensure safety (see 4.15.2). Current plans to expand the small boat harbor could be accelerated thus, increasing the number of slips available for small boats.

4.12.3 Airport

Scheduled airline traffic and both fixed and rotary-winged charter service would increase at the Valdez Airport during the construction phase of the project. This would have a positive effect on the regional air transportation industry. The Valdez Airport has the capacity to accommodate the expected increase in passenger and cargo loads, as demonstrated by the Valdez oil spill cleanup operations. Appropriate safety and preventive measures would need to be followed to handle an increase in average traffic. It is possible that additional hangar space would need to be constructed for plane storage.

4.13 SUBSISTENCE

The potential effects of the proposed project on subsistence uses are primarily 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; and

- new or greater use of subsistence resources in areas made more accessible by new or improved roads or trails.

Potential indirect impacts are adverse effects on communities and individuals from a loss of traditional harvest activities, including loss of traditional supply of foods, increased outlay of cash for substitute foods, 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; and

- availability of other sources of affected resources or acceptable replacement resources.

4.13.1 Impacts on Fish and Wildlife

Construction and operation of the project could affect fish and wildlife resources used for subsistence activities in three ways, all resulting in their reduced availability for subsistence harvest. First, mortality could occur from project construction or accidental events. Fish would be most at risk due to the potential for siltation or fuel spills into a waterbody. Second, fish and wildlife such as moose, deer, and bear, might avoid the project area due to construction activities. 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. Overall, because the Anderson Bay area and much of Port Valdez are not noted for significant subsistence use, the potential impacts on subsistence are likely to be minimal.

Valdez

No subsistence permits have been issued to residents of Valdez since 1987 when it was classified as nonrural. Although the project would not impact subsistence use in Valdez, it would have an impact on subsistence resources.

Large mammals presently occur in low numbers at or near the project area. Increased human disturbance and hunting from the construction workforce could result in reduced local population levels of goat and bear densities. Although this would result in greater competition for subsistence harvesting, such a reduction is minimal and should not significantly affect subsistence harvesting.

Loss of coniferous forest habitat would likely affect pine marten and mink, and the facility could affect the movement of mink foraging along the shoreline. The impact on these furbearers is unknown but is estimated to be minimal; thus, not significantly affecting subsistence users' harvesting (trapping) of pelts for personal use or for sale as a source of cash income.

Sea otters and harbor seals are the only marine mammals that occur in Port Valdez on a more than occasional basis, both being observed in Anderson Bay during ADFG surveys in 1991. The greatest impacts on these species are likely to result from blasting during construction. These impacts can be mitigated by establishing a zone of influence, from which spotters can be used to clear the area prior to blasting. These minimal impacts should not affect subsistence harvests of sea otters (for pelts) and harbor seals (for meat).

Direct facility construction and operational impacts on nesting waterfowl are anticipated to be minimal because of a general lack of nesting habitat in the project area. A greater impact on nesting waterfowl is anticipated from disturbances and hunting from the construction workforce. Overwintering Barrow's goldeneyes and surf scooters are likely to be affected by loss of habitat and blasting during construction and degradation of forage potential.

Overall, minimal impacts on resident freshwater fish resources are likely to occur because of their limited distribution on the site. No resident freshwater fish are present in Terminal, Short, and Strike Creeks so alteration of these channels by the project would not impact any fish resources. Pink and chum salmon are the only anadromous fish using the lower reaches of Seven Mile, Nancy, and Henderson Creeks. Henderson Creek would not be affected because it is on the edge of the project area, and Seven Mile and Nancy Creeks could be affected by increased sedimentation during construction.

Marine water fisheries resources could be affected by loss of 35 acres of habitat, altering nearshore migration, from blast shock waves during construction, increased water temperature, and potential chemical and fuel spills. Pink and chum salmon could be affected by these actions, although the level of impact cannot be determined without additional information, but they are not likely to affect subsistence harvesting because much of the harvesting occurs outside of Anderson Bay and Port Valdez.

It is likely that intertidal and subtidal organisms would be damaged, covered, or killed as a result of blasting, filling, and chemical spills during construction in the project site. Clams and crabs do not occur in significant numbers in Port Valdez and it is unlikely the loss of this habitat will impact them. Thus, these impacts are not likely to be significant on subsistence harvesting.

Tatitlek

A majority of Tatitlek residents' subsistence harvest activities occur outside of Port Valdez and, therefore, would not be affected by the construction-related impacts described for Valdez. However, marine mammal and fishery subsistence use could be affected by increased ship traffic and maritime accidents, should they occur. Increased traffic in the Valdez Arm, Prince William Sound, and its associated bays/inlets would have minimal effects from direct marine resource collisions with vessels. Increased traffic also might have a minimal effect on the local concentrations of marine mammals and their migratory patterns. In the event of an accident, LNG would evaporate relatively quickly and should not significantly affect marine resources.

Increased use and competition for subsistence resources is likely to occur from fishing and hunting activities conducted by project construction and operational workforces. Increased competition has been a concern since construction and operation of the TAPS pipeline and has been a growing concern since the early 1980s (Rural Alaska Community Action Program, 1981). This increased competition might result in the need to limit nonrural (Valdez) and project-related workforce recreational/personal harvesting in Prince William Sound and the Copper River area if subsistence resources become significantly affected.

Overall, reliance on local resources for subsistence does not appear to be high and because effects on these resources would be largely limited to the immediate site area where minimal subsistence harvesting occurs, the impacts are considered to be minor.

4.13.2 Interference/Access Impacts

The Yukon Pacific LNG Project construction and operation have the potential to interfere with some subsistence activities by restricting access to traditional subsistence use areas. Construction activities and placement of facilities, roads, and borrow pits throughout the project area would eliminate or restrict access to a relatively small area traditionally used for subsistence activities. Therefore, the impact would be less than significant.

4.13.3 Increased Sport Hunting, Fishing, and Trapping Competition

The project would introduce large numbers of direct and indirect employees into the area. 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 could threaten maintenance of the populations of fish and wildlife used for subsistence purposes. Although likely to be concentrated around construction camps, these activities could extend into the Copper River area.

Historically, the Joint Boards of Fisheries and Game have acted to protect subsistence harvest of fish and wildlife when such harvest levels have been deemed to be in jeopardy or inadequate to maintain traditional subsistence use of fish and wildlife. Such protection measures have taken the form of special subsistence hunting and fishing openings, or restrictions on sport and commercial harvest.

The duration of competitive impacts would be limited to the period of construction, although the operational workforce could continue to compete with subsistence users on a smaller scale. These impacts would not result in a significant restriction of subsistence uses.

4.13.4 Relocation/Increased Harvest Effort

The only potential indirect impact of the Yukon Pacific LNG Project, resulting from the primary impacts on subsistence 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 compensated effort in other areas unaffected by the project possibly involving extra time, travel, harvest effort, or cash for fuel and supplies.

4.14 CULTURAL RESOURCES

Background research failed to identify any previously recorded sites in the project area and no new cultural resource sites were identified during the field survey. The survey report concluded that "it appears highly unlikely that undiscovered prehistoric sites exist in the project area," and that the "lack of locales in the project area possessing characteristics associated with prehistoric sites elsewhere in the general region suggests few if any sites will be found there." The Alaska SHPO has reviewed the results of a 1990 cultural resources survey of the project area sponsored by Yukon Pacific. On the basis of the survey report the SHPO concluded in a March 13, 1992 letter, and we concur, that the project would have no effect on properties on or eligible for the NRHP.

4.15 ANALYSIS OF PUBLIC SAFETY

The operation of the proposed LNG facility poses a unique hazard that could affect the public safety without strict design and operational measures to control potential accidents. The primary concerns are those events which could lead to an LNG spill of sufficient magnitude to create an offsite hazard.

The first section presents a discussion of the principal properties and hazards associated with LNG (4.15.1). Next follows a summary of our preliminary design and technical review of the cryogenic aspects of the proposed LNG facility and marine terminal (4.15.2). The third section analyzes the thermal radiation and flammable vapor cloud hazards resulting from credible land-based LNG spills (4.15.3). And the final section examines the safety associated with the marine transportation by LNG tankers (4.15.4).

Also of critical safety importance for a facility located in a high seismic area are the seismic design criteria. The reader is referred to Seismicity (3.2 and 4.2) for an analysis of this issue.

4.15.1 LNG Hazards

LNG's principal hazards result from its cryogenic temperature (-260°F), its flammability, and its dispersion characteristics. As a liquid, LNG will neither burn nor explode. Although it can cause freeze burns and, depending on the length of exposure, more serious injury, its extremely cold state does not present a significant hazard to the public, which rarely, if ever, comes in contact with it as a liquid. As a cryogenic liquid, LNG will quickly cool materials it contacts, causing extreme thermal stress in materials not specifically designed for ultracold conditions. Such thermal stresses could subsequently subject the material to brittleness, fracture, or other loss of tensile strength. These hazards, however, are not substantially different from the hazards associated with the storage and transportation of liquid oxygen (-296°F) or several other cryogenic gases which have been routinely produced in the United States.

Methane, the primary component of LNG, is colorless, odorless and tasteless, and is classified as a simple asphyxiant. Methane could, however, cause extreme health hazards, including death, if inhaled in significant quantities within a limited time. At very cold temperatures, methane vapors could cause freeze burns. Asphyxiation, like freezing, normally represents a negligible risk to the public from LNG facilities.

When released from its containment vessel and/or transfer system, LNG will first produce a vapor or gas. This vapor, if ignited, represents the primary hazard to the public. LNG vaporizes rapidly when exposed to ambient heat sources such as water or soil, producing 620 to 630 standard cubic feet of natural gas for each cubic foot of liquid. LNG vapors in a 5- to 15-percent mixture with air are highly flammable. The amount of flammable vapor produced per unit of time depends on factors such as wind conditions, the amount of LNG spilled, and whether it is spilled on water or land. Depending on the amount spilled, LNG may form a liquid pool which will spread unless contained by a dike.

Once a flammable vapor-air mixture from an LNG spill has been ignited, the flame front will propagate back to the spill site if the vapor concentration along this path is sufficiently high to support the combustion process. The rate of flame propagation is called the laminar burning velocity. An unconfined methane-air mixture will burn slowly, tending to ignite combustible materials within the vapor cloud, whereas fast flame speeds tend to produce flash burns rather than self-sustaining ignition.

LNG is explosive if its vapor enters a confined space and is ignited. There is no evidence, however, suggesting that LNG is explosive in unconfined open areas. Experiments to determine if unconfined methane-air mixtures will explode have been conducted and, to date, all have been negative—unconfined methane-air mixtures will burn, but will not explode. Nevertheless, a number of experimental programs are currently being conducted to determine the "amount of initiator charge" required to detonate an unconfined methane-air mixture.

4.15.2 Cryogenic Design and Technical Review

The cryogenic design and technical review places its emphasis on the engineering design and safety concepts, and on the projected operational reliability of the proposed LNG facility and marine terminal. The principal areas of coverage include: a) materials in cryogenic environments, b) insulation systems, c) cryogenic safety, d) thermodynamics, e) heat transfer, f) instrumentation, g) cryogenic processes, and h) other relevant safety systems.

In preparation for this review, the Commission staff sent a cryogenic design data request to Yukon Pacific on February 1, 1990. Yukon Pacific filed partial responses on July 26, 1991, and on March 31, 1992. The Commission staff and its cryogenic consultant conducted a technical conference in Valdez on May 26, 1992, followed by a site inspection. The current phase of the review is presented in "Preliminary LNG Export Facility Preconstruction Cryogenic Design and Technical Review" (see appendix B).

Much of the technical data filed by Yukon Pacific reflects the initial conceptual design phase of the project. In a later phase, Yukon Pacific will develop the detailed design information necessary to assess the facility's adherence to the applicable standards, codes, and engineering practices. The following discussion summarizes the key findings, and the recommendations.

Spill Containment

At the present stage of design, spill containment systems for the proposed facility are tentative; final configurations are to be developed as design progresses. The impoundment systems are to be designed to comply with Federal Regulation 49 CFR Part 193 which requires that each LNG container and each LNG transfer system have an impoundment capable of containing the quantity of LNG that could be released by a credible accident.

For the proposed conventional metal double wall storage tank configuration (Type T-2, see figure 2.1.1-2), containment of LNG in the event of liquid spillage from the inner tank is to be provided by a Class 2 impoundment system, using an external high concrete wall dike capable of withstanding the hydrostatic head of the impounded LNG, the rapid thermal shock, the hydrodynamic action, etc., resulting from a tank failure as required by Part 193.2155. While the containment dike enclosure is to be equivalent to 137 percent of storage tank contents, Part 193.2181 requires a minimum capacity of 150 percent for Class 2 LNG storage tank impoundment.

Each of the other proposed LNG storage tank configurations (Type T-4 and Type T-6, see figure 2.1.1-2) would be constructed with an integral concrete outer wall which Yukon Pacific indicates is to serve as a Class 1 impoundment system capable of holding 110 percent of the tank contents. The use of an outer wall of a double-wall tank as a dike is permitted by DOT regulations in Parts 193.2153(a), 193.2161(b) and 193.2155(c), provided that the concrete wall is designed to withstand the equivalent impact loading of collision by, or explosion of, the heaviest aircraft which can take off at the Valdez Airport. This type of equivalent impact analysis has not been conducted for either of the two double- or increased-integrity tank designs proposed by Yukon Pacific and as such do not presently meet the DOT regulations. We recommend that Yukon Pacific submit to the DOT for approval and to the FERC the equivalent impact load analysis required by DOT regulations. If written approval of the impact analysis cannot be obtained, Yukon Pacific should construct a separate and independent impounding system for such storage tanks consistent with existing standards and codes.

Each LNG storage tank would have an approximately 30-foot wide by 100-foot long by 9-foot high impoundment trench for the 24-inch LNG fill and withdrawal lines. Each impoundment would provide containment of spills associated with the horizontal lines from the common pipe rack to the base of the LNG storage tank. Since all LNG transfer lines would enter or exit through the tank roof, the 24-inch fill and withdrawal lines would have a vertical segment from the base of the tank up to the roof—a distance of 96 feet for type T-2, 112 feet for T-4, and 91 feet for T-6.

Part 193.2161 prohibits any penetrations of a dike in order to accommodate piping. As a result, the vertical piping segments would be external to the outer tank wall of the type T-4 and T-6 tanks, and external to the impoundment as presently configured. The final design of the spill containment systems would also need to provide for impoundment of the vertical segments of the fill and withdrawal lines.

Perhaps the most difficult design task is to develop effective spill containment and diversion for the loading docks and associated trestles. Curbed concrete spill containment is to be provided beneath the LNG loading arms at each dock. Although several arrangements have been proposed to accommodate potential spills and possible diversion to an onshore impoundment, a final configuration has not been presented.

Equally difficult is to design spill impoundment systems that retain the required containment capacity at a site that may experience more than 500 inches of snowfall each year. Various ideas were discussed for snow control (snow removal from dikes, snow roofing, heat traced dike floors, etc.) but the issue remains unresolved. Although it was not discussed at the meeting, in addition to the above concepts, Yukon Pacific should be aware of a concentric "pipe-in-pipe" containment design system. The latter concept may in a limited way reduce snow control and removal activities around some specific piping arrangements, but may be of limited value in its use around flanges, elbows and other non-linear piping. Another potential application of this concept is impoundment for the vertical segments of the fill and withdrawal lines for the LNG storage tanks. However, it should be made clear that this design concept would be in addition to already planned containment systems.

Emergency Access Road

As a result of the remote location of the proposed site and lack of an all-weather vehicular access road, the primary access/egress to the plant for operating personnel, contractors, materials, and supplies would be waterborne transportation using the cargo/personnel ferry dock located west of the main terminal facilities in Anderson Bay. If an emergency situation necessitated the evacuation of plant personnel, either tugboats present at the terminal or worker transport boats would be used. Similarly, waterborne transportation would be required to receive any medical or emergency personnel and equipment at the site. Yukon Pacific also plans to make arrangements with Alyeska and the Coast Guard to mobilize their boats in an emergency situation.

During summer months, an overland emergency egress route would be available at the east end of the site using the TAGS pipeline right-of-way. Yukon plans to maintain this right-of-way as an unimproved private trail, removing brush to facilitate pipeline surveillance. While this route would allow evacuating personnel to reach the Alyeska Terminal, about 3.0 miles away, it is not envisioned to provide access for emergency personnel and equipment to the terminal.

The need for access to an LNG facility is addressed in the DOT regulations, under Subpart B - Siting Requirements. Specifically, Part 193.2055 requires in part:

> "...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." (emphasis added)

Plant access is also addressed in NFPA 59A. Under 2-2.1, some factors to be considered in selection of plant site locations include:

> (b) Accessibility to plant; at least one **all-weather vehicular road** shall be provided. (emphasis added)

The principal reliance on waterborne transportation for emergency evacuation of personnel and for access of medical and emergency personnel and equipment raises several concerns. During severe weather conditions, boats may be unable to reach the terminal to evacuate personnel or to supply emergency personnel and equipment. The cargo/personnel ferry dock, at an elevation of 25 feet, would be well below the 75-foot design tsunami and slide-induced wave runup. Further, an easterly wind could place the cargo/personnel ferry dock—the only year round access point—within the range of flammable vapors under some LNG spill scenarios. These concerns raise questions on compliance with the **all-weather vehicular road** requirement in NFPA 59A, as well as the ability of waterborne access to meet the **ease of access** requirement in Part 193.2055.

The conversion of the TAGS pipeline right-of-way into an all-season emergency access road could alleviate these concerns as well as providing several benefits:

- the road would provide a second principal access point at the opposite end of the site from the cargo/personnel ferry dock;

- the overland road would provide a second mode of emergency access to supplement or substitute for waterborne transportation;

- medical and other emergency equipment could access the site more quickly by an overland route and would be unaffected by severe marine weather;

- an overland road would provide direct access for contractors, maintenance specialists and their equipment to perform non-routine repairs at the facility. In some cases, early repair or replacement of critical components can prevent a simple problem from developing into more serious consequences; and

- an overland access road connecting with the Alyeska Terminal would enable both facilities to "pool" their mobile fire fighting equipment and provide mutual aid in the event of a hydrocarbon fire or other serious incident at either facility.

However, we recognize several obstacles in converting an unimproved trail—primarily designed to permit the passage of pipeline construction equipment on the right-of-way—into an all-season access road:

- additional clearing, cut and fill, and bridge construction would be required; and

- the high potential for rock slides and avalanches would present continuing maintenance difficulties;

- snow removal for the 3.0-mile road.

Regardless of the above obstacles, we believe that the safety and operational benefits of the all-weather access road clearly offset the problems. Further, the all-weather access road would comply with NFPA 59A and Part 193.2055.

While the Alyeska Terminal would be outside the hazard range of any credible accidents at the LNG facility, communication between the two facilities is essential to ensure that a serious incident at one facility or the associated shipping does not propagate to the other facility. It therefore appears prudent to establish a direct telephonic linkage between the two facilities solely devoted to emergency usage. Further, the respective emergency plans at each facility should identify potential incidents which could affect the adjacent facility and a procedure for notification and response.

Conclusions and Recommendations

Through careful consideration of existing cryogenic design, consistent with and acknowledging the present state-of-the-art, it must be recognized that additional detailed engineering analysis will be required to complete the intended review process. Although considerable care has been taken and extensive effort has been made by Yukon Pacific and its contractors in designing a facility embodying safeguards (including hazard control and safety systems) to either prevent the occurrence of accidents or to reduce the impact of credible accidents, the detail design remains in a preliminary stage.

Notwithstanding the fact that the material submitted by Yukon Pacific to the FERC is extensive, considering the initial phase of design, supplemental information is required before a more definitive assessment can be made on the adequacy of design and on the adherence of the design to various applicable standards, codes, and engineering practices. Areas of particular interest and concern where supplemental information is required include:

1) final selection of LNG storage tank contractor in order to establish design details;

2) confirmation of final design for dock facilities, particularly the details that would define spill containment, hazard detection, and hazard control systems;

3) impoundment for the vertical segments of the storage tanks fill and withdrawal lines;

4) specific manufacturer, number, and locations of hazard detection devices throughout the facility (only general locations without specific numbers have been presented in many instances);

5) specific hazard control systems, including chemical quantity, unit locations, dispersion flow rates, and foam confinement techniques,

6) specific interrelationship between the hazard detection system and the hazard control system that is to provide automatic emergency shutdown and actuation of hazard control devices;

7) design details and hazard control systems for the refrigerant storage vessels;

8) detailed procedures to define snow control and/or removal techniques for the heavy snowfall at the plant site to prevent adverse influence on operations and safety systems (especially spill impoundment systems);

9) analysis of safety considerations relating to the large quantity of refrigerants (MR fluids, propane, and ethane) contained in the process areas and the

desirability of containment systems to accommodate potential refrigerant spillage; and

10) the need for a permanent access road for emergency access/egress purposes.

Supplemental filings made by Yukon Pacific will be reviewed as appropriate. In addition to the above requirement for supplemental technical information, the following specific recommendations are made:

1) **We recommend that an additional technical conference (or conferences) be held as engineering design develops so that present areas of uncertainty may be more fully explored. These conferences should be held prior to initiating construction at the site. At least one technical conference should be held prior to initiation of construction after designs are finalized and major vendors (including LNG and other major storage tanks) have been selected and complete design details have been made available to FERC staff. The applicant should also provide design details to the Office of Pipeline Safety of the DOT and the Coast Guard Captain of the Port of Valdez so that they may have the opportunity to participate in the technical conferences to assure compliance with their applicable regulations.**

2) **We recommend that construction not be initiated without a written notice to proceed from the Director of OPPR. Any major alterations to facility design should be filed with the Secretary for review and written approval by the Director of OPPR prior to initiation.**

3) **Onsite inspections should be conducted as significant milestones develop during the construction phase and prior to commencement of initial facility operation.**

4) **Following commencement of operation, the facility should be subject to regular FERC staff technical reviews and site inspections on at least a biennial basis or more frequently as circumstances indicate. Prior to each FERC staff technical review and site inspection, the company should respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations, provision of up-to-date detailed piping and instrumentation diagrams reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below.**

5) **We recommend that Yukon Pacific submit semi-annual reports to the FERC after initiating construction and continuing through the operational period. During the construction phase the semi-annual reports should provide construction status of major components including significant design and schedule modifications required (and/or anticipated). The reports also should address changes in facility design including anticipated future plans. During the operational phase the semi-annual reports should provide changes in facility design and operating conditions, abnormal operating experiences, activities (liquefaction and LNG shipping schedules), plant modifications including those proposed during the forthcoming 12-month period.**

Abnormalities should include but not be limited to storage tank vibrations and/or vibrations in associated cryogenic plumbing, storage tank settlement, significant equipment and instrumentation malfunctions or failures, nonscheduled maintenance or repair (and reasons therefor), relative movement of the inner vessel, vapor or liquid releases, fires involving natural gas, refrigerants and/or from other sources, negative pressure (vacuum) within the LNG storage tanks and higher than predicted boiloff rates. The reports should be submitted within 45 days after each period ending December 31 and June 30.

Included in the above items should be a section entitled "Significant plant modifications proposed for the next 12 months (dates)". The section should be included in the semi-annual operational reports to provide Commission staff with early notice of anticipated future construction and maintenance projects at the LNG terminal.

6) **We recommend that a permanent all-weather access road be built to allow emergency equipment and personnel access/egress between the plant and the City of Valdez.**

7) **Regarding proposed use of double- or increased-integrity LNG storage tanks, if further consideration is contemplated, we recommend that Yukon Pacific immediately submit to the DOT for approval, and to the FERC, the equivalent impact load analysis required by Section 193.2161(b) and 193.2155(c) of the DOT regulations. If written approval of the impact analysis cannot be obtained, Yukon Pacific shall construct separate and independent impounding systems for such storage tanks consistent with existing standards and codes.**

8) **Yukon Pacific should establish direct telephonic linkage with the Alyeska Terminal and the Coast Guard Vessel Traffic Center in Valdez and ensure that procedures for notification and response to potential incidents are included in the emergency plans for each facility.**

4.15.3 Thermal and Dispersion Exclusion Zones

The DOT regulations governing the siting of an LNG facility appear in Subpart B of 49 CFR Part 193. In general, the siting requirements require that a facility be located at a site of suitable size, topography, and configuration so that it can be designed to minimize the hazards to persons and offsite property resulting from LNG spills at the site. Two sections specifically address offsite hazards. Part 193.2057, Thermal Radiation Protection, requires a thermal exclusion zone for several land uses based on four radiation flux levels. Part 193.2059, flammable Vapor-gas Dispersion Protection, prohibits various land uses within the range of potentially flammable vapors. Each LNG container and LNG transfer system must have thermal and dispersion exclusion zones.

In order to demonstrate facility compliance with Parts 193.2057 and 193.2059, Yukon Pacific contracted with Quest Consultants, Inc. (Quest) to calculate exclusion zones for the LNG containers, transfer systems, and their impoundments. Yukon Pacific submitted its July 1991 report titled "Trans-Alaska Gas System (TAGS) LNG Facility Siting Report" to the DOT for review.

The DOT contracted with the Volpe Transportation Systems and Applied Technology Corporation (Applied Technology) to review the report. Based on Applied Technology's March 1992 report, "Review of Trans-Alaska Gas System (TAGS) LNG Facility Siting Report—Thermal and Dispersion Exclusion Zones," DOT sent eight questions to Yukon Pacific on July 8, 1992. Yukon Pacific submitted its response on September 11, 1992. Subsequently, the DOT requested additional information on November 5, 1992, concerning the following outstanding issues:

- Calculations to support the LNG spill rates used in the analysis.

- Significance of having to recalculate using actual pump curves when pumps are selected.

- Calculations for the energy added by the pumps and the heat leak from the piping.

- Assumptions and calculations that snow and ice removal programs will be completely effective in preventing loss of impoundment capacity.

- Explanation of who will approve the final facility design purportedly necessary to negotiate agreements on the use of land and water for exclusion zones.

- Explanation of the significance of the increase in the buffer zone size—from about 2,500 acres in the July 1991 report to about 5,500 acres in the September 1992 response.

Yukon Pacific submitted its responses to these questions on January 8, 1993—they are presently under review by the DOT.

Impoundment Systems

The calculations of both the thermal and dispersion exclusions zones are based in part on the dimensions of the impoundment systems for each LNG container and LNG transfer system. Part 193.2183 requires that the minimum capacity of an impoundment system equal 100 percent of the volume of liquid in a container, plus the maximum discharge from a transfer line failure for a period of time necessary to detect and shutdown the system, but not less than 10 minutes. Part 193.2181 specifies the minimum capacity of the impoundments for LNG storage tanks—110 percent for Class 1, and 150 percent for Class 2. Further, impoundments must have sufficient capacity to provide for displacement by the containers served, and displacement by a higher density liquid—such as rain, snow, ice, or water from the firewater system.

The proposed LNG facility would have the following LNG containers:

- four LNG storage tanks
- one LNG flash drum in each LNG train
- one liquefaction column in each LNG train
- one loading arm drain drum at each berth

Table 4.15.3-1 identifies the principal LNG transfer systems and the design flow rates from the preliminary design criteria. The spill rates used to size impoundments and calculate exclusion zones are derived from the design flow rates with upward adjustments to reflect (1) pump flow at zero discharge head, and (2) maximum storage tank head.

TABLE 4.15.3-1

Principal LNG Transfer Systems and Design Flow Rates

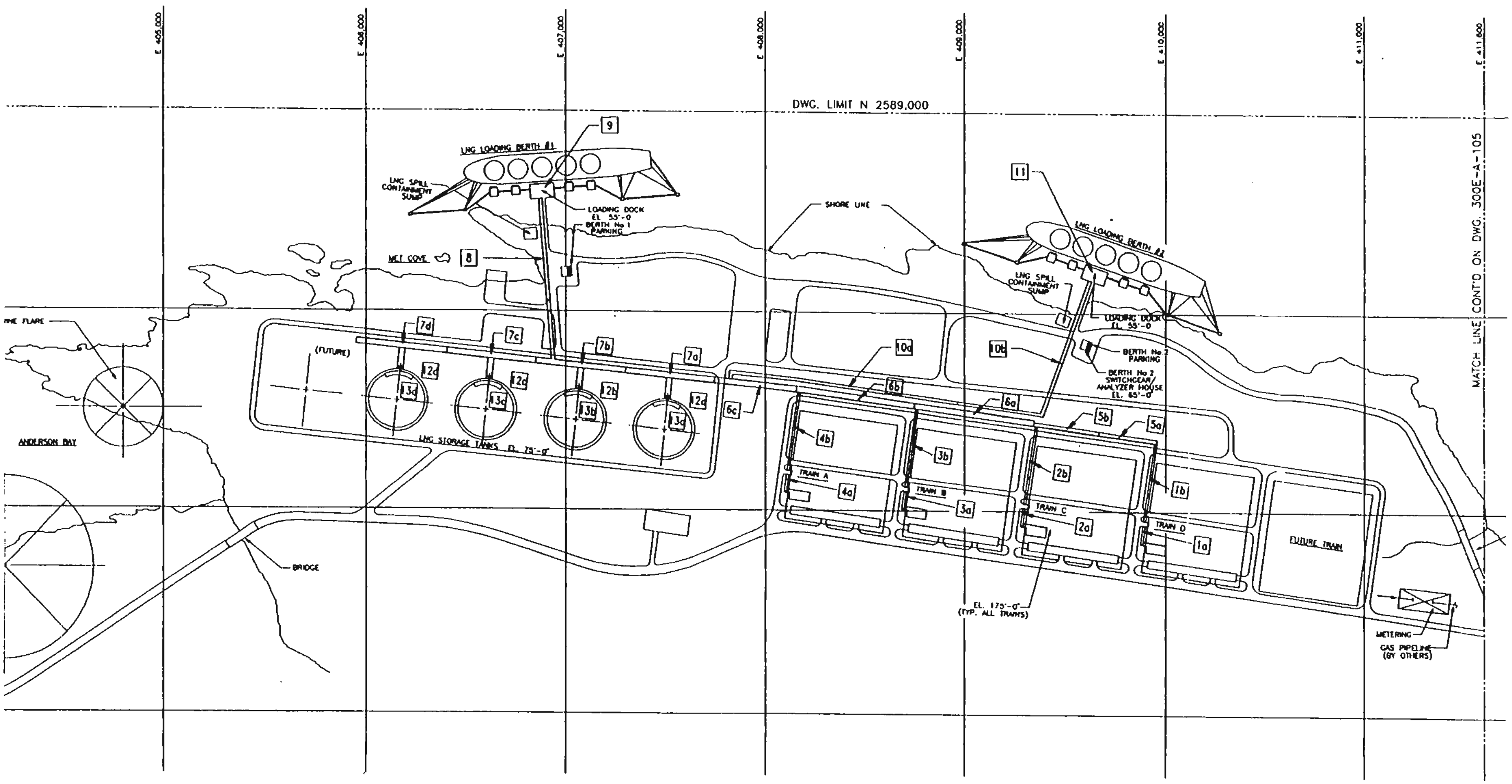
Transfer System	Design Flow gpm	Spill Rate gpm (ft^3/sec)
production from one liquefaction train	4,780	4,760 (10.6)
production from two liquefaction trains	9,560	9,520 (21.2)
maximum ship loading rate - six pumps	44,000	69,750 (155.4)
maximum storage tank sendout - four pumps	30,000	46,500 (103.6)

Table 4.15.3-2 presents the design spill rates and volumes, dimensions, and components served for each of the impoundment systems. This represents the preliminary spill containment dimensions developed in the July 1991 Quest report to the extent necessary to perform the exclusion zone analysis. Subsequently, dimensions were revised in the September 11, 1992 response to DOT's July 8, 1992 data request—the heights of six of the impoundments were increased 50 percent to accommodate larger design spill rates. Figure 4.15.3-1 identifies the location of each impoundment.

The final configurations of the LNG spill containment systems will be developed during a later stage in project design. At that time, it will be necessary to reexamine all calculations to ensure that the analysis based on preliminary impoundment dimensions properly reflects the final design.

Thermal Exclusion Zones

If a large quantity of LNG spilled in the presence of an ignition source, the resulting LNG pool fire could cause high levels of radiation. Exclusion distances for various flux levels were calculated according to DOT's regulations, part 193.2057. The analysis assumes a flame angle of 45 degrees and the incident flux factors listed in subsection (d) for each flux level. Table 4.15.3-3 presents the calculated exclusion distances for incident flux levels ranging from 1,600 to 10,000 Btu/ft^2 hr and the effects of those levels of thermal radiation. The levels represent the maximum thermal radiation permitted by the DOT regulations for offsite targets identified in the table.



NOTE: REFER TO TABLE 4.15.3-2 FOR A DESCRIPTION OF IMPOUNDMENT DESIGNATIONS

FIGURE 4.15.3-1	
DETAILED LAYOUT OF THE LNG SPILL CONTAINMENT SYSTEM	
SCALE: AS SHOWN	

TABLE 4.15.3-2

LNG Impoundment Systems

Components Served	Impoundment Designation	Spill Rate (ft^3/sec)	Spill Volume (ft^3)	Component (ft^3)	Total Volume (ft^3)	Dimensions Width x length x height (ft)	Area (ft^2)
Liquefaction column, Flashdrum, product piping - each LNG train	1a, 1b, 2a, 2b, 3a, 3b, 4a, 4b	10.6	6,348	698	7.046	10 x 250 x 6	2,500
Rundown piping - Trains C, D	5a, 5b	21.2	12,696	1,494	14,190	20 x 285 x 6	5,700
Rundown piping - all LNG trains	6a, 6b, 6c	155.4	93,240	9,550	102,970	30 x 543.3 x 9	16,300
Product and sendout piping	7a, 7b, 7c, 7d	155.4	93,240	7,540	100,780	40 x 570 x 9	22,800
Sendout to Dock 1	8	155.4	93,240	10,053	103,293	16 x 800 x 9	12,800
Dock 1 - drain drum, loading arms	9	155.4	93.240	10,053	103,293	155 x 155 x 4.5	24,025
Sendout to Dock 2	10a, 10b	155.4	93,240	14,985	108,225	16 x 1,145 x 9	18,320
Dock 2 - drain drum, loading arms	11	155.4	93,240	14,985	108,225	160 x 160 x 4.5	25,600
Class 2 storage tank option	12a, 12b	103.6	62,160	377	6,737,968	310 ft dia.	75,477
Class 1 storage tank option	13a, 13b	NA	NA	NA	4,941,177	280 ft dia.	61,575

Since the exclusion distance length calculated according to the formula in Part 193.2057 is directly proportional to the surface area of the impoundment, the largest exclusion distances occur at the LNG storage tank impoundments. Table 4.15.3-3 presents these distances for the Class 1 and Class 2 impoundment options. Although other impoundments have smaller surface areas, their proximity to the property line may actually create a greater offsite hazard, as in the case of the dock impoundments, areas 9 and 11. The combined effects of the thermal exclusion zones from all impoundments is presented on the map on figure 4.15.3-2.

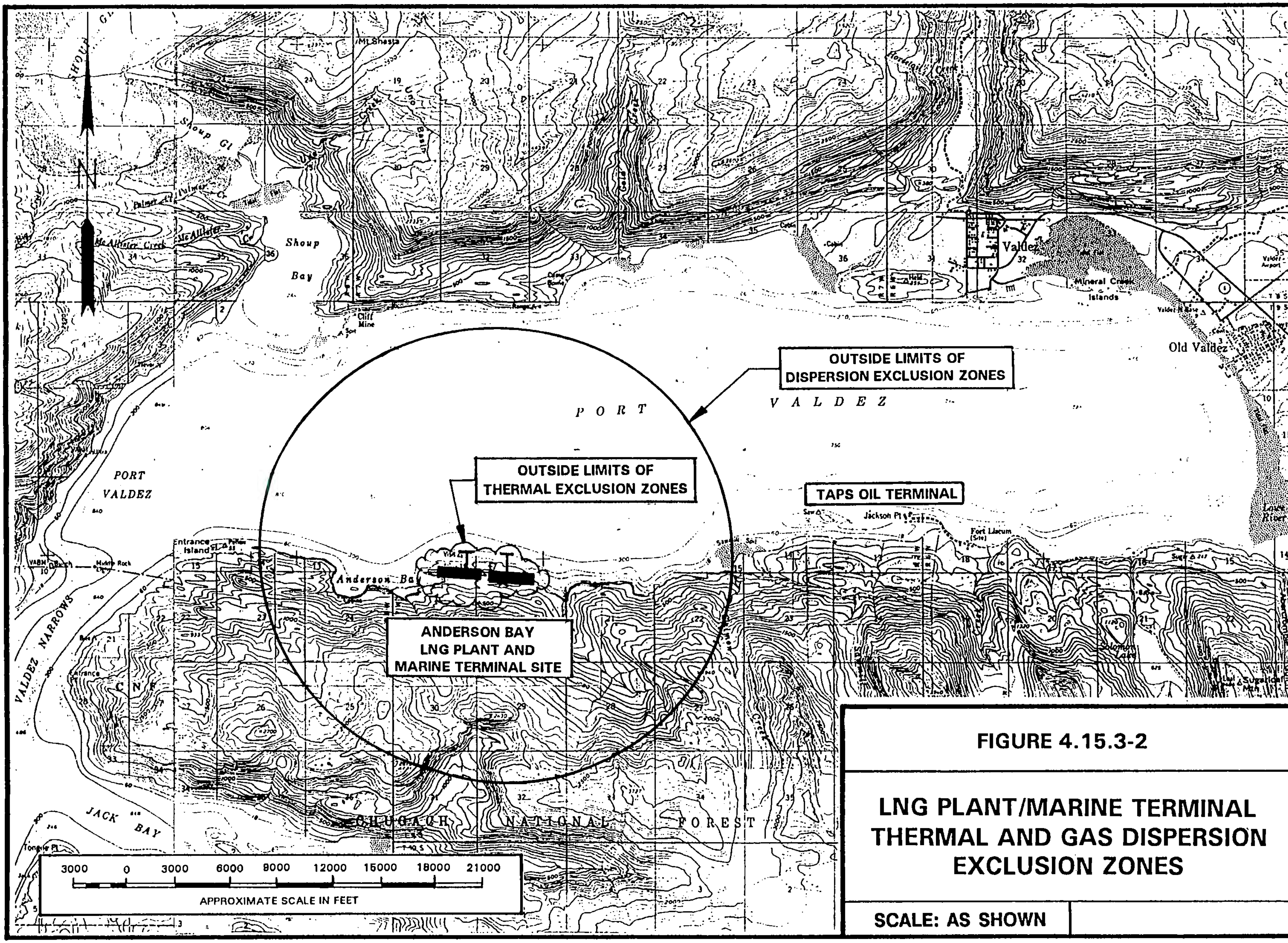


FIGURE 4.15.3-2

LNG PLANT/MARINE TERMINAL
THERMAL AND GAS DISPERSION
EXCLUSION ZONES

SCALE: AS SHOWN

TABLE 4.15.3-3

Thermal Exclusion Zones
For Storage Tank Impoundments

Incident Flux (Btus/hour/square foot)	Effects of Thermal Radiation	Offsite Targets Exclude By DOT a/	Exclusion Zone (Feet)	
			Class 1 Impoundment	Class 2 Impoundment
1,600	Extreme pain after 10 to 15 seconds, second degree burns within 40 seconds.	Outdoor areas occupied by 20 or more people.	963	1,075
4,000	Extreme pain after 3 to 4 seconds. Second degree burns in 10 seconds.	Residences, non fire-resistant building of historic value and those containing hazardous materials.	471	532
6,700	Second degree burns in 3 seconds; metal loses structural integrity	Fire-resistant structures, public streets, and highways.	296	337
10,000	Clothing and wood can ignite spontaneously	Plant property line	191	221

a/ Summary of offsite targets defined in 193.2057(d)

Dispersion Exclusion Zones

A large quantity of LNG spilled without ignition would form a flammable vapor cloud which could affect offsite areas under adverse meteorological conditions. Part 193.2059 establishes a flammable vapor dispersion exclusion zone which prohibits the following activities, unless it is a 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 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;

(v) Could result in additional hazard if exposed to a vapor-gas cloud.

The regulations require that dispersion distances be calculated for a 2.5 percent average gas concentration under meteorological conditions which result in the longest downwind distances at least 90 percent of the time. Alternatively, maximum downwind distances may be estimated for stability Class F and a wind speed of 4.5 mph. The regulations further specify the mathematical models in Appendix B of the American Gas Associations's "Evaluation of LNG Vapor Control Methods." Use of alternative models must be approved by the Director.

The vaporization rate used in the Appendix B model to compute the dispersion distance is the sum of three components: (1) the fraction of the superheated LNG that flashes upon release, (2) the vapors displaced by LNG entering the impoundment, and (3) the vaporization due to heat transfer from the impoundment. The third component varies with time and is calculated using Equation C-9 based on impoundment dimensions, thermal properties of the impoundment surface, and the volume and rate of LNG spilled.

The Quest report computed vaporization rates using thermal properties for structural concrete with a density of 150 lb/ft^3, a heat capacity of 0.156 Btu/lb-°F, and a thermal conductivity of 2.2 Btu/hr-ft-°F. The temperature of the impoundment surface was assumed to be 60°F. A flashing fraction of 0.0063 was used to account for heat leak from transfer lines and heat input from pump energy.

Table 4.15.3-4 presents the time for vapor overflow and the corresponding vaporization rate for each impoundment. The distances to the 2.5 percent methane concentration are based on stability Class F and a wind speed of 4.5 mph. The longest dispersion exclusion zones result from spills at the dock.

TABLE 4.15.3-4

Dispersion Exclusion Zones

Impoundment System	LNG Spill Rate (ft^3/sec)	Time to Overflow (sec)	Vaporization Rate at Overflow (lb/sec)	Exclusion Distance (ft)
LNG Train	10.6	13.2	71.6	2,390
Rundown piping-Trains C, D	21.2	13.5	161.3	4,000
Rundown piping-all trains	155.4	25.2	363.0	6,800
Product sendout piping	155.4	26.5	477.9	8,200
Sendout to Dock 1	155.4	23.9	306.7	6,100
Dock 1	155.4	7.3	924.4	12,850
Sendout to Dock 2	155.4	25.5	406.7	7,350
Dock 2	155.4	7.4	978.5	13,350
Class 2 tank dike	103.6	1,782.0	47.9	945
Class 1 tank dike	NA	NA	NA	NA

Conclusions and Recommendations

The outer limits of both the thermal and dispersion exclusion zones have been depicted on the map on figure 4.15.3-2. The thermal exclusion zone is either confined to the plant property or the immediate vicinity of the waters at the two LNG tanker docks. None of the excluded land uses are located within the thermal exclusion zone.

The dispersion exclusion zone is by far the controlling exclusion zone for land-base spills at the facility. The dispersion exclusion zone extends northward more than 13,000 feet offshore from the tanker loading docks into Port Valdez. The southern extent of the dispersion exclusion zone depicted on figure 4.15.3-2 probably overstates the true flammable vapor hazard since the Appendix B dispersion model assumes vapor cloud travel over level terrain. As such it does not account for the trapping effects of the steep slopes above Anderson Bay.

No prohibited buildings listed under Part 193.2059(a)(2) currently exist within the dispersion exclusion zone or will occur in the future, since the area is closed to development. However, outdoor recreation areas defined under Part 193.2059(a)(1), may include Anderson Bay and Seven Mile Creek. These areas are located within the dispersion exclusion zone, and presently support recreational fishing during the summer months. In order to demonstrate compliance with the dispersion exclusion zone, Yukon Pacific will need to ensure that normal usage in these areas is below 20 people. In its September 1992 response to DOT question 8, Yukon Pacific stated that no decisions will be made concerning the establishment of an exclusion zone until final facility designs are approved. Any recreation plan will require a public notice and hearing and probably promulgation of State Regulations pursuant to the State Administrative Procedure Act.

In conclusion, a number of uncertainties exist in the thermal and dispersion exclusion zones analysis which prevent a finding of compliance with Part 193 at this stage in the design process. Most of these uncertainties have been identified in the DOT's November 4, 1992 questions. A further uncertainty is how closely the preliminary impoundment systems used in the analysis will reflect the final design. Although a finding of compliance with Part 193 will await the DOT's evaluation of Yukon Pacific's responses, the remote location of the site and lack of population in the plant vicinity should ultimately permit compliance with the siting requirements.

4.15.4 Marine Safety

The hazards associated with the marine transportation of LNG differ from the land-based spills analyzed in the previous section (4.15.3). Whereas the land-based facilities would have features to limit the duration of LNG spills and contain credible spill volumes, any LNG spill on water would be unconfined and vaporize rapidly due to heat input from water.

While the history of LNG shipping has been free of major incidents, the possibility of a major LNG spill over the duration of the project cannot be discounted. The events most likely to cause a significant release of LNG cargo would be a grounding severe enough to penetrate the tanker's double bottom or collision with another vessel sufficiently large and with sufficient momentum to penetrate the double sides. In addition, potential collisions with a loaded crude oil tanker must also be considered.

Prince William Sound Vessel Traffic

Vessel traffic in Prince William Sound is predominated by oil tanker traffic between Hinchinbrook Entrance and the Alyeska Marine Terminal in Port Valdez, about 3.5 miles east of the proposed Anderson Bay LNG terminal. Approximately 900 crude oil tankers, varying in size from 32,000 to 265,000 DWT, are loaded each year at the Alyeska Marine Terminal.

Port Valdez also receives refined petroleum products, general cargo, and several foreign freezer ships. About 35 cruise ships visit Valdez each summer. The Alaska State Ferry provides year round service between Valdez and Cordova and between Whittier and Valdez year round, with an abbreviated winter schedule. Whittier, at the terminus of the Alaska Railroad in western Prince William Sound, handles general cargo and some refined petroleum products. Neither Port Valdez nor the Port of Whittier receives more than 200 ships or barges each year.

The Coast Guard regulations in 33 CFR 161.301 through 161.387 prescribe the rules for vessels operating in the Prince William Sound VTS Area. The VTS Area includes the navigable waters north of a line between Cape Hinchinbrook Light to Schooner Rock Light, between longitudes 146° 30'W and 147° 20'W, and including Valdez Arm, Valdez Narrows, and Port Valdez (see figure 4.15.4-1). Highlights of the major requirements of the VTS Area include:

I. General Operating Procedures - The applicability of the regulations to various vessels.

II. Communication Procedures - Radio equipment and watch requirements.

III. Vessel Movement Reporting Procedures - Mandatory reports before a vessel enters the VTS Area and at other points and conditions.

IV. Traffic Separation Scheme Procedures - A TSS comprised of one-way traffic lanes with a separation zone from Hinchinbrook Entrance to Valdez Arm (see figure 4.15.4-1).

V. Valdez Narrows Procedures - One-way traffic in Valdez Narrows whenever a tank vessel of 20,000 DWT or more is navigating therein.

VI. Special Requirements for Tank Vessels - Tank vessels greater than 20,000 DWT operating in the VTS Area must have:
- two separate marine radar systems for surface navigation;
- an operating LORAN-C receiver;
- an operating rate of turn indicator; and
- two operating radiotelephones, one battery powered, capable of operating at the designated VTS Area frequency.

VII. Description and Geographic Coordinates - Navigation coordinates for the separation zone, traffic lanes, and the Valdez Narrows one-way traffic area.

Operation of the VTS Area is controlled by the Coast Guard VTC in Valdez. The VTC maintains radio communications with vessels in the VTS Area, and receives, processes and

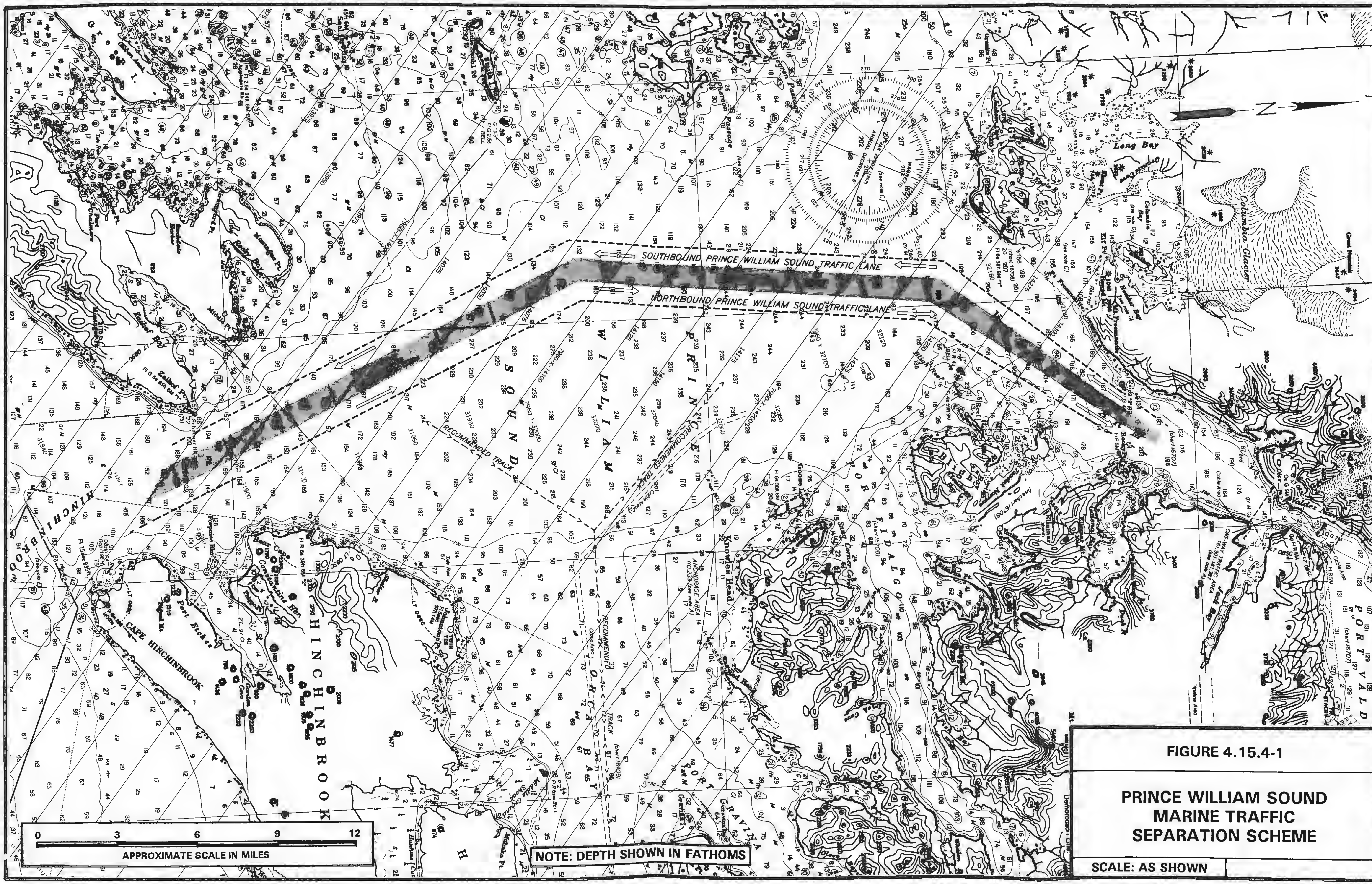


FIGURE 4.15.4-1

PRINCE WILLIAM SOUND MARINE TRAFFIC SEPARATION SCHEME

SCALE: AS SHOWN

disseminates information from voluntary and mandatory reports to vessels in the area. The Coast Guard also operates two radar sites—one at Potato Point on the west side of Valdez Narrows, and the other on Valdez Spit—to provide continuous radar surveillance in Valdez Arm, Valdez Narrows, and Port Valdez. The designated anchorage area in Prince William Sound is located east of the TSS and south of Knowles Head.

On July 17, 1992, the Coast Guard issued a final rule amending the Prince William Sound VTS regulations by incorporating the use of Automated Dependent Surveillance using a Differential Global Positioning System. No later than August 1, 1993, tank vessels greater than 20,000 DWT must have an operating ADSSE that meets the requirements of 33 CFR 161.376(a)(5). The ADSSE will automatically provide the VTC in Valdez with position information on tank vessels at greater distances than now available, allowing for more timely and reliable traffic decisions.

On March 10, 1993, the Coast Guard issued a final rule in 46 CFR Part 15 concerning pilotage in Prince William Sound. The rule allows coastwise seagoing vessels to navigate south of 60 49' North latitude through Hinchinbrook Entrance with two licensed officers instead of a Federal pilot. Vessels must be under the direction and control of a federally licensed pilot when operating from 60 49' North latitude to Port Valdez.

The State of Alaska imposes additional requirements on crude oil tankers as reflected in Alyeska's Prince William Sound Tanker Spill Prevention and Response Plan. This document requires that all tankers transporting crude oil from the port of Valdez use two escort vessels—a conventional towing vessel and an Escort/Response vessel—for the tanker's transit out of Prince William Sound.

On July 7, 1992, the Coast Guard issued a notice of proposed rulemaking, to implement section 4116(c) of the Oil Pollution Act of 1990, requiring at least two suitable escort vessels for single hull tankers over 5,000 gross tons operating in Prince William Sound and Puget Sound. The comment period was reopened in a notice issued March 26, 1993, inviting further public review on those portions where additional comments are needed: (a) definition of escort vessel, (b) escort vessel criteria, and (c) pre-escort conference.

In a May 25, 1990 memorandum, the Commanding Officer, Coast Guard Marine Safety Office Valdez, stated that it does not anticipate VTS problems with the increased LNG tanker traffic, but has recommended additional restrictions governing LNG tankers in the VTS Area:

(1) an LNG tanker and any other tank vessel shall not be underway at the same time in Valdez Arm, Valdez Narrows, or Port Valdez;

(2) LNG tankers will enter the TSS at Hinchinbrook Entrance;

(3) LNG tankers will be conned (i.e. direct the steering of the tanker) by a pilot licensed for the portion of Prince William Sound being transited;

(4) an LNG tanker and any other tank vessel will maintain a separation of not less than 5 nautical miles, except when the LNG tanker or the other tank vessel is moored, at anchor, or in the opposing lane of the TSS;

(5) unless moored at the terminal in Port Valdez, an LNG tanker will be attended by an adequate number of ship assist tugs;

(6) while in the VTS Area, all LNG tankers shall have a towing bridle or wire rigged and ready for immediate use; and

(7) all VTS regulations that apply to tank vessels greater than 20,000 DWT should also apply to LNG tankers regardless of size.

In addition, the Coast Guard recommended a study be conducted by a creditable firm to review the operation of the VTS and provide suggestions for reducing the risks involved with the inclusion of LNG tankers in the system. **We recommend that the above Coast Guard recommendations be implemented prior to commencement of shipping activities.**

Further, the Coast Guard has stated that it would develop a Captain of the Port operating plan specific to LNG tanker operations similar to that in use at other ports with LNG shipping. Caption of the Port operating plans have been developed for LNG operations in a number of ports—Lake Charles, Louisiana; Boston Harbor, Massachusetts; the Chesapeake Bay; Nikiski, Alaska; and the Port of New York. The Coast Guard indicated it would develop an LNG plan for Prince William Sound when facility construction begins.

The Coast Guard regulations in 33 CFR Part 127, Liquefied Natural Gas Waterfront Facilities, apply to the marine transfer area of new and existing waterfront facilities between the LNG tanker and the last manifold or valve located immediately before a storage tank. Part 127 regulates the design, construction, equipment, operations, personnel training, fire fighting, and security of LNG waterfront facilities. Under Part 127.206, an operator must submit a letter of intent to the Captain of the Port at least 60 days before construction begins. The Caption of the Port then issues a letter of recommendation to the operator and to state and local agencies having jurisdiction of the waterway.

LNG Tanker Safety

Since the marine transportation of LNG began in 1959, there have been more than 16,000 trips by LNG tankers worldwide. This includes more than 430 deliveries to receiving terminals in the U.S. and 740 voyages from Nikiski, Alaska to Japan. During this period, there have been six significant incidents involving LNG tankers—none resulted in spills due to rupturing of the cargo tanks. Those incidents are described below:

- El Paso Paul Kayser grounded on a rock in June 1979 in the Straits of Gibralter. Extensive bottom damage bottom restricted to ballast tanks -- cargo tanks not damaged. 90,000m^3 of LNG transferred to El Paso Sonatrach.

- LNG Libra fractured propeller shaft enroute to Japan with full cargo in October 1980. Ship towed, cargo transferred to LNG Leo.

- LNG Taurus grounded in December 1980 near entrance to Tobata Harbor, Japan. Extensive bottom damage, but cargo tanks not affected. Ship refloated, cargo unloaded.

- Ramdane Abane collided with Yugoslavian ship near Gibralter in August 1985. Collision did not affect cargo tanks.

- Tellier blown off berth during storm at Skikda, Algeria in February 1989. Residual LNG in loading arms spilled on deck and fractured some plating.

- Larbi Ben M'Hidi broke from moorings while laid up during storm at Oran, Algeria. Some hull damage, no LNG on board.

LNG tankers returning from Pacific Rim Countries in ballast would enter Prince William Sound through Hinchinbrook Entrance and follow the rules of the VTS Area. Tankers would proceed north through the sound into Valdez Arm, then pass through Valdez Narrows. As the LNG tanker approaches Anderson Bay, the vessel and accompanying tugs would make a 180° turn to starboard prior to berthing at the marine terminal. This would enable the LNG tanker to berth on its port side with its bow toward the sea. After securing the tanker with berthing and mooring lines, the loading and vapor return arms would be connected to tanker cargo manifold and cargo transfer would commerce. Typically cargo loading would require 12 hours, with a tanker turnaround time of about 18 hours.

On the inbound voyage through Prince William Sound, LNG tankers would be in ballast and have only a small amount of cargo, or heel, necessary to maintain cryogenic temperatures in the cargo tanks. In this condition, any release of cargo in a severe accident would be minimal. On the outbound voyage, only a severe grounding or collision would have the potential to cause a significant release of cargo from the loaded LNG tanker.

Unlike many conventional crude oil tankers, all LNG tankers used in this project would have double-hull construction, with the inner and outer hull separated by more than 10 feet. Further, the bottom of the cargo tanks are normally separated from the inner hull by a layer of insulation approximately 1 foot thick. As a result, many grounding incidents severe enough to cause a cargo spill on a conventional single-bottom oil tanker would be unable to penetrate both inner and outer hulls of an LNG tanker. An earlier FPC study estimated that the double-bottom of an LNG tanker would be sufficient to prevent cargo tank penetration in 85 percent of the cases that penetrated a single-bottom oil tanker.

The probability of an LNG tanker sustaining cargo tank damage in a collision would depend on several factors—the displacement and construction of both the struck and striking vessels, the velocity of the striking vessel and its angle of impact with the struck vessel, and the location of the point of impact. The previous FPC study estimated the additional protection afforded by the double-hull construction. While the double-hull would be effective in low energy collisions, overall it would prevent cargo tank penetration in about 25 percent of the cases that penetrated a single-bottom oil tanker.

In the event of a collision of sufficient magnitude to cause the rupture of an LNG cargo tank, it is likely that sparks or flames would ignite the flammable vapors at the spill site. The resulting LNG pool fire would result in intense thermal radiation levels within several thousand feet of the fire. While this event would have little if any impact on the general public, it would pose an extreme hazard to the crews of the vessels involved.

In a grounding of sufficient magnitude to rupture an LNG cargo tank, the damage would occur under water and the potential for ignition is far less than for collisions. In this case an LNG spill on water would rapidly vaporize and form a potentially flammable vapor cloud.

If unignited, the flammable vapor cloud would drift downwind until the effects of dispersion would dilute the vapors below the lower flammable limit for methane. However, if the flammable vapor cloud would encounter a source of ignition, the cloud would burn back to the spill site.

The maximum range of potentially flammable vapors—the distance to the lower flammable limit—is a function of the volume of LNG spilled, the rate of the spill, and the prevailing meteorological conditions. Yukon Pacific's study identified that an instantaneous spillage of 20,000 cubic meters of LNG with a 10 mph wind and typical atmospheric stability could travel up to 3.3 miles in 25 minutes.

The LNG tanker route through Prince William Sound to the marine terminal is far offshore for the majority of the voyage. There exist no populated areas within the maximum range of thermal radiation hazard or flammable vapor cloud hazard for an instantaneous one-tank cargo spill. As a result, the general public would not be exposed to a hazard from these events.

The instantaneous spillage of one cargo tank is considered to be a "worst case" event. Physical constraints on maximum vessel speeds and maximum depths of penetration required to rupture one LNG cargo tank render the possibility of an instantaneous release of more than one cargo tank to be implausible. This is not to imply that the loss of multiple cargo tanks could never occur, but that the extent of the hazard would not exceed that of the instantaneous spillage of one tank.

The possibility of a collision between a loaded outbound crude oil tanker and an inbound LNG tanker in ballast has been suggested as a possible event that could lead to a significant oil spill. Presently, crude oil tankers make about 900 round trips annually—an average of 2.5 per day—through Prince William Sound. The proposed project would add 275 LNG tanker trips per year, or an average of 0.75 per day. This increase in total tanker traffic from an average of 2.5 to 3.25 per day is believed to be well within the limitations of the VTS system. The modest increase tanker traffic in Prince William Sound would not significantly increase the potential for a collision between an outbound crude oil tanker and any inbound tanker, either LNG or another crude oil tanker.

Conclusions

- LNG tankers have experienced safe operation without cargo tank spillage for more than 30 years. Given the present and planned Coast Guard controls in the Prince William Sound VTS Area, LNG tankers can safely operate in these waters.

- The thermal radiation and flammable vapor cloud hazards from the maximum credible LNG tanker spill would not affect the general public.

- Although it is possible for an LNG tanker to spill cargo in a grounding type incident, the liquid would rapidly vaporize and would not have the long-term environmental consequences associated with a major oil spill.

- The addition of LNG tankers within the VTS Area would not have a significant increase on the percent potential of a collision with an outbound crude oil tanker.

4.16 ALTERNATIVE CONSTRUCTION CAMP SITE AND ACCESS ROAD

Use of the upgraded camp site in Valdez to house the construction workforce would result in environmental impacts in two main areas—the camp site itself, and road access from the camp to the work site. These are discussed below and are summarized in table 4.16-1.

Valdez Camp Site

The expansion of the commercial camp site in the City of Valdez from its current capacity of 700 to 4,000 could be accommodated within the properties currently owned by Arctic Camps and would require very little site preparation and only standard housing-type construction practices. The majority of the structures are modular and are within the company's current inventory. Adjacent land uses include the airport, a city park, a National Guard Armory, a trailer park, and the Senior League Field, none of which would be unduly disturbed by the modest construction/erection activities. Arctic Camps would contract any required services locally (e.g., electrical, carpentry).

Use of the camp would impact upon the City of Valdez in several ways. Although the city sewer system is adequate to handle the output from the greater than 3,000-person expansion to the camp, the water supply capability is currently insufficient to handle the additional demand. It would be necessary for the city to install a new well to supply the expanded camp.

Off duty construction workers would undoubtedly avail themselves of the goods and services offered in the City of Valdez. This would contribute economic benefit to the town over and above an expanded tax base. The increased population would stress other public services within the community, as previously discussed in section 4.11; however, at public scoping sessions in Valdez, city representatives expressed confidence in the city's capability to handle the influx of people associated with construction, citing their previous experience with both the Alyeska construction and the Exxon Valdez cleanup as examples. Further, in the case of the cleanup, the influx was unexpected and uncontrollable.

The presence of as many as 4,000 single status workers could result in increased pressure on the area's natural resources, in the form of hunting and fishing during off-shift hours. Bear poaching has been a problem identified in remote construction camps, but should be less so with the camp located in an urban environment. Robe Lake is a waterfowl nesting area and is within 4 miles of the Valdez camp site. Encroachment by humans during the critical spring period could affect nesting success. Worker education regarding the sensitivities of the local environment and resources would limit the potential for negative impact from these avenues.

Use of the Valdez camp would affect local transportation since convoys of buses, reaching a peak of 40 in year 5 (to transport roughly 2,000 workers), would make their way from the camp, south along the Richardson Highway and then along the Dayville Road to the Alyeska Marine Terminal property. These roads are heavily used by local traffic and particularly so during the summer tourist season. With two full shifts operating at the construction site, there would be three inbound (i.e., camp to site 7 a.m., 3 p.m., and 11 p.m.) and three outbound (i.e., site to camp 8 a.m., 4 p.m., and midnight) transits per day 1/. The

1/ Scheduling approximate only. The 8 a.m. outbound and 11 p.m. inbound convoy buses would be empty.

TABLE 4.16-1

Summary of Impacts of the Alternative Camp Site at Valdez

Affected Environment	Valdez Camp Site	LNG Site Access Road Via Alyeska Marine Terminal
Geology and Soils	• erosion and sedimentation control achievable with standard practice • flat gravel outwash from Valdez Glacier requiring little grading	• cut and fill for road bed preparation of 3.0 miles of road over moderate terrain
Water Quality	• no major waterbodies on site • erosion/sedimentation control achievable with standard practice • wastewaters discharged to city sewers	• potential sedimentation during stream crossings at Sawmill, Salmon, and Seven Mile Creeks
Fisheries	• no impact on habitat but there may be increased fishing pressure from offshift workers	• Sawmill Creek, Salmon Creek, Seven Mile Creek crossings required. Schedule May to July to avoid spawning/incubation for pink and chum salmon. • use bridges crossings
Vegetation/Wetlands	• minimal loss; grass and shrub vegetation only • no wetlands (site very well drained)	• only 1 mile of road alignment is new (off right-of-way), requiring clearing of extra 9 acres of predominantly spruce/hemlock/alder forest; minor impact • some small wetlands may be filled
Wildlife	• minimal habitat loss but potential for increased hunting pressure or poaching • potential disturbance of Robe Lake waterfowl nesting	• disturbance of resident wildlife from noise during construction of road and potential increase in road kills during transit periods
Endangered and Threatened Species	• none known or likely	• none known but bald eagles possible (need survey)
Air Quality	• no significant new emissions sources	• minor emissions from bus traffic
Noise	• minor impact expected	• minor noise from bus traffic
Land Use	• compatible with current and adjacent land uses since only involves expansion of existing camp	• infringement on Alyeska operations during bus transit through Alyeska Marine Terminal • most of the road (2.0 of 3.0 miles) is within pipeline right-of-way
Recreation	• some competition of workers with local residents but camp would have its own recreation facilities to lessen infringement • outdoor recreation (hunting, fishing, hiking) would be infringed upon	• no impact expected since road would not be open to the public during construction or operation
Visual	• minor impact expected	• minor visual impact as road would be at low elevation and should not require massive rock cuts

TABLE 4.16-1 (cont'd)

Affected Environment	Valdez Camp Site	LNG Site Access Road Via Alyeska Marine Terminal
Socioeconomics	• economic benefit to City of Valdez with worker and camp purchases of goods and services • employment for camp operations • city would have to drill another well to meet water demand • minor impact on city services but can be planned for	• disruption to Alyeska Marine Terminal requiring increased security and site traffic or scheduling changes
Transportation	• bus convoys during shift changes on Richardson Highway and Dayville Road	• temporary interference with local and tourist traffic on Richardson Highway and Dayville Road during shift changes
Subsistence	• no impact expected	• no impact expected
Cultural Resources	• no impact expected	• no impact expected

roads have the capacity to handle the additional traffic but there would be some intermittent inconvenience to regional travelers during the shift changes.

From the worker's perspective, the Valdez camp site is conveniently situated to allow privacy without isolation. Travel out of Valdez would be facilitated by the camp's proximity to the airport and the Richardson Highway. Travel to the Anderson Bay work site would be via a company-owned fleet of buses, which would take a fresh shift of workers directly from the camp to the construction site in about a half hour, returning with the offshifting crew. At the end of the last shift the buses would return to the construction site empty, to bring the crew back to camp.

Visually, the Valdez camp site would be unobtrusive, being located well off Richardson Highway and with no residential neighbors. The facilities would consist of single or two-story structures and visual barriers in the form of berms or vegetation could be used to ensure privacy for the camp residents as well as for the passing public.

Access Road

Although public roads can be used to convey workers as far as the Alyeska Marine Terminal, this alternative would necessitate the crossing of the Alyeska property and the construction of an additional 3.0 miles of all weather road (the western 2.0 miles of which would be within the proposed pipeline right-of-way) extending from the end of the existing Alyeska road on the western edge of the Alyeska Marine Terminal, to the Anderson Bay site as described in section 2.3.1. The out-of-right-of-way road alignment, shown on figure 2.3.1-2, could follow the 100-meter contour for the most part and would therefore require only modest cut and fill to achieve gradients suitable for bus traffic. The moderate slopes would allow standard erosion control practices to be used.

Assuming a 75-foot clearing requirement, this length of road would require the clearing of approximately 9 acres of forested land, typical of the spruce hemlock habitat within the area. The impact of this loss is not considered to be significant. Although unconfirmed, the presence of small wetland areas along the alignment is likely. If they could not be avoided, they would require delineation and the preparation and approval of mitigation plans prior to construction. It is also possible that bald eagles could be present as they are known to nest in the region.

The access road alignment requires the crossing of Sawmill, Salmon, and Seven Mile Creeks. All three of these streams are known to be used by spawning pink and chum salmon. Bridge crossings would be required and would be scheduled for construction during the May to July timeframe, outside of the spawning and incubation period. The actual location of the crossings should be selected so as to avoid the most critical reaches, as identified in stream surveys prior to construction.

Use of this access route, once constructed, would impact upon the Alyeska Marine Terminal operations. The six daily bus transits of Yukon Pacific construction workers would interrupt activities at the Alyeska site. Close coordination between the two companies would be necessary to minimize disruption and to safeguard security. Figure 4.16-1 plots the expected number of buses in each convoy through the 8-year construction period. It follows the projected peak workforce requirements. The actual transit time for a convoy, once past the terminal gate security, would be less than 10 minutes (based on a maximum peak workforce using a 40-bus convoy, traveling at 20 miles per hour). The scheduled crossings (three

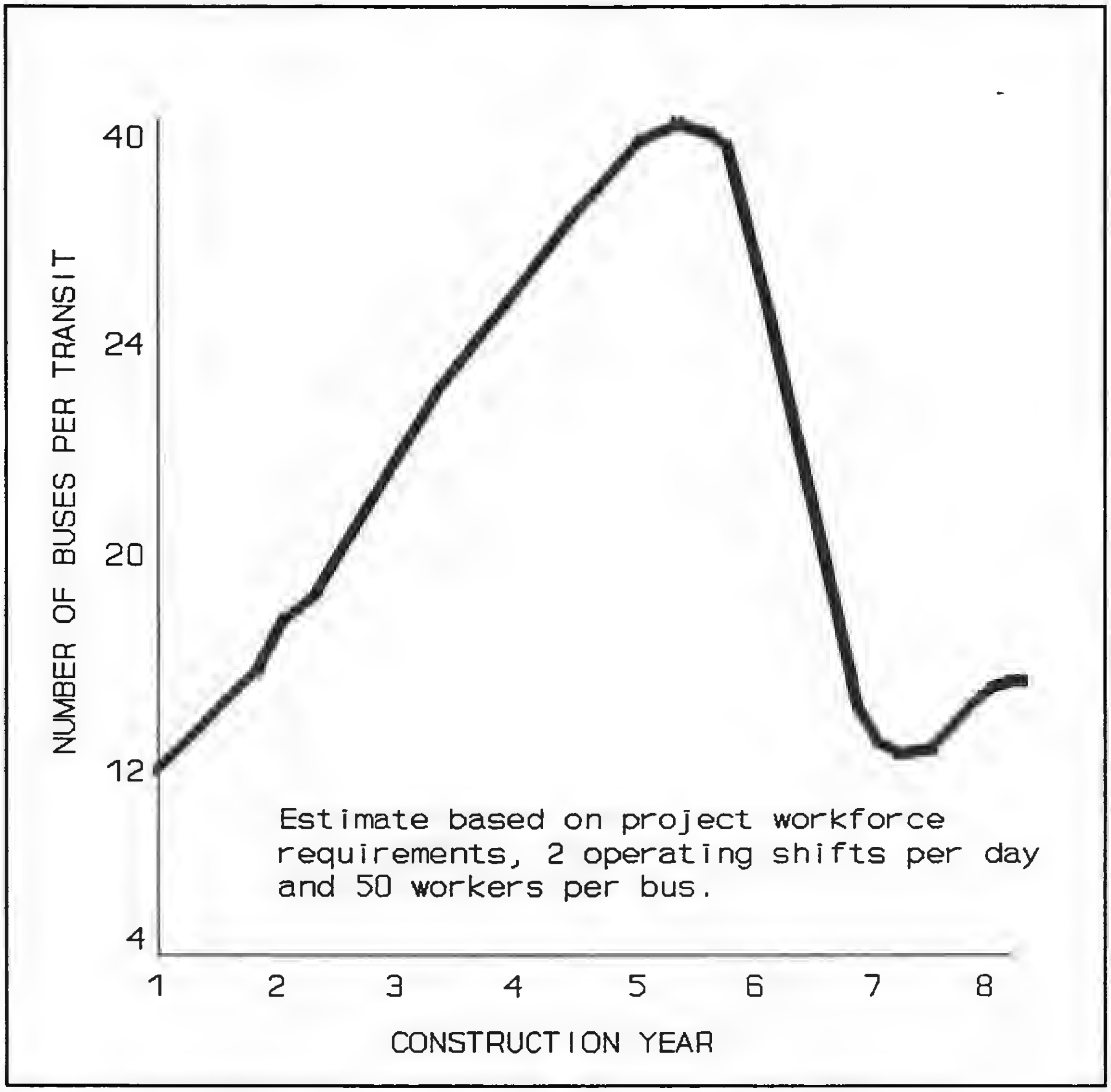


FIGURE 4.16-1 **Anticipated Bus Movements**

eastbound and three westbound) would have to be carefully controlled and would be limited to those required for construction shift changes. Scheduling would have to accommodate Alyeska's anticipated traffic needs. All other Yukon Pacific construction movements of personnel, equipment, and materials to the Anderson Bay site would be via marine transport. The overall impact on the Alyeska operations would thus be limited to whatever security improvements would be needed and to whatever traffic limitations would have to apply during the six, 10-minute transits, to avoid conflict. An agreement on emergency access and egress would also require articulation.

The largest obstacles to this alternative would be the potential disruption to Alyeska's operations during Yukon Pacific's shift changes and the potential impact on security within Alyeska proper, a matter which Alyeska takes very seriously. There are also legal and other institutional questions which would also have to be resolved with respect to requiring Alyeska to grant access through its property and compensation. None of these latter issues have been addressed by any of the parties and the FERC staff is seeking specific comments concerning these issues, particularly from Alyeska.

Comparison with Seven Mile Creek Camp Site

Table 4.16-2 summarizes the comparative environmental and social consequences ascribed to the two options. The Seven Mile Creek site restricts the physical impacts to what is now a wilderness area, with a specific acreage of forest being transformed through grading and clearing, to temporary camp use. Site access is not an issue. The Valdez option expands upon an existing land use for the camp itself, but access to the construction site becomes a key feature, necessitating the 3.5 miles of new road through currently forested terrain. Since the camp is a commercial venture, it remains in place at the owner's discretion.

There is only one waterway affected significantly by the onsite camp—Seven Mile Creek, which would be impounded to provide the camp water supply. With the Valdez camp, this impoundment would not likely be necessary, as industrial and non-potable water demands at the construction site could be satisfied by direct withdrawals from Seven Mile or Nancy Creek and/or by desalination (see table 4.16-3). Bottled drinking water could satisfy potable needs for a non-resident workforce. The access road would, however, necessitate three stream crossings. The impact of the crossings could be limited by construction timing and the limitation of in-stream activities.

If the workforce is housed at Seven Mile Creek, they are forced by limitations in access, to spend the majority of their offshift time in the camp, or in the wilderness environment surrounding it. The latter can lead to undesirable pressure on the local fisheries and wildlife or to encounters with bears, as discussed in section 4.4. If the workforce is housed in Valdez, the recreational opportunities available to them are less limited, but the infringement is felt by the residents of the community. Community representatives expressed no concern about the city's ability to cope with additional burdens on infrastructure or services, imposed by the large influx of workers and recognized the economic advantage of providing the necessary goods and services.

Visually, the Seven Mile Creek camp site would be conspicuous. Even if the buildings were dismantled and removed following completion of the construction, the tailored configuration of the slope adjacent to the Creek would remain visible permanently, contributing incrementally to the overall visual aesthetics of the LNG facility. The Valdez camp site is not highly visible.

A major distinction between the two camp site options, is the impact on the operations at the Alyeska Marine Terminal. With the Seven Mile Creek site, the oil terminal would be unaffected in any direct way, by the construction of the LNG facility. Obviously the transit of buses through Alyeska's property, as the most expedient access option for worker shift changes at the LNG site, would affect security and traffic movements at Alyeska at its existing level of production.

From the construction workers' perspective, housing onsite would minimize travel time to and from the workplace but would impose social isolation. Housing in Valdez would foster stronger interaction with the community but would add an extra hour of travel to each work day.

TABLE 4.16-2

Comparative Environmental Impacts of Construction Camp Alternatives

Affected Environment	Seven Mile Creek	Valdez with Road Access
Geology and Soils	• cut and fill .175 million yds^3	• no cut and fill for camp; modest for road
Freshwater Quality and Supply	• dam and 3.5-acre reservoir on Seven Mile Creek	• City of Valdez water supply from well source. Road crossings of Seven Mile, Salmon, and Sawmill Creeks.
Freshwater Fisheries	• impoundment of Seven Mile Creek with flow regulation downstream (potential positive impact during low flow) • fishing pressure on eight creeks within project area	• road crossings of three salmon creeks would have to be carefully scheduled • fishing pressure on streams in vicinity of Valdez
Vegetation	• 47 acres forest cleared for camp	• 9 acres forest cleared for road
Wetlands	• none	• potentially some small wetlands could require filling along 3.0 mile access road route
Terrestrial Wildlife	• forest habitat loss - minor impact • hunting pressure on wilderness • bear/human interaction (risk high)	• forest habitat loss - minor • hunting pressure near Valdez • low risk bear encounter • Robe Lake waterfowl • road kill along access road
Marine Water Quality	• minor impact during dam construction	• no impact
Marine Wildlife	• no impact	• no impact
Endangered and Threatened Species	• no impact	• no impact
Noise	• minor impact	• minor noise from bus traffic
Land Use	• conversion of 47 acres forest to camp • 3.5-acre reservoir • 0.17 mile stream inundated	• expansion of current land use • no clearing for camp, 9 acres clearing for road
Recreation	• minor impact from competition of offshift workers for limited recreation resources in Valdez	• more competition for recreation resources, particularly outdoor recreation
Visual	• camp very visible from Port Valdez but could be dismantled post construction	• not visible; commercially reusable
Socioeconomics	• local employment for camp construction and operation • economic benefit to Valdez through purchase of goods and services for camp • economic benefit from worker purchases • no impact on Alyeska Marine Terminal operations	• local employment for road construction • employment for camp operation • economic benefit to Valdez through purchase of goods and services for camp • camp is commercial operation; therefore, remains in place • pressure on Valdez infrastructure and services—considered minor • significant impact on Alyeska Marine Terminal operation

TABLE 4.16-2 (cont'd)

Affected Environment	Seven Mile Creek	Valdez with Road Access
Transportation	• marine transport of workers—minor increase in Port traffic	• bus traffic to and from construction site • increased traffic in Valdez
Subsistence	• no impact	• no impact
Cultural Resources	• no impact	• no impact
Worker/Management Perspective	• isolated from community • minimal travel time to and from work • maximum management control of workforce and schedule	• proximity to City of Valdez for recreation, goods, and services • half hour bus ride to and from work • less management control

TABLE 4.16-3

Water Requirements Without Camp Site at Seven Mile Creek

	7Q10 Nancy Creek (cfs)	7Q10 Seven Mile Creek (cfs)	Average Seasonal Water Requirements (cfs) Industrial	Other a/ Non Potable	Total
Winter					
December	0.1	0.3			
January	0.1	0.2			
February	0.1	0.3	0.0588	0.0309	0.0897
March	0.1	0.2			
April	0.2	0.6			
Summer					
May	2.4	6.2			
June	9.3	26.9			
July	4.9	14.8			
August	2.0	6.0	0.0495	0.1238	0.1733
September	1.4	4.2			
October	0.6	1.9			
November	0.3	0.9			

a/ Assumes 20 gpd per person and summer maximum of 4,000 workers, winter maximum of 1,000 workers.

In conclusion, the principal negative features associated with the proposed Seven Mile Creek camp site include:

- the clearing of 47 acres of coastal spruce/hemlock forest compared to only 9 acres for the access road for the Valdez camp site. However, 47 acres represents only 13 percent of the total spruce/hemlock forest to be cleared within the construction limits of the site and is even less significant when compared with the Port Valdez forest area.

- the construction of a 3.5-acre dam on Seven Mile Creek. However, this may be partially offset by the potential for the dam to maintain minimum stream flow rates to support salmon spawning.

- the clearing and grading of the gorge at the outfall of Seven Mile Creek. However, the staff has recommended that clearing be minimized within 100 feet of the streambanks.

The principal negative features associated with the Valdez camp site are related to the access road required to transport workers to the site:

- construction of 1 mile of new access road and converting 2 miles of TAGS right-of-way to a commuter access road partially through Alyeska. However, the operational requirement for an all-weather emergency access road may partially offset the impact.

- the potential disruption of 6 daily convoys with up to 40 buses on Alyeska security and plant operations, as well as on local and tourist traffic on the Richardson Highway and Dayville Road.

Based on the above, the information presently available does not support a finding that either the impact of the proposed Seven Mile Creek camp site is unacceptable or that the Valdez camp site is a significantly superior alternative. However, we remain open to new information and are seeking serious comments from those who would be affected and from anyone else who can provide constructive ideas.

4.17 CUMULATIVE IMPACT

Cumulative impact results when impact associated with a proposed project is superimposed on or added to impact associated with past, present, or reasonably foreseeable future projects within the area affected by the proposed project. Although the individual impacts of the separate projects might be minor, the additive or synergistic effects from all the projects could be significant. Generally, we believe that cumulative impact could result only from the construction and operation of other projects in the same vicinity and timeframe as the Yukon Pacific LNG Project. To identify other projects presently being constructed or planned for construction within the project area, we contacted the City of Valdez. It reported that there are no projects that are presently being constructed or planned.

Past projects (already in place) in the area affected by the proposed project, include the southernmost segment of the TAPS pipeline and Alyeska Marine Terminal completed in 1977 and Petro Star Refinery completed in 1993. In addition, the southern segment of the TAGS pipeline would be constructed within the timeframe of the LNG facility construction. The impact of its construction and operation is documented in the TAGS FEIS. In the context of the entire TAGS project, the Anderson Bay export site is merely the end point of an 800-mile-long pipeline and related production facilities.

This EIS provides a detailed environmental analysis of the proposed LNG facilities and our recommendations to mitigate environmental impact. In each case, the site resources and marine environment affected by the proposed facilities would be relatively small and no scarce or critical resource would be affected. Selection of the alternative camp site near the Valdez Airport would not result in any construction-related cumulative impact different from developing the proposed camp site at Seven Mile Creek. There are no other past, present, or reasonably foreseeable projects whose construction would result in significant cumulative impact when added to the construction impact of the Yukon Pacific LNG Plant.

Operation of the Alyeska Marine Terminal, Petro Star Refinery, and proposed LNG Project would have cumulative impacts on air quality, socioeconomics, recreation and visual resources, and public safety and marine environment.

Air resources could be potentially affected by the cumulative effects of operation of the proposed LNG facilities, Alyeska Marine Terminal, and Petro Star Refinery. Table 4.17-1 shows estimated and permitted emissions. The proposed LNG facility would increase NO_x and CO emissions most in the Valdez area while less significantly increasing VOC, PM_{10}, and SO_2

emissions. Both Alyeska and the Petro Star Refinery are completed or nearing operation and have the necessary state operating permits. Issuance of the required permits implies the associated impact is acceptable. The Yukon Pacific LNG plant would comply with Alaska Air Quality Control Regulations. No significant cumulative effect would be allowed.

TABLE 4.17-1

Permitted and Estimated Emissions (tpy)

Pollutant	Alyeska Marine Terminal a/	Petro Star Refinery a/	Anderson Bay LNG b/	Total
NO_x	1,732	70	2,528	4,330
CO	76	13	780	869
VOC	57,296 c/	70	374	57,740
PM_{10}	296	3	256	555
SO_2	1,043	40	89	1,172

a/ Permitted emissions.

b/ Estimated emissions.

c/ VOC emissions from tanker filling operations are 56,110 tpy.

Cumulative operational impacts associated with the local and regional economy in the project area would be positive. The project would add 200 to 300 permanent jobs in the Valdez area. This could have the effect of maintaining employment levels as Alyeska operations phase down and result in more efficient utilization of infrastructure. Declining tax revenues would be offset by LNG plant property taxes.

Cumulative impact would be associated with recreation and visual resources. The LNG facility at Anderson Bay could provide a point of interest for tourists to Port Valdez and tour opportunities. This would be similar to the current situation at the Alyeska Marine Terminal resulting in a beneficial but minor cumulative impact. The addition of the LNG plant to the existing refineries would result in furthering the change in the character of Port Valdez to a modern industrialized port. Although the overall visual impact of each facility may not be significant, the cumulative effect on the landscape quality of Port Valdez would have a moderate adverse impact.

The cumulative risk to public safety and marine environment would be associated with collisions between LNG tankers and oil tankers and the additive effect of shipping operations. Vessel traffic in Prince William Sound is controlled by the Coast Guard through a comprehensive set of regulations. The State of Alaska imposes additional requirements. The increase in total tanker traffic from an average of 2.5 to 3.25 per day is believed to be well within the limitations of the Coast Guard's VTS system. Other impact on the marine environment would be related to shipping operations such as introduction of foreign organisms in ballast water, leakage of diesel fuels during loading operations, and collisions with marine mammals, and would be minor.

As a result of the analysis included in this EIS, mitigation measures have been identified and recommended to reduce or avoid environmental impact associated with construction of the Yukon Pacific LNG Project. We believe that impacts associated with past, present, or reasonably foreseeable future projects which could be identified would not result in significant impact when added to the impact of the Yukon Pacific LNG Project.

5.0 FERC STAFF'S CONCLUSIONS AND RECOMMENDATIONS

The conclusions and recommendations presented herein are those of the staff of the Federal Energy Regulatory Commission (FERC or Commission). This Draft Environmental Impact Statement (DEIS) evaluates the environmental impact associated with the construction and operation of the facilities that would be required to liquefy pipeline natural gas, store the liquefied natural gas (LNG), and to export it via LNG tankers to various Asian Pacific Rim countries. These facilities have been proposed to be constructed and operated by Yukon Pacific Company L.P. (Yukon Pacific) as part of the Trans Alaska Gas System (TAGS) pipeline project and involve only those facilities that are associated with the site of export.

Information provided by Yukon Pacific and further developed from data requests, field investigations, literature research, alternatives analyses, and contacts with Federal, state, and local agencies and individual members of the public indicates that construction of the proposed Yukon Pacific LNG Project would result in a limited adverse environmental impact during construction and operation. As part of our analysis, we have developed specific mitigation measures, including additional studies and field investigations, that we believe to be appropriate and reasonable for the construction and operation of the LNG production and shipping facilities to proceed. We believe that these measures would substantially reduce the environmental impact that would result from construction and operation of the project and ensure the safety of the facility as proposed. Where additional studies or field investigations are recommended, significant impacts that are identified would either be avoided or mitigated to non-significant levels. We have concluded that if this project is constructed and operated in accordance with our mitigation recommendations, it would be an environmentally acceptable action. We are therefore recommending that our mitigation measures be attached as conditions to any authorization issued by the Commission.

5.1 SUMMARY OF THE STAFF'S ENVIRONMENTAL ANALYSIS OF THE PROPOSED ACTION

With implementation of our recommended mitigation measures, the stability and erosion of soils and overburden materials should not significantly affect construction or operation. The extensive excavation proposed for the site would remove and relocate 3,018,000 cubic yards of overburden and 6,655,000 cubic yards of rock. During construction these materials could be susceptible to slumping and erosion. Slumping can be controlled and should not pose serious adverse effects. Excavation of the benches could affect bedrock stability of the cutslope at the back of the site. Yukon Pacific proposes to install rock bolts in these walls. It also plans to dewater the bedrock using weepholes. These actions would minimize the potential for bedrock instability.

Considering that 392 acres of the site would be exposed, the potential for soil erosion during construction is high. Yukon Pacific has filed an Erosion Control Best Management Practices Manual (BMPM) and has indicated that a detailed site-specific erosion and sediment control plan that conforms to the BMPM will be submitted prior to construction. That plan would detail site preparation, slope stabilization, channel control, sediment retention, and revegetation. To ensure preparation of an adequate plan, we have recommended site-specific drawings and procedures be included in the plan specifying the number, size, and placement of erosion control structures; areas that would be revegetated; seedmixes, and mulching methods. We have also recommended that a full time environmental inspector be onsite during construction to ensure compliance with the erosion control plan and all other recommended mitigation measures. Impacts on soil and those caused by erosion would be minimized by implementing the measures in the BMPM and our recommendations.

The steep slope behind the facility may direct snow avalanches into the rear of the site. Only facilities on the southern edge of the cargo dock may be in the path of one identified snow avalanche path (path No. 3). Further evaluation of this path has been recommended prior to completion of final design. Final design for structures in its vicinity would incorporate mitigation for the potential effects of this avalanche path.

There is a significant probability that the project would experience severe earthquakes during its lifetime. The project area has the potential for being affected by some of the largest earthquakes recorded in North America. The primary areas of concern are surface faulting, shaking of structures, soil liquefaction, and seismically induced waves.

There are no active faults on the site. All of the significant faults in the area are related to ancient ruptures. As a result, the major seismic concerns are shaking of structures, liquefaction, and seismically induced waves.

Once the appropriate design level earthquakes are chosen, the design to protect facilities against earthquake shaking is relatively straightforward. We have recommended some slight modification to the design parameters proposed by Yukon Pacific, and we believe the modified design would afford the facility an adequate level of protection.

For those facilities that are placed on natural soil there are significant hazards from soil failure by liquefaction. Critical facilities would not be placed on natural soils.

Seismically induced waves are a major concern for the marine terminal portion of the facilities, not because they present insurmountable design problems for the terminal facilities, but because it would be difficult to protect tankers at berth from wave damage. The rest of the plant site is at high enough elevation that there should be little potential from damage with proper mitigation.

We believe that this site satisfies the seismicity-related siting criteria in the U.S. Department of Transportation's (DOT) LNG regulations. However, there are a number of details of design that have not been fully addressed or finalized by Yukon Pacific, and which we believe must be reviewed before they are finalized. A number of these details relate to the type of storage tank that is ultimately chosen. Therefore, we have included recommendations that the Commission be provided the opportunity to review and approve design details and the basis for them.

Key impacts on freshwater and water quality include the potential for increased nearshore turbidity from construction and fill activities, localized temperature effects within mixing zones of the desalination and Heat Recovery Steam Generator (HRSG)/Blowdown discharges, and water supply concerns. Grading activities are expected to cause significant short-term impact on Nancy, Terminal, Strike, and Short Creeks due to turbidity increases and rechanneling. Terminal Creek and the associated pond would be permanently lost as natural waterbodies. A detailed water balance and design supply analysis of streamflow requirements has also been recommended in connection with the proposed dam as a water supply on Seven Mile Creek. A Spill Prevention, Containment, and Control Plan as well as a site-specific

Erosion and Sediment Control Plan have also been recommended to ensure that best management practices are followed to minimize impact on water quality.

Overall, there would be minimal impacts on resident fish resources because of their limited distribution at the site. Anadromous fish resources spawning in Nancy Creek would not be significantly affected if disturbance to the streambed is avoided or minimized and the runoff of fine sediments is controlled. The impacts on anadromous fish spawning in Seven Mile Creek are less clear because the flow patterns are not well understood. To identify these flow patterns and how they might be affected by water releases and the damming of Seven Mile Creek, we have recommended that Yukon Pacific, in conjunction with the Alaska Department of Fish and Game (ADFG), conduct an in-stream flow study. Once our recommended in-stream flow study has been completed, Yukon Pacific can coordinate with the ADFG to determine a flow regime to minimize impacts on spawning fish. Grading and clearing the banks would cause some disturbance of the streambed and increased runoff of fine sediments. If the disturbance and runoff are minimized by careful construction and adequate sediment and erosion control, the impacts would not be significant.

Construction and operation of the proposed LNG facility is not expected to have any significant impact on local wildlife. In the case of waterfowl, there is a general lack of suitable nesting habitat at the Anderson Bay site, so the birds are not present to be affected. Similarly, the intertidal zones of Anderson Bay provide only limited foraging habitat for shorebirds compared to elsewhere in the Port Valdez region due to the lack of mudflats and other shallow water areas. Although the project would reduce the intertidal habitat of Anderson Bay, the impact on shorebirds would be minimal.

The greatest concern for raptors relates to the potential disturbance of bald eagle nest sites. To minimize these impacts, we have recommended that Yukon Pacific conduct surveys for bald eagle nest sites in the year prior to the commencement of site activities and in each subsequent year and, if birds move into the site, that consultation with the U.S. Fish and Wildlife Service (FWS) and ADFG be undertaken to determine appropriate action. A variety of large ungulates and large predatory mammals occur within the Port Valdez area, but most in such low numbers in the vicinity of the project that adverse impacts are not expected. Indirect impacts could occur on mountain goats at Abercrombie and Sulphide gulches, 10 to 14 miles east of Anderson Bay, with the influx of the large construction workforce but would not be significant, given existing regulatory systems. Since both black and brown bears are known to inhabit the site, there is a potential for interaction between bears and people onsite. To reduce the potential conflict with bears at the site, we have recommended that Yukon Pacific develop a mitigation plan stressing worker education programs and bear-proofing waste disposal areas. Impacts on small mammals and furbearers would be minor, arising from the loss of forest habitat through site clearing and preparation.

Construction of the LNG site would require clearing of approximately 392 acres of vegetation, primarily consisting of mature coastal spruce and hemlock forest. This represents a relatively minor impact since this vegetation covertype is well represented in the areas surrounding Anderson Bay and Port Valdez. Secondary impacts related to clearcutting large tracts may occur. These include increased soil erosion, loss of wildlife habitat, and secondary loss of trees along the edge of the cleared area. Other impacts associated with clearing include potential sedimentation of surface waters due to loss of vegetation. To reduce this impact, we have recommended that a minimum 50-foot-wide natural vegetative buffer strip be maintained between all waterbodies, including marine waters, and construction areas.

Development of the site would also result in the direct loss of approximately 49 acres of estuarine and palustrine wetlands. Yukon Pacific has developed a mitigation plan, based on replacement or offset of the loss of wetland functional values. This mitigation includes rectification through repair or restoration, reduction or elimination of impacts through recovery and maintenance, and compensation for impacts through onsite and offsite replacement or substitution. In general, however, the U.S. Army Corps of Engineers (COE), National Marine Fisheries Service (NMFS), and U.S. Environmental Protection Agency (EPA) commented on the need for a thorough analysis of alternatives that would avoid the destruction of shallow intertidal areas, and the lack of information regarding successes and failures of other mitigation efforts that have been done in similar areas. Additionally, we believe that Yukon Pacific should have assessed the loss of subtidal wetland areas. Consequently, we have recommended that Yukon Pacific revise its wetland mitigation plan to include specific details incorporated from an extensive literature review of successes and failures in wetland mitigation in the Pacific Northwest, a discussion of monitoring and evaluation of mitigation after implementation, and mitigation for subtidal wetlands.

Construction of the Anderson Bay facility would impact the marine environment in several ways. Since estuarine spawning areas at the mouths of Seven Mile and Nancy Creeks are used by pink and chum salmon, these areas would be highly sensitive to changes in the flow regime. Salmon fry use protected, shallow intertidal areas in Anderson Bay. The project would fill approximately 35 acres of this habitat and create changes in the rocky intertidal and subtidal areas in the tanker berthing location and along the face of the cargo dock. Although salmon fry have been observed in this area, the importance of this area relative to other parts of Port Valdez and other habitat types has not been documented. Therefore, it is difficult to determine the degree of impact on these habitat types. As a result, we have recommended that Yukon Pacific conduct a study to determine the importance of this habitat and develop mitigation to minimize impacts on salmon rearing habitat.

The release of heated water from the desalination plant and HRSG/Boiler blowdown may impact the marine environment. To reduce this impact, we have recommended that Yukon Pacific utilize a dilution model to determine the final design of the diffusers and that the mixing zone allowance set strict limits on the vertical extent of the mixing zone in Port Valdez. Shock waves from underwater blasting may injure or kill fish which occur in the area. We have recommended blasting mitigation procedures to minimize the impacts.

Intertidal and subtidal construction, and blasting in the tanker docking area would cause long-term physical changes in bathymetry and benthic substrate. In the short term it is likely that intertidal and subtidal organisms and algae would be damaged, covered, or killed. Disruption of the rocky intertidal zone due to ice scour and extreme weather is common in Port Valdez. The intertidal marine community has adapted to this and tends to recover quickly. The subtidal community is subject to high rates of fine sediment deposition from glacial runoff. The benthos has adapted to this and areas covered by fill are unlikely to cause long-term impacts. The changes in substrate profiles and substrate types may cause changes in the benthic community, but since there is a low species diversity in Port Valdez, it is unlikely these changes would be significant. Finally, we have recommended additional restrictions to the proposed ballast water exchange procedures to further minimize the potential to introduce exotic species or organisms from other geographic areas into Prince William Sound and Port Valdez.

While several species of marine mammals have been recorded in Valdez Arm, only sea otters and harbor seals occur more than occasionally. The greatest potential source of impact to them during the construction and operation of the project is blasting. We have consequently recommended measures to ensure that marine mammals are not present at the time of underwater blasting.

No federally listed or proposed endangered or threatened plant or wildlife species have been reported in the vicinity of the Anderson Bay site. Although occasional transients of listed falcon species may occur in the area, we have determined that they would not be affected by the project. We have also concluded, with concurrence of the NMFS, that no federally listed or proposed endangered or threatened marine mammals would be adversely affected. A Biological Assessment was prepared and submitted to the NMFS as required under Section 7 of the Endangered Species Act.

The Anderson Bay LNG facility would have an impact on air quality in the project area during the 8-year construction period and a long-term impact from operation of the facility. At full capacity, the facility would emit approximately 2,528 tons per year (tpy) of nitrogen oxides (NO_x), 780 tpy of carbon monoxide (CO), 374 tpy of volatile organic compounds (VOC), 256 tpy of particulate matter (PM_{10}), and 89 tpy of sulfur dioxide (SO_2). Primary sources of emissions are gas turbine-driven compressors used in the liquefaction process, gas turbines used to generate steam and electricity, and the tankers docked at the facility plus flares and leakage from equipment. Dispersion modeling done with the most recent emission estimates and source parameters show that the facility will meet Prevention of Significant Deterioration (PSD) increments, National Ambient Air Quality Standards (NAAQS), and Alaska standards. When final equipment selections have been made, Yukon Pacific will perform more accurate dispersion modeling which will include other nearby sources and background ambient concentrations measured at the Alyeska Marine Terminal, to ensure that the facility would not cause violations of PSD increments, NAAQS, and Alaska standards. This modeling must be done for the facility to obtain any air emission permits from the Alaska Department of Environmental Conservation (ADEC).

The Anderson Bay LNG facility would increase noise levels in the vicinity of the site during both construction and operation. Anderson Bay is a remote area with the closest permanent buildings being part of the Alyeska Marine Terminal. The nearest noise-sensitive areas (NSAs) are Shoup Bay State Marine Park, approximately 3.7 miles northwest of the proposed LNG main utility building; a camping area north of Dayville Road and east of the Alyeska Marine Terminal's eastern gate, approximately 5.9 miles east; and residences in Valdez, approximately 6.1 miles northeast. Yukon Pacific's noise analysis predicted a 24-hour equivalent sound level (Leq(24)) of 46 decibels of the A-weighted scale (dBA) at the site's eastern property line. The resulting impact on all NSAs would be well below a day-night sound level (Ldn) of 55 dBA. This noise analysis was based on the assumption that exhaust stack noise levels would not exceed 85 dBA at 10 feet and no other plant equipment would exceed a noise level of 85 dBA at 3 feet, which does not agree with the design Noise Control Specification A-09. Therefore, we recommend that a revised noise analysis be filed once the actual equipment is selected and manufacturer's noise data are available, and a noise survey taken once the terminal is in service to ensure that noise impacts are below the 55-dBA Ldn limit at the NSAs.

The primary land use impact would be the conversion of 377 acres of spruce hemlock forest and shrub, and 49 acres of palustrine and estuarine wetland habitat to an industrial use.

In addition, public access would be restricted to the 2,500 acres of land which would constitute the site and buffer zone. Restricting access to the upland areas adjacent to the plant site would have little impact, due to the remoteness of the area. For safety reasons, there would be a large dispersion exclusion zone in which normal usage of outdoor areas would be limited to less than 20 people. We have recommended that Yukon Pacific prepare an outdoor activity usage plan to aid in optimizing outdoor land usage within the exclusion zone. The project would not conflict with any local comprehensive plans.

The proposed project would not have significant short-or long-term negative effects on recreation in the Port Valdez area, although during the construction period, the noise, dust, and activity could impact recreation in and near Anderson Bay and the popular Seven Mile Creek area. During operation, recreation would be limited in the upland areas adjacent to the plant site because of the buffer zone, and the dispersion exclusion zone would restrict outdoor activities within an approximately 2.5-mile radius of the site. Temporary increased demand on recreational facilities in the City of Valdez from construction personnel would occur but would not be great, with the greatest potential impact being on indoor facilities. This would be limited because the number of workers would be reduced dramatically during the winter when indoor recreational activity would be greatest.

The proposed project would permanently change the visual characteristics of a 2-mile stretch of the south shore of Port Valdez, by regrading the current rocky forested shoreline and forested backshore and constructing large industrial structures, which would contrast sharply with the environment. The overall impact is not considered to be significant however, because of the low number of possible viewing points and their distance from the site. We have recommended that Yukon Pacific prepare a visual mitigation plan which preserves the current shoreline and to develop appropriate landscape and architectural treatments to improve the aesthetic qualify of the facility.

The Yukon Pacific LNG Project would significantly increase total employment and population in the City of Valdez during construction and operation of the plant. Temporary impacts associated with construction would be more significant than permanent impacts associated with operation of the project because employment levels would be higher during construction. The increase in population associated with construction and operation of the project would lead to greater demands on public services, creating a need for additional teachers, doctors, police officer, and fire fighters. Housing demand would increase as workers and their families relocate to Valdez.

The project would stimulate economic activity in Valdez. Local businesses would experience an increase in demand for goods and services from Yukon Pacific. Workers and families would frequent local grocery stores, restaurants, bars, and other establishments. Property tax payments by Yukon Pacific would offset increased costs associated with additional public service needs and could finance further growth and development within the city.

The movement of goods, supplies, and people in and out of Valdez would increase because of the project. The port and boat harbor would be significantly affected because access to the project site would only be possible by water. The waterways, in and around Port Valdez, would experience an increase in barge, tanker, and large boat traffic. Road, highway, and airport traffic would increase, especially during summer months when construction activity would escalate and tourists visit the city. Port and airport revenues could rise with greater activity.

Impacts on subsistence use of area resources are anticipated to be minor. Project construction would have minor impacts on subsistence use on Port Valdez, Anderson Bay, and the surrounding land area. These areas receive minor subsistence use and Valdez residents, the greatest users of the area, are in a designated nonrural area (thereby qualifying as recreational rather than subsistence users). Populations of land mammals and fish would be minimally affected and increased competition would result from the addition of the direct and indirect construction workforce to the area population. Tatitlek residences would also experience minor impacts on fishery resources from increased competition with nonrural (Valdez) users during construction and operation. Increased competition with construction and operational workforces might require restrictions on nonrural residents' harvesting of subsistence resources. Fishery and marine mammal resources and related subsistence uses could be minimally affected from increased shipping in Prince William Sound and the increased potential for accidents.

No previously recorded or newly identified cultural resource sites were identified during background literature research or field studies, respectively. The Alaska State Historic Preservation Officer has reviewed the results of a 1990 cultural resource survey and concluded, and we concur, that the project would have no effect on properties on or eligible for the National Register of Historic Places.

The operation of the proposed LNG facility poses a unique hazard that could affect the public safety without strict design and operational measures to control potential accidents. The primary concerns are those events which could lead to an LNG spill of sufficient magnitude to create an offsite hazard.

The staff and its cryogenic consultants conducted a cryogenic design and technical review emphasizing the engineering design and safety concepts, and on the projected operational reliability of the proposed LNG facility and marine terminal. The review included a technical conference in Valdez on May 26, 1992, followed by a site inspection. Much of the technical data filed by Yukon Pacific reflects the initial conceptual design phase of the project. In a later phase, Yukon Pacific will develop the detailed design information necessary to assess the facility's adherence to the applicable standards, codes, and engineering practices. Considering that the material submitted by Yukon Pacific to the FERC is in the initial phase of design, none the less supplemental information is required before a more definitive assessment can be made on the adequacy of design and on the adherence of the design to various applicable standards, codes, and engineering practices.

The DOT regulations governing the siting of an LNG facility require the establishment of both thermal and flammable vapor exclusion zones to protect offsite land uses. While the thermal exclusion zone is either confined to the plant property or the immediate vicinity of the waters at the two LNG tanker docks, the dispersion exclusion zone extends northward more than 13,000 feet offshore into Port Valdez. Outdoor recreation areas at Anderson Bay and Seven Mile Creek—sport fishing during the summer months—are located within the dispersion exclusion zone. In order to demonstrate compliance with the dispersion exclusion zone, Yukon Pacific would need to ensure that normal usage in these areas is below 20 people when the terminal becomes operational. Although a finding of compliance with Part 193 will await the DOT's evaluation of Yukon Pacific's responses, the remote location of the site and lack of population in the plant vicinity should ultimately permit compliance with the siting requirements.

While LNG tankers have experienced safe operation without cargo tank spillage for more than 30 years, the possibility of a major LNG spill over the duration of the project cannot be discounted. The events most likely to cause a significant release of LNG cargo would be a grounding severe enough to penetrate the tanker's double bottom or collision with another vessel sufficiently large and with sufficient momentum to penetrate the double sides. Our analysis finds that: (1) given the present and planned Coast Guard controls in the Prince William Sound Vessel Traffic Service (VTS) Area, LNG tankers can safely operate in these waters, (2) the thermal radiation and flammable vapor cloud hazards from the maximum credible LNG tanker spill would not affect the general public, (3) although it is possible for an LNG tanker to spill cargo in a grounding type incident, the liquid would rapidly vaporize and would not have the long-term environmental consequences associated with a major oil spill, and (4) the addition of LNG tankers within the VTS Area would not have a significant increase on the percent potential of a collision with an outbound crude oil tanker.

5.2 SUMMARY OF ALTERNATIVES CONSIDERED

5.2.1 No Action and Alternative Sites

Alternatives considered that would avoid constructing the project at Anderson Bay include locating the project at another site and no action. The U.S. Department of Energy (DOE) previously concluded that the Valdez export site (Anderson Bay) is preferable to all other export sites that were considered in the TAGS Environmental Impact Statement (EIS) and disapproved all sites other than the Valdez site (DOE, 1989). Accordingly, further consideration of alternative sites is outside the scope of this DEIS. However, we have summarized and incorporated by reference the relevant sections of the TAGS Final Environmental Impact Statement (FEIS) on this issue. The no action alternative would avoid all of the environmental effects of the project, but would result in the entire TAGS Project, including the pipeline, not being built.

5.2.2 Alternative Construction Camp Sites

Yukon Pacific proposes to locate the construction camp along the bank of Seven Mile Creek. Several alternatives to the proposed construction camp at Seven Mile Creek were examined. After a preliminary screening, the three onsite alternatives were eliminated from further consideration because they offered no environmental advantages over the proposed onsite location. The offsite alternative at Valdez was considered in combination with three different access options. Two (ferry transport and road transport around the Alyeska Marine Terminal) were determined to be impractical but the third, road transport (north road) through the Alyeska property was carried forward for further consideration.

The analysis in section 4.16 compared the proposed camp site with the alternative camp site with access through Alyeska. The principal negative features associated with the proposed Seven Mile Creek camp site are:

- the clearing of 47 acres of coastal spruce/hemlock forest compared to only 9 acres to link the access road for the Valdez camp site. However, 47 acres represents only 13 percent of the total spruce/hemlock forest to be cleared within the construction limits of the site and is even less significant when compared with the Port Valdez forest area.

- the construction of a 3.5-acre dam on Seven Mile Creek. However, this may be partially offset by the potential for the dam to maintain minimum stream flow rates to support salmon spawning.

- the clearing and grading of the gorge at the outfall of Seven Mile Creek. However, the staff has recommended that clearing be minimized within 100 feet of the streambanks.

The principal negative features associated with the Valdez camp site are related to the access road required to transport workers to the site:

- construction of a new 3-mile commuter access road partially through Alyeska and the TAGS right-of-way. However, the operational requirement for an all-weather emergency access road may partially offset the impact.

- the potential disruption of 6 daily convoys with up to 40 buses on Alyeska security and plant operations, as well as on local and tourist traffic on the Richardson Highway and Dayville Road.

The analysis determined that the information presently available does not support a finding that either the impact of the proposed Seven Mile Creek camp site is unacceptable or that the Valdez camp site is a significantly superior alternative. However, we remain open to new information and are seeking serious comments from those who would be affected and from anyone else who can provide constructive ideas.

5.2.3 Alternative Disposal Sites

Construction of the proposed LNG facilities would require substantial excavation and benching of the bedrock. Although most of the rock and overburden materials produced during excavation could be used as structural fill on the site, the remaining surplus material would require disposal (see section 2.3.2). Yukon Pacific identified and evaluated six potential disposal sites—four entirely on land, one partially on land and in Anderson Bay, and one entirely in the deep water of Port Valdez. Three of the onshore sites were entirely within the boundaries of the proposed construction area. In addition to these alternative sites, we identified and evaluated two other disposal options which involved the use of multiple onshore and offshore sites and the utilization of the completed disposal Site B' (Yukon Pacific's proposed disposal site) for the construction of the proposed cargo dock facilities to reduce the overall impact on the shoreline and intertidal area of Anderson Bay.

None of the sites located entirely on land had enough storage capacity to store the excess volumes of waste material. Other factors, such as the potential to impact surface waters and the construction of new, offsite access roads further precluded these sites from being acceptable.

Although we evaluated offshore disposal opportunities, water quality considerations involving the uncontained openwater disposal of organic materials in Port Valdez have precluded us, at this time, from recommending these options. The materials to be disposed of would consist of both overburden and rock. Since the overburden waste material has been estimated to consist of up to 50 percent organics, we evaluated the option of segregating the rock and mineral portion of the overburden from the organic portion and disposing of the lesser total volume of organic material in two of the onshore disposal sites and the clean rock material offshore. We concluded, however, that even if we assumed that the overburden material consisted of only 30 percent organics, there would still not be sufficient onshore storage capacity to dispose of the organics, and offshore disposal of organic materials would still be required. Unless the EPA and the COE will approve this type of disposal in Port Valdez, we do not believe this to be a feasible alternative.

During our evaluation of the use of the proposed disposal Site B′ for the construction of the cargo dock, we identified several potential problems, including size and area constraints, the need for additional grading and filling of the Anderson Bay intertidal and shoreline areas, and the orientation of the cargo dock at Site B′ resulting in a more difficult, time consuming and possibly less safe approach and departure for barges and cargo ships. Additionally, Site B′ would be used during the last 5 years of construction as a storage and laydown area.

The most significant problem we identified for this alternative, and one that is very difficult for the staff to fully evaluate at this time, is that the grading and excavation schedule for development of the LNG site is scheduled to take up to 3 years to complete. Yukon Pacific has indicated that Site B′ would not be fully filled and developed for 3 years and consequently could not be used for construction of the cargo dock, since that facility is required to be in operation during the first year of construction.

While we recognize the constraints associated with the schedule of excavation of the site and the completion of filling of Site B′, in addition to the other disadvantages discussed above, the superior environmental benefits of this alternative when compared with the filling of 12 acres of intertidal wetlands associated with the proposed construction dock cannot be summarily dismissed. Therefore, we have recommended that Yukon Pacific provide a revised site grading and construction plan reflecting the use of Site B′, instead of grading and filling the proposed construction dock. Yukon Pacific should file this plan with the Secretary of the Commission during the comment period for this DEIS so it can be presented in the FEIS.

5.3 FERC STAFF RECOMMENDED MITIGATION MEASURES

To mitigate environmental impact associated with the construction and operation of the proposed Yukon Pacific LNG Project, we recommend that the following measures be included as specific conditions to any certificate issued by the FERC.

1. Yukon Pacific shall follow the construction procedures and mitigation measures described in its application and amendments (including responses to staff data requests) and as identified in the EIS, except as specifically modified by these certificate conditions. Any modification to these procedures, measures, or conditions must be requested in a filing with the Secretary of the Commission (Secretary) and approved in writing by the Director of the Office of Pipeline and Producer Regulation (OPPR) before use. Such modifications must be justified by site-specific conditions and provide an equivalent or greater level of environmental protection.

2. Yukon Pacific shall file with the Secretary detailed maps and aerial photographs at a scale not smaller than 1:6,000 identifying all staging areas, storage yards, new access roads, and any other areas that would be used or disturbed and have not been previously identified in filings with the Secretary. This includes any alteration to facility

locations previously filed. All areas shall be clearly identified and must be approved in writing by the Director of OPPR before construction in or near that area.

3. Within 30 days of the acceptance of this certificate, Yukon Pacific shall file an initial implementation plan with the Secretary for review and written approval by the Director of OPPR describing how each of the mitigation measures required by this Order will be implemented. Show the timetable for implementing each measure. File revisions to the plan as schedules change. It shall identify:

   a. how these requirements will be incorporated into the contract bid documents, construction contracts (especially penalty clauses and specifications), and construction drawings so that the mitigation required at each site is clear to onsite construction and inspection personnel;
   b. company personnel and contractors who will be provided copies of the appropriate material;
   c. what training and instructions will be provided to these personnel;
   d. the company employee (if known) and what specific portion of Yukon Pacific's organization will be responsible for compliance and what procedures (especially assessment of contract penalties) will be followed if noncompliance occurs;
   e. a Gantt or PERT chart (or similar project scheduling diagram), and dates for:

      (1) The completion of all required surveys and reports;
      (2) The mitigation training of onsite personnel;
      (3) The start of construction; and
      (4) The start and completion of restoration.

4. Yukon Pacific shall employ at least one independent environmental inspector responsible for monitoring and ensuring compliance with all mitigative measures, and for evaluating the construction contractor(s) in implementing the mitigation measures required in the contract (see condition 3 above). The environmental contractor shall be empowered to order correction of acts that violate the environmental conditions of the FERC certificate. In addition, the environmental inspector shall document compliance with the environmental conditions of this Order and maintain status reports. Yukon Pacific shall file updated status reports with the Secretary every 2 weeks.

5. Yukon Pacific shall prepare a site-specific erosion control and sedimentation plan that:

   - provides detailed procedures for controlling sediment from access road construction including the roadbed, cut and fill materials, culvert installation, and bridge installation;

   - provides detailed drawings that show the number, size, and placement of erosion and sediment control structures on the site;

   - provides detailed drawings which show the areas that would be revegetated and include a description of the seedmix, seeding methods, soil amendments, and mulching methods that would be used; and

   - shall be filed, together with comments of the appropriate state agencies (Alaska Division of Governmental Coordination, Alaska Public Utilities Commission, Alaska Department of Natural Resources (ADNR), and ADFG), with the Secretary for review and approval by the Director of OPPR prior to initiation of construction.

6. To avoid the potential for avalanche damage to facilities and hazards to personnel at the construction dock area, further field evaluation of avalanches on path No. 3 shall be undertaken prior to the development of final design in order to determine the need for mitigation.

7. All final seismic design plans and specifications shall be filed with the Secretary for review and approval by the Director of OPPR. The seismic design measures shall take into account the specific recommendations and results of studies specified below:

   i. The intracycle earthquake specified for facility design purposes shall be set at moment magnitude (M_w) 8.2.

   ii. The Maximum Design Earthquake (MDE) value for the effective acceleration be at least 0.6 gravitational force (g).

   iii. Yukon Pacific shall evaluate the adequacy of the long period levels of the proposed design response spectra using seismological modelling analyses to estimate directly the long period ground motion from postulated critical design earthquakes on the Aleutian megathrust and in the Yakataga Gap. A report on the methods, assumptions, and results shall be filed with the Secretary. The results of that analysis shall be incorporated into the seismic design, as appropriate.

   iv. The vertical design accelerations shall be set as equal to the horizontal accelerations for design purposes.

   v For all structures not directly supported by rock, design spectra for "competent soil conditions" as recommended by Newmark and Hall (1982) shall be used.

   vi. Yukon Pacific shall conduct a specific analysis of the duration of strong ground shaking likely to be experienced at the site as a result of the design earthquake, and document that the structures are designed to accommodate the ductility demand associated with the duration of the shaking. A report on the methods, assumptions, and results shall be filed with the Secretary.

   vii. Yukon Pacific shall file with the Secretary a discussion of each of the following issues, as the design of the facility progresses:

      - Unless there is clear and convincing justification for lesser values, the load combination factors specified in ASCE 7-88 (1990) shall be used.

      - Use of the calculated flat-roof snow load of 169 pounds per square foot in conjunction with earthquake loads appears to be conservative. This snow load corresponds to a mean recurrence interval of approximately 100 years and does not account for any load reduction due to snow slide-off on the steeper roof slopes. If the ASCE 7-88 (1990) load combination factors are used, then the design snow load with a 50-year recurrence interval could be used in conjunction with earthquake loads.

- The design load criteria shall account for the possibility of combined seismic and impounded fluid loading for the outer tank. This load combination could be critical for the so-called "double integrity" tank designs.

- Since snow load is one of the controlling design factors, the design basis for snow load shall be consistent with that for earthquakes. Therefore the design for maximum snow load shall use an annual failure probability of 10^{-4}.

- For the double integrity tanks, the secondary containment is not isolated from the primary containment, thus creating the potential for collapse of the outer tank as the inner tank fails. There does not appear to be a structurally independent impounding system.

- The detail for the joint between the floor of the double concrete wall tank needs additional development to assure proper function under strong ground shaking and possible differential movements and settlement of the tank footing.

- The behavior of the circumferential prestressing for the double concrete wall tank is unclear in the event of a wire failure due to corrosion or "missile" impact.

- Weathering effects on the bedrock formation could affect the rock anchors for the tank foundation and rock slopes in the project area.

viii. Yukon Pacific shall develop plans to consider and mitigate, to the maximum practical extent, the effects of damaging waves (especially those resulting from subsea landslides) on the marine terminal facilities and on tankers at berth.

xi. Yukon Pacific shall conduct an analysis of rock slope stability and potential effects of snow avalanches on the plant, especially under seismic conditions, and incorporate appropriate mitigative measures into the plant design and operation plans.

8. To clearly demonstrate water supply requirements for the proposed facilities, Yukon Pacific shall prepare, in consultation with the ADFG, and file with the Secretary, a detailed water balance and design supply analysis, prior to initiation of construction.

9. Yukon Pacific, in coordination with the ADFG and in conjunction with preparation of the detailed water balance and design supply analysis, shall conduct an in-stream flow study to determine the minimum flow requirements to minimize impact on spawning fish and maintain flow through Seven Mile Creek above the minimum levels. The study shall be filed with the Secretary, with the comments of the ADFG, for review and approval by the Director of OPPR.

10. Yukon Pacific, prior to commencing construction, shall develop and file with the Secretary for review and approval by the Director of OPPR a Spill Prevention, Containment, and Control Plan (SPCC Plan) that would describe the preventive and mitigative measures it would employ to minimize the impact associated with such occurrences. These measures shall include but not be limited to: requiring all fueling and lubricating to be done in areas designated for such purposes, with such areas to be located at least 100 feet away from all waterbodies; specifying collection and disposal procedures for wastes generated during vehicle maintenance; requiring each construction crew to have on hand sufficient supplies of absorbent and barrier materials to allow the rapid recovery of any spills; and development of standing procedures regarding excavation and offsite disposal of any soil materials contaminated by spillage. In addition, Yukon Pacific shall ensure that construction contractors are able to demonstrate to environmental, local, or state inspectors their ability to implement the SPCC Plan. The SPCC Plan shall also identify the types and quantities of hazardous materials that would be stored or used on the construction site.

11. To document compliance with Federal and state stormwater discharge requirements, Yukon Pacific shall develop a stormwater monitoring plan. This plan shall be developed in conjunction with the new National Pollutant Discharge Elimination System (NPDES) stormwater permit requirements that will be imposed under Section 402 of the Clean Water Act (40 CFR Part 122.26(c)(ii)). This plan shall be prepared in conjunction with the site-specific Erosion and Sediment Control Plan and shall provide a detailed description of the stormwater collection and treatment process, including best management practices to control pollutants in stormwater discharges during both construction and operation. These plans shall be filed with the Secretary, and provided to the EPA as part of the documentation with the NPDES permit application.

12. To prevent potential disturbance of the limited anadromous and resident fish habitat in Nancy Creek, the cargo dock access road crossing shall be made above a small falls which may currently be acting as a fish barrier.

13. To minimize impacts due to siltation on spawning gravels and incubating redds from construction and from road runoff, (1) all in-stream construction shall be limited to the period between May 1 and July 15 when there are no spawning fish or incubating redds present, and (2) sediment traps shall be placed along the road to prevent fines from running off into the stream. To prevent loss or disruption of habitat, there shall be no other in-stream construction activity or in-stream equipment crossing or fording the streambed at any time. Any temporary crossing structures shall be limited to portable construction bridges or crushed, clean rock and culvert bridges.

14. No construction equipment or in-stream activity shall occur in the area of Seven Mile Creek below the falls and any in-stream construction or activity which may cause siltation (above and below the falls) shall be scheduled between May 1 and July 15 when there are no salmon or incubating redds present in the stream.

15. Yukon Pacific shall prepare a revised site plan that avoids grading and clearing the riparian zones within 100 feet of the streambanks along Seven Mile Creek above the proposed dam. The revised plan shall also avoid grading and clearing to preserve the gorge area surrounding the water falls and the associated intertidal shoreline area located on either side of the confluence of Seven Mile Creek and Anderson Bay. The revised plan shall be filed with the Secretary for review and approval by the Director of OPPR.

16. Yukon Pacific shall conduct surveys for bald eagle nest sites during the year prior to the commencement of site activities and each year subsequently, to determine nesting activity at the site. If active nests are found, Yukon Pacific must consult with the FWS and ADFG to ensure the project does not violate the Bald and Golden Eagle Protection Act.

17. To reduce the potential conflict with bears at the site, Yukon Pacific shall develop and file with the Secretary, for review and approval by the Director of OPPR prior to initiation of construction, a mitigation plan which details procedures for avoiding bear/human conflicts. This plan shall stress implementation of an education program for workers, in addition to methods of bear-proofing the site, especially the waste disposal area.

18. Yukon Pacific shall maintain a natural, uncleared vegetative buffer strip at least 50 feet wide between construction areas and waterbodies. Yukon Pacific shall indicate the location and size of these buffer strips on its final site plans that would be filed with the Commission prior to construction. Where Yukon Pacific believes maintenance of a 50-foot-wide buffer strip would be infeasible, Yukon Pacific shall file with the Secretary for review and approval by the Director of OPPR prior to construction a detailed explanation of why the required buffer strips cannot be maintained. Yukon Pacific shall include with this explanation a description of alternative sediment control measures that would be employed on a site-specific basis instead of maintaining the vegetative buffer strip.

19. Yukon Pacific shall file with the Secretary for review and approval by the Director of OPPR prior to construction a revised wetland mitigation plan that contains the following:

- identification of, and proposed mitigation for, all the subtidal wetlands that would be affected by the site's development;
- a detailed literature review of the other wetland mitigation projects that have been conducted in the Pacific Northwest, including a summary of the successes and failures of these projects;
- site-specific construction plans that incorporate information learned from the literature review regarding how the proposed mitigation would be implemented including detailed information regarding the key factors that are known to influence the success of wetland construction (e.g., elevation, substrate, hydrology);

- details regarding how the proposed wetland mitigation would be monitored and evaluated following construction to ensure its success; and

- written comments from the Joint Pipeline Office (JPO), COE, NMFS, and EPA on Yukon Pacific's revised wetland mitigation plan.

20. Yukon Pacific shall use a dilution model to design the diffusers for the high temperature of the desalination and HRSG/Blowdown discharges, and determine the vertical extent of the mixing zone so that the surface and bottom thermal layers of Port Valdez are not subject to periodic surges of hot water.

21. Yukon Pacific shall require ballast water discharge/exchange at least 10 kilometers south of Hinchinbrook Entrance in addition to its proposed 36-hour period.

22. Yukon Pacific, in conjunction with the ADFG and FERC, shall develop and conduct a salmon fry utilization study, designed to determine the importance of the nearshore areas affected by plant construction relative to other areas in Port Valdez. This study along with proposed mitigation shall be submitted to the ADFG and filed with the Secretary for review and approval by the Director of OPPR to determine if the proposed mitigation measures would be effective or whether additional mitigation measures are required.

23. Yukon Pacific shall prepare a blasting plan that considers the following measures: (1) scare charges and/or bubble curtains to move resident fish away from the area prior to blasting, (2) coordination with the ADFG and the Solomon Gulch hatchery personnel to avoid blasting activities when adult or juvenile salmon are likely to be in the area, and (3) use of spotters or lookouts, to ensure marine mammals are not present within the zone of influence prior to blasting.

24. Yukon Pacific shall consult with the EPA, ADFG, and NMFS to determine the allowable location, frequency, and duration of warm water discharges into Port Valdez.

25. Yukon Pacific shall file a copy of all air emission permit and open burning permit applications submitted to the ADEC with the Secretary. Additionally, when the ADEC grants any air emission permit or open burning permit to Yukon Pacific, a copy shall be filed with the Secretary.

26. Yukon Pacific shall file with the Secretary a revised acoustical analysis of the Anderson Bay LNG site reflecting far-field sound data of equipment finally selected (from either the manufacturer or a similar unit in service elsewhere), manufacturer's specifications and attenuation data for the intake and exhaust silencers finally selected, and the actual noise control equipment, for review and written approval of the Director of OPPR before commencing construction of the facilities.

27. Yukon Pacific shall file with the Secretary a noise survey of the Anderson Bay LNG Terminal no later than 60 days after placing the terminal in service. If the noise attributable to the operation of the facility exceeds Yukon Pacific's predicted property line noise level, additional noise controls shall be added to meet that level within 1 year.

28. Yukon Pacific shall prepare and file with the Secretary for review and approval by the Director of OPPR an outdoor usage plan to ensure normal outdoor activity usage does not exceed 20 people within the dispersion exclusion zone but still provides for small boat anchorage and recreational uses.

29. Yukon Pacific shall file with the Secretary for review and approval by the Director of OPPR prior to construction a visual mitigation plan that includes:

- shoreline protection measures that provide a more natural appearance by preserving existing landform and mature vegetation at prominent features along the shoreline, developed in conjunction with the recommended 50-foot-wide vegetation buffer strips; and

- landscape and architectural treatments that reduce the contrast of the aboveground structures with the natural landscape.

30. An additional technical conference (or conferences) shall be held as engineering design develops so that present areas of uncertainty may be more fully explored. These conferences shall be held prior to initiating construction at the site. At least one technical conference shall be held prior to initiation of construction after designs are finalized and major vendors (including LNG and other major storage tanks) have been selected and complete design details have been made available to FERC staff. The applicant shall also provide design details to the Office of Pipeline Safety of the DOT and the U.S. Coast Guard Captain of the Port of Valdez so that they may have the opportunity to participate in the technical conferences to assure compliance with their applicable regulations.

31. Yukon Pacific shall not commence construction without a written notice to proceed from the Director of OPPR. Any major alterations to facility design shall be filed with the Secretary for review and written approval by the Director of OPPR prior to initiation.

32. Onsite inspections shall be conducted as significant milestones develop during the construction phase and prior to commencement of initial facility operation.

33. Following commencement of operation, the facility shall be subject to regular FERC staff technical reviews and site inspections on at least a biennial basis or more frequently as circumstances indicate. Prior to each FERC staff technical review and site inspection, the company shall respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations, provision of up-to-date detailed piping and instrumentation diagrams reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below.

34. Yukon Pacific shall submit semi-annual reports to the FERC after initiating construction and continuing through the operational period. During the construction phase the semi-annual reports shall provide construction status of major components including significant design and schedule modifications required (and/or anticipated). The reports also shall address changes in facility design including anticipated future plans. During the operational phase the semi-annual reports shall provide changes in

facility design and operating conditions, abnormal operating experiences, activities (liquefaction and LNG shipping schedules), plant modifications including those proposed during the forthcoming 12-month period. Abnormalities shall include but not be limited to storage tank vibrations and/or vibrations in associated cryogenic plumbing, storage tank settlement, significant equipment and instrumentation malfunctions or failures, nonscheduled maintenance or repair (and reasons therefor), relative movement of the inner vessel, vapor or liquid releases, fires involving natural gas, refrigerants and/or from other sources, negative pressure (vacuum) within the LNG storage tanks and higher than predicted boiloff rates. The reports shall be submitted within 45 days after each period ending December 31 and June 30. Included shall be a section entitled "Significant plant modifications proposed for the next 12 months (dates)". The section shall be included in the semi-annual operational reports to provide Commission staff with early notice of anticipated future construction and maintenance projects at the LNG terminal.

35. A permanent all-weather access road shall be built to allow emergency equipment and personnel access/egress between the plant and the City of Valdez.

36. Regarding proposed use of double- or increased-integrity LNG storage tanks, if further consideration is contemplated, Yukon Pacific shall immediately submit to the DOT for approval, and to the FERC, the equivalent impact load analysis required by Section 193.2161(b) and 193.2155(c) of the DOT regulations. If written approval of the impact analysis cannot be obtained, Yukon Pacific shall construct separate and independent impounding systems for such storage tanks consistent with existing standards and codes.

37. Yukon Pacific shall establish direct telephonic linkage with the Alyeska Terminal and the Coast Guard Vessel Traffic Center in Valdez and ensure that procedures for notification and response to potential incidents are included in the emergency plans for each facility.

38. Yukon Pacific shall implement the following Coast Guard recommendations prior to commencement of shipping activities.

- an LNG tanker and any other tank vessel shall not be underway at the same time in Valdez Arm, Valdez Narrows, or Port Valdez;

- LNG tankers shall enter the Traffic Separation Scheme (TSS) at Hinchinbrook Entrance;

- LNG tankers shall be conned (i.e. direct the steering of the tanker) by a pilot licensed for the portion of Prince William Sound being transited;

- an LNG tanker and any other tank vessel shall maintain a separation of not less than 5 nautical miles, except when the LNG tanker or the other tank vessel is moored, at anchor, or in the opposing lane of the TSS;

- unless moored at the terminal in Port Valdez, an LNG tanker shall be attended by an adequate number of ship assist tugs;

- while in the VTS Area, all LNG tankers shall have a towing bridle or wire rigged and ready for immediate use; and

- all VTS regulations that apply to tank vessels greater than 20,000 deadweight ton shall also apply to LNG tankers regardless of size.

39. Yukon Pacific shall conduct a study by a creditable firm to review the operation of the VTS and provide suggestions for reducing the risks involved with the inclusion of LNG tankers in the system.

40. Yukon Pacific shall provide a revised site grading and construction plan reflecting the use of Site B' as the construction dock instead of grading and filling the proposed construction dock. Yukon Pacific shall file this plan with the Secretary during the comment period for this DEIS so it can be presented in the FEIS.

APPENDIX A

REVIEW COMMENTS ON THE DESIGN CRITERIA FOR THE
ANDERSON BAY TERMINAL OF THE
TRANS-ALASKA GAS SYSTEM

REVIEW COMMENTS ON THE DESIGN CRITERIA FOR THE ANDERSON BAY TERMINAL OF THE TRANS-ALASKA GAS SYSTEM

Felix Y. Yokel, Richard D. Marshall
National Institute of Standards and Technology
December 23, 1992

SCOPE OF WORK

At the request of the Office of Pipeline and Producer Regulation, Federal Energy Regulatory Commission, a review was undertaken of the geoseismic studies, design criteria and supporting data for the proposed Anderson Bay Terminal of the Trans-Alaska Gas System. Specifically, this review addresses the liquefied natural gas (LNG) storage tanks and compliance of the seismic investigation and structural design criteria with the requirements of 49 CFR Part 193 and related codes and standards. By necessity, certain design criteria and structural details included in this review are preliminary and are subject to change. Activities in support of this review included participation in a public hearing at Anchorage, Alaska on May 20, a visit to the proposed site at Anderson Bay, Port of Valdez, on May 21, 1992, and review of Yukon Pacific Corporation (YPC) responses to queries by the National Institute of Standards and Technology (NIST) and by the United States Geological Survey (USGS).

DOCUMENTS REVIEWED

The comments address the following documents:

1. Yukon Pacific Corporation, "LNG Storage Tank Study, LNG Plant/Marine Terminal, Anderson Bay, Alaska," July 18, 1991.

2. Preload, Inc., "Yukon Pacific Project (4) 800,000 BBL Tanks, Preload Drawing SK-1, Rev. 2, (and Drawing SK-2)," April, 1992.

3. Bechtel Corp., "Yukon Pacific Trans-Alaskan Gas System (TAGS), Anderson Bay Facility Site Design Data," Issued to YPC on 2/14/91.

4. Donovan, N., "Seismic Hazard Study for the Anderson Bay Terminal of the Trans-Alaska Gas System," Dames and Moore, July, 22, 1991.

5. Hall, W.J., "Seismic Design Criteria for the Anderson Bay Terminal of the Trans-Alaska Gas System," July, 22, 1991.

6. Wen, K.Y., and Tang, W., "Risk Analysis on Zero Period Acceleration (ZPA) at Anderson Bay Site," Executive Summary, July 22, 1991.

7. Geologic and Seismic Studies, Trans-Alaskan Gas System, Anderson Bay LNG Terminal, Port Valdez, Alaska," Dames and Moore, July 1991, Executive Summary.

8. Yukon Pacific, C3 - 4, Seismic Baseline; Seismic Design Criteria, July, 1991.

9. Dames and Moore, "Geologic and Seismic Studies - Trans-Alaska Gas System--Anderson Bay LNG Terminal, Port Valdez, Alaska," 2 Vol., July 22, 1991.

10. Yukon Pacific Corporation Responses to National Institute of Standards and Technology queries 1 to 4 and United States Geological Survey questions 1 to 4.

SEISMIC DESIGN CRITERIA

The seismic design criteria adopted for the site are summarized in Document 8, and are said to be based on studies reported in Documents 4 to 6. These criteria, which apply to sites on rock and controlled compacted fill, are:

1. an **Operating Basis Earthquake** (OBE) with a free field effective horizontal acceleration of 0.4 G.

2. a **Maximum Design Earthquake** (MDE) with a free field effective horizontal acceleration of 0.55 G.

These recommendations are generally supported by Documents 4 to 6. However, in Document 6, Figure 9, the zero period accelerations with an annual exceedence probability of 10^{-4} are recorded as follows:

Upper Bound Estimate	0.72 G
Lower Bound Estimate	0.35 G
Reasonable Estimate	0.51 G
Conservative Estimate	0.62 G

For LNG installations, the provisions of the Code of Federal Regulations, 49 CFR Part 193, apply. Guidelines for site exploration are given in NBSIR 84-2833, "Data Requirements for the Seismic Review of LNG Facilities" (Kovacs et al., 1984).

The CFR requirements for seismic investigation and design forces, as given in § 193.2061 and applicable to this project, are interpreted herein as follows:

> In accordance with (c) the seismic design forces shall be determined on the basis of a detailed geotechnical investigation in accordance with paragraphs (d) and (e). This investigation must include (1) Identification of faults and their Quaternary activity, tectonic structures, static and dynamic properties of the subsurface profile and, as applicable, tectonic provinces within 100 miles; (2) Identification and evaluation of all historically reported earthquakes which could affect the determination of the most critical ground motion or differential displacement; and (3) Evaluation of the hydraulic regime and the potential for soil liquefaction.
>
> In accordance with (d) the most critical ground motion must be determined probabilistically with a yearly probability of 10^{-4} or less, or deterministically with the objective of attaining this probability.
>
> In accordance with (e) the determination of the most critical ground motion includes (1) Use of an appropriate attenuation relationship, (2) Development of a horizontal design response spectrum determined from the mean + 1 standard deviation of the free field elastic response spectra

consistent with the most critical ground motion; and (3) A vertical design response spectrum that is equal to the horizontal design response spectrum when the earthquake source is 10 miles or less from the site, or at least 2/3 of the horizontal design response spectrum otherwise.

In accordance with (f), the site is not acceptable for LNG tank and dike construction if : (1) The estimated design horizontal acceleration exceeds 0.8 G; (2) The data base is sufficient to predict future differential displacements, but displacements not exceeding 30 inches cannot be assured, (3) The data base is not sufficient to predict future displacements, and the estimated cumulative displacement of a Quaternary fault within 1 mile of the tank foundation exceeds 60 inches; and (4) The potential for soil liquefaction cannot be accommodated by suitable design and construction.

Section (g) details the information to be included in the application for approval.

<u>Comments</u>:

A review of the Yukon Pacific seismology study, conducted by USGS, is presented in Appendix A to this document. The following comments are based in part on this latter review. The USGS review includes consideration of the YPC responses to USGS questions 1 to 4 (Document 10).

The seismicity of the region is discussed by Donovan (Document 4). In our opinion the scope of the information provided in Document 4 and in the related geoseismic studies referenced therein satisfies the CFR requirements for seismic information and the evidence presented does not indicate that the site is unsuitable for construction of LNG storage tanks and dikes in accordance with § 193.2061 (f) of the Code of Federal Regulations.

One of the important conclusions of the Yukon Pacific seismologic studies is that, during the service life of the LNG project, the chance for a repeat of a great subduction zone earthquake similar (in terms of moment magnitude and source distance) to the March, 1964 earthquake in the Prince William Sound area is remote, and thus can be discounted. A great subduction zone earthquake is judged possible in the Yakataga region (the "Yakataga Gap") approximately 100 km from the project site.

The "service life" in these studies was defined as 25 to 30 years. However, in accordance with information conveyed in Anchorage on May 20, 1992, the natural gas supply is sufficient to operate the facility for close to 200 years. We therefore believe that serious consideration should be given to the possibility that the facility may be operated for more than 30 years. Additionally, it will take several years to complete the construction of the facility. These years should be added to the projected service life. YPC should develop an acceptable rationale for their choice of a design service life.

While Yukon Pacific presented evidence to support their conclusion that the possibility of a great earthquake in Prince William Sound can be disregarded, we believe the Yukon Pacific scenario is not the only credible one that can be deduced from the available data. In Appendix A to this document it is observed that in the western Aleutian zone an M_w8.0 earthquake occurred in the rupture zone of the 1957 M_w8.6 earthquake after an interval of only 29 years. It is noted in Appendix A that an intracycle earthquake of $M_w > 8$ could conceivably occur near the end of the projected (by YPC) 30-year service life. We therefore believe that the M_w7¾ intracycle earthquake recommended as the design earthquake may not be conservative enough.

Another factor also should be taken into consideration: For the tank dimensions contemplated, hydrodynamic effects would have a fundamental period on the order of 10 seconds and very low damping (a critical damping ratio on the order of 0.5%). The wavelength associated with a 10-second period is approximately 35 km. Thus the applicable low frequency component of a ground motion originating from a great earthquake in the Yakataga area, about 100 km from the site, would not be significantly attenuated. Therefore, the potential effects of an $M_w > 8$ earthquake in the Yakataga Gap region must be taken into consideration in the long-period portion of the design spectrum and in the evaluation of sloshing effects.

For the previously discussed reasons we suggest that more conservative seismic design criteria for the LNG tanks should be considered by Yukon Pacific.

Proposed design spectra for the MDE and the OBE earthquakes are presented by Hall (Document 5). Response spectra derived by Donovan (Document 4) on the basis of attenuation relationships for subduction zone earthquakes are shown in Figure 6.1 of Document 4 to fit within an elastic response spectrum for 5% damping derived in the same way as the MDE spectrum presented by Hall. This is taken by YPC as a corroboration of the design spectra proposed by Hall. The Donovan response spectra are discussed in Appendix A. We have several comments on the Hall spectra:

1. **Damping and Ductility**: As previously noted, we believe that the possibility of an $M_w 8+$ near-source earthquake during the service life of the facility should not be categorically ruled out. In a great earthquake the duration of shaking would be longer, and cyclic strength degradation and ductility demand would be more severe than in the assumed $M_w 7\frac{3}{4}$ magnitude design earthquake. The MDE design spectrum recommended by Hall assumes a damping value of 7% of critical. According to Table 2 in the Hall report, this represents the lower bound of recommended values for prestressed concrete with no prestress remaining. While this damping value seems reasonable for the stated condition of the structure, we question the ability of a prestressed concrete tank to contain LNG without a major spill if this condition were allowed to develop, particularly in the case of a great earthquake where the duration of shaking would be relatively long.

The use of a ductility ratio of 1.2 should also be examined for the case of a longer-duration earthquake. The selection of a ductility ratio carries with it the need to ensure that it actually is achieved reliably through proper selection of materials, proper structural detailing, and reliable quality assurance procedures, and that the deformations associated with this ductility ratio do not cause failure. In Document 10 (7/15/92, last paragraph) it is stated that the selection of overly conservative values for damping and ductility would introduce dangers from overly stiff and brittle behavior mechanisms. However, it is also stated in Document 10 that in the case of an LNG tank the damping (and probably also quasi-ductile behavior) is primarily derived from frictional mechanisms at the double-bottom surface and from the perlite packing, mechanisms which are not associated with the deformation of the tank itself. It is therefore not obvious that a stronger and stiffer inner tank would necessarily lead to brittle behavior mechanisms. Allowable deformations of LNG tanks in the MDE must be predicated on the premise that an LNG spill would lead to failure, even if it is not triggered by total structural collapse.

2. **Effective Acceleration, Velocity, and Displacement**: Hall uses 0.4 G and 0.55 G, respectively, for effective acceleration of the OBE and MDE. The MDE value can be compared with the "reasonable estimate" of the zero period acceleration in Document 6. The "conservative estimate" is 0.62 G, and the "upper bound" estimate is 0.72 G. Thus, even though effective accelerations are generally smaller than the corresponding zero period values, the study in Document 6 suggests that the value of effective acceleration recommended for the MDE may be on the low side. Another source of information is the NEHRP provisions which are resource documents for standards developed by a consensus process (NEHRP, 1988 and 1991). In the appendix to the 1988 version, Figures 1-7 and 1-8 present maps with contours for horizontal accelerations and velocities in rock with a 90% probability of not being exceeded in 250 years. These maps were prepared by USGS and are referred to in the following discussion as NEHRP-250. For Anderson Bay the NEHRP maps show values in excess of 0.8 G for ground acceleration, and in excess of 80 cm/s (800 mm/s) for ground velocity. The service life of the LNG project could be 200 years which is not much less than the 250-year period for which the USGS maps were prepared. The USGS values for maximum ground acceleration and velocity would be associated with a much more conservative design spectrum than that recommended by Hall. We believe that YPC should review their recommendation for effective acceleration for the MDE in view of the possibility that the service life of the facility could exceed 30 years and that the intracycle earthquake could exceed the $M_w 7\frac{3}{4}$ projected in the YPC study.

3. **Design Spectra and Hydrodynamic Effects**: The spectra proposed in Document 5 are plotted as recommended by Newmark and Hall (1982). However, in this instance, long-period motions of long duration could be transmitted from a magnitude 8+ earthquake originating in the Yakataga Gap. The effect of increasing the spectral response for long periods would be to significantly increase the estimated hydrodynamic effects which have a long period. The wave height due to sloshing of the tank contents was evaluated (see Figures 6.5 and 6.6, Appendix C, Document 1) on the basis of TID 7024 (AEC, 1963). There is more recent information on sloshing effects and Hall (Document 5) notes that "... the U.S. expressions for sloshing tend to be on the low side of observations, and that the Japanese standards are believed to be more representative of the observed sloshing." The tank freeboard provided for sloshing and the hydrodynamic forces associated with sloshing should be no less than those associated with an $M_w > 8$ earthquake in the Yakataga Gap region.

4. **Subsurface Conditions:** The spectra recommended by Hall are for structures on rock and compacted fill. We suggest that, for all foundations which are not supported on rock, spectra for "competent soil" as recommended by Newmark and Hall (1982) be used.

5. **Vertical Accelerations**: The level of vertical accelerations recommended by Hall is 2/3 of the horizontal accelerations. In CFR 193 it is stated that for source distances less than 10 miles (16 km) horizontal and vertical accelerations should be assumed equal. It is true that the likely source distance of the design earthquake is 12, rather than 10 miles (20, rather than 16 km). However, the horizontal projection of the source distance is zero. It is therefore suggested that the rationale for the choice of vertical accelerations should not be solely based on a literal interpretation of the CFR provisions.

It is not the intention of this review to recommend specific design spectra. However, it is suggested that consideration should be given to a more conservative approach to seismic design. In particular, consideration should be given to a more conservative value for the free field effective acceleration for the MDE and more conservative spectral values for calculating sloshing effects because of the greater amplification that would result from a great earthquake of long duration.

In their feasibility study of the LNG tanks (Document 1, Appendix C), Chicago Bridge and Iron (CB&I) used effective horizontal accelerations of 0.4 G and 0.6 G for the OBE and the MDE, respectively. CB&I assumed 7% structural damping and 0.5% damping for hydrodynamic effects. The ductility ratio was assumed to be unity. While the CB&I spectra were used for study purposes only, they establish the feasibility of designing the LNG storage tanks using spectra which are much more conservative than those recommended by Hall.

WIND LOADS

49 CFR, Part 193, contains the following applicable requirements for the design of LNG facilities to resist wind forces:

§ 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:
(2) For all other LNG facilities:
(i) An assumed sustained wind velocity of not less than 200 miles per hour, unless the Administrator 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 exceedence in a 50-year period of 0.5 percent or less, if adequate wind data are available and the probabilistic methodology is reliable.

<u>Comments</u>:

The design wind speed listed in Appendix B (Design Criteria) of Document 1 is 110 mph or 49.2 m/s. Presumably this value was obtained by multiplying the basic wind speed for the proposed site (ASCE, 1990, Figure 1) by an importance factor of 1.05. This factor is intended for use with Category I (ordinary) structures in hurricane-prone regions to provide the same probability of overload that applies to the non-hurricane regions of Figure 1. A Category I structure designation as well as wind speed adjustments for hurricane conditions are inappropriate in this case. The associated mean recurrence interval for the selected design wind speed is 50 years (annual probability of being exceeded equal to 0.02). In view of items (b)(2)(i) and (ii) above, it is clear that an annual probability of 0.02 is unacceptable for the design of LNG tanks to resist wind effects. In fact, the requirement of item (b)(2)(ii) corresponds to an annual probability of 10^{-4}, or a mean recurrence interval of 10,000 years. Unless it can be demonstrated otherwise, the basic wind speed to be used for facility design is 200 mph or 89.4

m/s. Although Appendix C (LNG Storage Tank Study Evaluation) of Document 1 cites this value of 200 mph, no actual wind load calculations are presented.

In response to Query (3a), YPC notes that the design wind speed of 110 mph given in Document 1 was intended to apply to § 193.2067 (b)(1) and not to the design of the proposed LNG storage tanks. For preliminary design evaluation, a sustained wind speed of 200 mph was assumed as is noted in Appendix C of Document 1. YPC state their intention to carry out a formal probabilistic analysis of local wind data to determine whether or not a lower design wind speed is justified.

One approach to satisfying the requirement of (b)(2)(ii), and thus obtain some relief from the 200 mph design requirement, is to utilize the wind speed distributions contained in Simiu, et al. (1979) which extend to return periods of 10,000 years and beyond for extratropical storms. Analyses of data used to develop the wind speed distributions shown in Figure 3.2.3 of ANSI/ANS-2 (1983) indicate that for the western United States, design speeds corresponding to annual probabilities of 10^{-4} are dictated by extratropical storms rather than by tornadoes. Given the relatively lower frequency of tornadoes in Alaska, it is to be expected that extratropical storms also will dictate design speeds of similar annual probability for Alaska. It is reasonable to expect this approach could lead to a substantial reduction in the requirement of (b)(2)(i). However, the resulting wind speed will be the fastest-mile speed (as opposed to sustained speed) at 10 m in open terrain (standard exposure). Adjustments will be required for the over-water wind fetch at the site and for local topographic effects (flow over an escarpment). Although ASCE 7-88 (1990) does not address local topographic effects, guidance can be obtained from other sources such as AS 1170.2 (1989).

Given the magnitudes of the design earthquake and snow loads for the proposed site, it is doubtful that wind loads will have a significant effect on the LNG storage tank design. Nevertheless, it is important that these loads be accounted for. Particularly critical are the uplift forces, both local and global, acting on the roof structure in combination with the design internal positive pressure. Note that this loading will, in certain cases, cause load reversals in members designed for dead load plus snow load.

SNOW LOADS

49 CFR, Part 193, contains the following applicable requirements for the design of LNG facilities to resist loads due to ice and snow:

§ 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.

§ 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:

(h) Predictable snow and ice loads.

Comments:

A ground snow load of 235 psf (11.25 kPa) is cited in Appendix B (Design Criteria) of Document 1 as the basis for design snow loading of the LNG storage tanks. This loading is converted to an equivalent flat-roof loading, p_f, using the requirements of ASCE 7-88 (1990). For Alaskan stations, the conversion formula is

$$p_f = 0.6C_eC_tIp_g$$

where C_e is an exposure factor to account for wind effects on roof snow accumulation, C_t is a thermal factor to account for heating of the structure, I is an importance factor to account for the risk of overload, and p_g is the ground snow load corresponding to a mean recurrence interval of 50 years.

The flat-roof loading is calculated in Appendix C (LNG Storage Tank Study) of Document 1 using the following values for the factors in the conversion formula:

C_e = 1.0 (Locations in which snow removal by wind cannot be relied upon to reduce roof loads because of terrain, higher structures, or several trees nearby)

C_t = 1.2 (Unheated structure)

I = 1.0 (Normal case: mean recurrence interval = 50 years)

p_f = (0.6)(1.0)(1.2)(1.0)(235) = 169 psf = 8.09 kPa

In response to Query (2a), YPC notes that the 100-yr ground snow load provided by the National Weather Service for Valdez is 195 psf (9.34 kPa), and the corresponding value provided by the Soil Conservation Service is 169 psf (8.09 kPa). The higher value was selected as a basis for the 100-yr ground snow load at Valdez. To account for local variations between the south and north shores of Port Valdez, a "local variation adjustment factor" of 1.2 was determined "by consensus." Also, YPC notes that this factor may be adjusted on the basis of additional meteorological data that will become available at Anderson Bay prior to development of final snow load design criteria.

ASCE 7-88 (1990) specifies a 50-yr ground snow load of 170 psf (8.14 kPa) for Valdez and the corresponding 100-yr value is (1.2)(170) = 204 psf (9.77 kPa). If the "local variation adjustment factor" of 1.2 is correct, then the 100-yr ground snow load at the Anderson Bay site would be (1.2)(204) = 245 psf (11.73 kPa). The equivalent 100-yr flat-roof snow load would be (0.6)(1.0)(1.2)(1.0)(245) = 176 psf (8.43 kPa). Note that an importance factor of 1.0 is applied here since the ground snow load corresponds to the 100-yr value. According to the criteria of ASCE 7-88, the annual probability that the equivalent flat-roof snow load of 169 psf (8.09 kPa) proposed by YPC will be exceeded is somewhat greater than 0.01.

The adoption of such a low load intensity (or high annual probability) for the preliminary design evaluation is the subject of Query (2b). YPC's response to this query attempts to justify their use of an importance factor of 1.0 for snow load on the grounds that the only structural classification in ASCE 7-88 that covers LNG tank facilities is Category I. If this were true, then the equivalent flat-roof snow load should be based on the 50-yr ground snow load, not the 100-yr value, and the corresponding annual probability would be 0.02. This obsession with structural classification for snow loads is perplexing in view of the fact that such classification does not appear to be a problem with the development of criteria for wind or earthquake loads, both of which include provisions for structural classification in ASCE 7-88.

If the risk of tank failure due to snow load alone is to be consistent with that due to earthquake or wind, the associated annual probability of the ground snow load being exceeded should be approximately 10^{-4}. The appropriate multiplier (importance factor) to be applied to the 50-yr ground snow load will depend on the cumulative probability distribution function that best models the series of annual extremes for Port Valdez (with due regard for local variations between south and north shore) and an analysis of this series needs to be carried out. Some cumulative probability distribution functions that have been used to model ground snow load data are described by Sack (1989).

The calculated flat-roof design snow load does not account for the likelihood that snow near the perimeter of the tank will slide off due to the steeper roof slope, and this has been noted by YPC in their response to Query (2b). If the tank design and piping details are such that a slippery and unobstructed roof surface is assured, then a slope factor, C_s, should be applied, consistent with the requirements of Section 7.4 of ASCE 7-88 (1990), or with the requirements of other accepted tank design standards.

COMBINED LOADS

While it is appreciated that the load criteria are incomplete and/or uncertain at this time, it is important that deficiencies and inconsistencies be identified so that flawed criteria do not become part of the final design criteria. The design loads and load combinations employed in the preliminary storage tank evaluations are described in Document 1. Specific comments concerning the seismic design criteria, wind loads and snow loads have been presented in other sections of this document. Load combinations that relate to specific containment schemes are discussed in this section.

Load Combination Factors:

In Appendix C of Document 1, the load combination factor of 0.75 for D+S+E as required by ASCE 7-88 (1990) is reduced to 0.66 for the case of the OBE. The justification given for this reduction is that "... the earthquake loads are much higher than contemplated in ASCE 7-88." However, it is also true that the acceptable risk of failure for LNG storage tanks is substantially less than the risks of failure deemed acceptable for ordinary buildings and structures. The load combination factor of 0.75 specified in ASCE 7-88 (1990) should be used unless a more clear and convincing justification for a lesser value can be provided.

Combined Seismic and Snow Loading:

For the design conditions outlined in Appendix C of Document 1, the calculated flat-roof snow load of 169 psf (8.09 kPa) is assumed to act in conjunction with the earthquake loads. This load combination appears to be overly conservative, given that the two loading events are uncorrelated and that the design snow load corresponds to a mean recurrence interval of approximately 100 years. The apparent conservatism is offset somewhat by the choice of 0.66 (vs. 0.75) for a load combination factor. In view of the associated risk, it would appear more reasonable to base the combined snow and earthquake loading on the 50-yr flat-roof snow load and to expect some load reduction due to snow slide-off with the commencement of strong ground shaking. However, this reduced snow load should not be used in conjunction with a reduced load combination factor.

Combined Seismic and Impounded Fluid Loading:

The load combinations considered by CB&I (Appendix C, Document 1) in their evaluation of the outer tank do not include the combination of seismic loading and impounded fluid. It is understood that the possibility of hydrodynamic loading on the outer tank due to failure of the inner tank is greatly diminished by the presence of insulation between the two tanks and the absence of inlets and outlets at the bottom of the inner tank. However, there still remains the possibility of rapid leakage from a damaged inner tank, combined with ground shaking of long duration or the effects of aftershocks.

The two containment schemes described by CB&I in Document 1 differ only in the type of outer tank employed; one consisting of a conventional steel outer shell and the other consisting of a prestressed concrete outer shell. In both designs the outer shell carries the roof loads as well as other imposed loads such as wind, insulation and internal pressure. The major difference, however, is that the conventional double metal wall tank is intended to be used with an independent impoundment structure while the so-called "double integrity" tank is not. Thus the consequences of the outer tank failing are quite different for the two schemes. The same concern for this particular load combination (seismic plus impounded fluid) applies equally to the containment scheme proposed by Preload, Inc. and described in Appendix E of Document 1.

This issue constitutes the first part of Query (4b). The YPC response quotes the Preload Inc. revised report of 4/21/92 and the CB&I report of 5/21/91. In each case full hydrostatic loading of the outer tank plus a design seismic event is not considered to be a credible event. But the outer tanks are designed to accommodate full hydrostatic loading plus aftershocks to the OBE level in the case of the Preload design, and to some lesser event (not defined) in the case of the CB&I design.

In view of the possibility that during the service life of the structure a $M_w > 8$ earthquake could occur in the Yakataga Gap region, and possibly even closer to the project site, and as a consequence the duration of shaking could be longer than that associated with a $M_w 7\frac{3}{4}$ earthquake, it is recommended that combined seismic and impounded fluid loading be considered in the design of the outer tanks.

STRUCTURAL DETAILS

Certain structural details presented in Document 1 are cause for concern and raise a number of questions as to the level of performance that can be expected with loading conditions at or near the design level.

Proximity of Inner and Outer Tanks:

There is concern about the expected behavior of the inner/outer tank combination used in the so-called "double integrity" tank design. Because of their close proximity, the tanks cannot be viewed as separate entities in the event of a structural failure. Failure of the outer shell will virtually assure failure of the inner shell, either through interaction of the tank shells or through progressive collapse of the outer wall and roof structure. This concern does not apply to the conventional double metal tank because of its structurally independent impoundment system.

This issue constitutes the second part of Query (4b). The YPC response does not address directly the concern for progressive failure initiating in the outer tank and carried to the inner tank, either through interaction of the tank shells or through the roof structure.

Double Concrete Wall Tank:

Appendix E of Document 1 presents the general details of the double concrete wall tank proposed by Preload, Inc. Both the inner and outer walls rest on 10 mm thick sketch plates which are allowed to move radially to accommodate shrinkage, elastic shortening due to prestressing, and thermal expansion or contraction due to seasonal temperature changes and tank cool-down. The sketch plates are attached to the tank floor plates by means of a welded lap joint and are keyed to the tank walls by weld blocks located 1 m center-to-center around the inside face of the tank wall. No foundation details are shown, although Drawing SK-1 shows the outer wall sketch plate resting on a 5 mm thick fiber cement plate faced with teflon.

The concern with this detail centers on its ability to function properly under strong base shear induced by horizontal accelerations. If there is relative movement between the wall/sketch plate and the foundation, what will be the effect on the bottom plates of the tanks? The possible need for some radial/tangential restraint beyond that provided by friction is mentioned in Document 2, but no specific details are provided. In the extreme case, there is the potential for the tanks to slide off of their footings. And finally, what degree of differential settlement in the footing can be accommodated by the sliding joint detail without loss of the contained fluid?

This concern for proper anchorage is the subject of Query (4c). In their response, YPC notes that it is Preload's opinion that ring-wall foundation anchors are not required to resist overturning and base sliding. YPC also notes that Preload Inc. prepared details of their tank design and submitted them directly to FERC without benefit of technical support or input from the YPC engineering staff. This concern for anchorage details has been noted by YPC and will be evaluated during the detailed design stage and prior to selection of a final tank design.

Circumferential Prestressing:

Another issue of concern with the double concrete wall tank is the behavior of the circumferential prestressing in the event of wire failure due to corrosion or missile impact. What assurances are there against a sudden loss of prestress due to unwinding of the wire helix, or a gradual loss of prestress due to progressive failure of the bond between the wire and the pneumatic mortar coating?.

Rock Anchors:

The rock profiles at the site indicate interbedded phyllite and graywacke, weathered to depths between 15 and 35 feet (4.5 and 11 m). The phyllite may be susceptible to rapid weathering. There is some concern that: (1) rock anchors could experience an initial displacement before developing adequate load resistance; and (2) anchors which initially have adequate load resistance could lose some load resistance during the service life of the structure due to weathering effects. Weathering is primarily caused by water and frost penetration. While it is understood that the base of the tank foundation will be kept at a temperature designed to prevent freezing under the tanks, there still will be frost penetration adjacent to the tanks. Consideration should be given to a suitable surface and subsurface drainage system to prevent weathering in the vicinity of the tank foundations. Document 1 indicates that it is contemplated to proof test a portion, but not all, of the anchors. However, it may be necessary to pre-load all the anchors in order to assure adequate performance during an earthquake.

Rock Slopes:

The rock at the site consists of interbedded layers of phyllite and graywacke. The phyllite layers are very susceptible to erosion. This could result in stability failures, particularly during seismic events. It is suggested that rock slopes should be no steeper than the dip of the layers, should be secured by rockbolts, and should have an internal drainage system monitored by piezometers.

Steel Dome Roof:

Other than the one described by Preload Inc., the roof structure for the proposed containment schemes does not include a concrete overlay, thus making these containments vulnerable to penetration by light aircraft and/or wind-born missiles. What are the criteria for missile resistance and how do the proposed roof designs satisfy those criteria?

AVALANCHE HAZARD

The terrain directly south of the proposed site at Anderson Bay rises to a maximum elevation of 2,400 feet (730 m) over a horizontal distance of 9,000 feet (2,740 m). For approximately half of this distance the average slope is 1 in 3 (Vert., Horiz.) and this raises concerns about the avalanche hazard. By comparison, the terrain to the south of the Alyeska Marine Terminal rises to an elevation of 3,800 feet (1,160 m) over a distance of 9,000 feet and the slope over most of this distance is approximately 1 in 2. Although sliding snow has been a problem in the 15 years that the terminal has been in service, the magnitudes of these slides have been relatively small. Nevertheless, it is our understanding that the avalanche potential is closely monitored and that a plan of action has been developed to selectively trigger the sliding of accumulated snow should that become necessary to forestall a major slide or avalanche.

With regard to the Anderson Bay site, there does not appear to have been any serious consideration given to the avalanche hazard. An assessment of this hazard is needed and should include the stability of snow and loose rock on the slopes above the site, the possible effects of ground shaking on this stability, the volume of material (snow and rock) that is likely to be involved in the event of an avalanche, the volume of material that can be retained at the toe of the slope in such an event, and the probable runout of material into the storage tank area.

SUMMARY:

Seismic Design

1. The scope of the geoseismic study and the data presented appear to meet the requirements of the Federal regulations. The evidence presented seems to indicate that the site meets the requirements for construction of LNG tanks and containment dikes, as stipulated in § 193.2061 (f)

2. We recommend that YPC should justify the design service life of the installation.

3. We have reservations with regard to the validity of the conclusion that an earthquake similar to the 1964 Prince William Sound earthquake should not be considered for the design of the facility. We also suggest that the low frequency components of the ground motion generated by a great earthquake in the Yakataga Gap region would not be

significantly attenuated. We therefore recommend that a conservative approach be taken in the selection of the level of the effective accelerations on which design spectra are based, and that the potential effect of a great earthquake in the Yakataga Gap be considered in the choice of the long-period portion of the design spectra.

4. It is recommended that the design effective acceleration, ductility, and damping ratios should reflect the possibility that an $M_w > 8$ earthquake may occur during the service life of the installation.

5. It is suggested that the choice of vertical accelerations should not be based solely on a literal interpretation of the CFR.

Wind Load

1. The stated design wind speed of 110 mph (49.2 m/s) does not meet the requirements of CFR, Part 193, § 193.2067. Either a design wind speed of 200 mph (89.4 m/s) must be adopted, or a rational analysis must be provided to show that the design wind speed is consistent with an annual probability of 10^{-4} of being exceeded.

2. Even though the wind loads may not have a significant effect on the tank design, they have the potential for causing load reversals in elements of the roof system designed to resist dead load and snow load.

Snow Load

1. The rationale for the design ground snow load of 235 psf (11.25 kPa) requires additional study. To make the risk of overload due to snow consistent with the effects of earthquake and wind forces, an importance factor for use with the 50-year ground snow load needs to be derived.

Combined Loads

1. Unless there is clear and convincing justification for lesser values, the load combination factors specified in ASCE 7-88 should be used.

2. Use of the calculated flat-roof snow load of 169 psf (8.09 kPa) in conjunction with earthquake loads appears to be overly conservative. This snow load corresponds to a mean recurrence interval of approximately 100 years and does not account for any load reduction due to snow slide-off on the steeper roof slopes.

3. The design load criteria do not account for the possibility of combined seismic and impounded fluid loading for the outer tank. This load combination could be critical for the so-called "double integrity" tank designs.

Structural Details

1. For the so-called "double integrity" tanks, the secondary containment is not isolated from the primary containment, thus creating the potential for progressive collapse of the outer

and inner tanks. Without a structurally independent impoundment system, failure of the outer tank could be catastrophic. Additional secondary impoundment should be considered.

2. The detail for the joint between the wall and floor of the double concrete wall tank needs additional development to assure proper function under strong ground motion and possible differential settlement of the tank footing.

3. There is concern about the behavior of the circumferential prestressing for the double concrete wall tank in the event of wire failure due to corrosion or missile impact.

4. There is concern about weathering effects on the bedrock formation. These concerns affect the rock anchors for the tank foundation and rock slopes in the project area.

5. Resistance of the steel dome roof to missile penetration is questionable without the inclusion of a concrete overlay.

Avalanche Hazard

1. There is no evidence that an assessment of the avalanche hazard has been carried out for the Anderson Bay site. This needs to be done in view of the proposed location of the LNG storage tanks.

REFERENCES

American National Standards Institute (1983). "Estimating Tornado and Extreme Wind Characteristics at Nuclear Power Sites." American National Standard ANSI/ANS-2.3-83, 1983, 19 pages.

American Society of Civil Engineers (1990). "Minimum Design Loads for Buildings and Other Structures." ASCE 7-88, July, 1990, 94 pages.

ICBO (1991). "Uniform Building Code." International Conference of Building Officials, Whittier, CA, 1991.

Kovacs, W.D. et al. (1984). "Data Requirements for Seismic Review of LNG Facilities." NBSIR 84-2833, National Bureau of Standards, Washington, DC, June 1984.

National Earthquake Hazards Reduction Program (1992). "NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings." 1988 Edition, FEMA 95/Oct., 1988 and 1991 Edition, FEMA 223/ Jan., 1992.

Newmark, N.M. and Hall, W.J. (1982). "Earthquake Spectra and Design." Engineering Monograph on Earthquake Criteria, Structural Design and Strong Ground Motions, EERI, 1982, 103 pages.

Sack, R.L. (1989). "Designing Structures for Snow Loads." Journal of Structural Engineering. American Society of Civil Engineers, Vol. 115, No. 2, February 1989, pp 303-315.

Simiu, E., Changery, M.J. and Filliben, J.J. (1979). "Extreme Wind Speeds at 129 Stations in the Contiguous United States." NBS Building Science Series 118, National Bureau of Standards, Washington, DC, March 1979, 318 pages.

Standards Association of Australia (1989). "Minimum Design Loads on Structures, Part 2: Wind Loads." AS 1170.2-1989, 96 pages.

Code of Federal Regulations, 49 CFR Part 193 - Liquefied Natural Gas Facilities: Federal Safety Standards, 12-31-91 Edition, 1991.

U.S. Atomic Energy Commission (1963). "Nuclear Reactors and Earthquakes." Technical Information Document 7024, prepared by Lockheed Aircraft Corporation and Holmes & Narver, Inc., August 1963.

APPENDIX A
REVIEW COMMENTS ON THE SEISMIC DESIGN CRITERIA FOR THE ANDERSON BAY TERMINAL OF THE TRANS-ALASKA GAS SYSTEM

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U.S. Geological Survey
15 December 1992

These comments address the following documents:

1. Geologic and Seismic Studies by Dames and Moore, July 1991
2. Seismic Hazard Studies by Neville Donovan, July 22, 1991
3. Seismic Design Criteria by William J. Hall, July 22, 1991
4. Responses by Yukon Pacific Corporation to FERC-USGS Questions 1-6

SEISMIC SOURCE CHARACTERIZATION

If there are sufficient gas reserves to operate the proposed facility for close to 200 years, the use of project lifetimes of 25 to 30 years in developing seismic design criteria is not conservative. A 30-year lifetime is assumed in Doc. 1 (Chapter 7), and a 25-year lifetime is assumed in Doc. 2 (Appendix C).

1964-type earthquake

There is a large discrepancy between estimates of repeat times for 1964-type earthquakes derived from paleoseismic studies (600-950 years) and from plate tectonic studies (175-333 years) as presented in Doc. 1 (p.7-7). This discrepancy is a long-standing issue of discussion in the research community, and the lack of definitive data assures the issue will not be resolved quickly.

The paleoseismic studies are subject to several difficulties: obtaining sufficient samples over a broad region, constraining ages of events, correlating events between samples over large distances, and knowing that all events have been sampled. Given these difficulties, it is difficult to draw reliable conclusions about the repeatability of 1964-type events. While the available data may be consistent with the conclusion of Doc. 1 (p. 7-7) for 600-950 year repeat times, alternative interpretations are also possible. The possibility of shorter repeat times should be considered.

The plate tectonic estimates provide shorter average repeat times (175-333 years). If earthquakes occur regularly at such intervals, the next 1964-type shock is not due for 150 to 300 years. If the project lifetime is about 200 years, the conclusion that "a repeat of a great 1964-type event should not be considered in seismic hazard analysis and estimation of ground motions" (Doc. 1, p. 7-7) is not justified. Furthermore, consideration should be given to the possibility that major earthquakes do not occur at regular intervals but cluster in time.

Intracycle earthquake

Magnitude $M_w 7\frac{3}{4}$ does not seem to be a conservative value for the maximum intracycle earthquake. To estimate a limiting magnitude, the 1964 source zone is compared to other subduction zones that have generated $M_w \geq 9.0$ earthquakes (Doc. 1., p. 7-10). The comparison may not be appropriate because the tectonic setting of the 1964 zone is much more complex than that of the southern Chile and Kamchatka zones. The relatively short intervals between great shocks in the latter two zones (100-160 years) further suggest that they may not be good analogs to the 1964 zone. Perhaps, the western Aleutian zone is an equally good analog; there, an M_w8.0 earthquake in 1986 occurred in the rupture zone of the 1957 M_w8.6 (as given in Doc. 1, p. 7-10) earthquake, only 29 years after that great earthquake.

As an alternative method of estimating the limiting magnitude, the accumulated slip potential since the last earthquake is calculated for various assumptions about the fraction of slip that occurs coseismically. The possibility that all the slip occurs coseismically is not considered. The assumptions about coseismic slip percentage assume that the recurrence interval for 1964-type earthquakes lies in the range 600 to 950 years, as suggested by geologic investigations, and that no significant slip occurs in intracycle shocks. The latter assumption is inconsistent with the exercise of estimating the maximum magnitude of an intracycle shock. In regard to the former assumption, if the repeat time were significantly shorter than 600 years, the estimate of coseismic slip fraction would approach unity. If all the slip is coseismic, then the maximum intracycle earthquake would range from M_w7.6 in 1995 to M_w8.2 in 2025.

Finally, if a 200-year project lifetime is assumed rather than a 30-year lifetime, the estimate of the maximum possible earthquake at the end of the project life (Doc. 1, Table 7-2, p. 7-13) increases by 1.2 magnitude units. Thus, at the end of a 200-year lifetime, there could be the potential for an M_w8.2 earthquake, even if 80-percent of the slip on the megathrust occurs aseismically.

SEISMIC DESIGN MOTIONS

Doc. 2 states on p. 14 that the "seismic response of the cryogenic product in LNG storage tanks is very sensitive to long period motions in the 8 to 12 second period range", yet the report does not address estimation of ground motion in that critical period range. The response to FERC-USGS Question 5 (in Doc. 4) states that "... the level of long-period motions will be specified through adoption of a broad-band, fixed-shape response spectrum anchored to ground motion at high frequency." The level of long-period motions are to be specified through the Newmark-Hall response spectra method using fixed ratios between controlling values of acceleration, velocity and displacement as defined in Newmark and Hall (1982, p. 45). The use of fixed ratios yields a response spectrum whose shape is independent of magnitude; however, several studies show that the shape of the response spectrum for real earthquakes is strongly dependent on magnitude. Joyner and Boore (1988) state "... at frequencies less than about 3 Hz, large errors can result from the practice of scaling fixed spectral shapes by peak acceleration. These errors can be partially avoided by Newmark and Hall's (1969) method, in which the short-period portion of the spectrum is proportional to peak acceleration, the intermediate portion (about 0.3 to 2.0 sec) to peak velocity, and the long-period portion to peak displacement." In this design study, however, no attempt is made to allow for the effect of magnitude on spectral shape. This raises the question of whether the proposed OBE and MDE response spectra are sufficiently conservative at periods in the range of 8 to 12 seconds, in view of the very large earthquakes that occur in southern Alaska. To assess the adequacy of the long-period levels of the design response spectra, one can use seismological modelling capabilities to estimate directly the long-period ground motion from postulated critical design earthquakes on the Aleutian megathrust and in the Yakataga seismic gap.

An important factor in the damage potential of earthquakes is the duration of ground shaking. This factor is particularly important for major earthquakes of the size that occur along the southern coast of Alaska There is no explicit discussion or consideration of the duration of shaking for the largest earthquakes that could affect the site in either Doc. 2 or Doc. 3. The YPC response to FERC-USGS Question 6 (in Doc. 4) claims that the broad-band design spectrum adequately accounts for duration effects. The issue of duration, however, is not explicitly addressed. Nowhere is the duration of ground shaking estimated. Accordingly, it is difficult to place confidence in the YPC response to Question 6.

The ground-motion attenuation relations for rock sites developed in Doc. 2 appear to seriously underestimate the larger levels of peak acceleration in the data set from which the relations were derived (Figures 3-4 and 3-5) and also the 1-second spectral accelerations at distances beyond 70 km (Figures 3-6 and 3-7). This concern is not adequately addressed in the YPC response to FERC-USGS Question 4 (in Doc. 4). Use of the distance to the energy center in the attenuation relations (Doc. 2, p. 9) should be provided.

The recommendation that "the vertical design spectrum should be taken as two-thirds of that applicable to the horizontal design spectrum" (Doc. 3, p. 19) should be justified, especially with respect to the motions in critical spectral bands (such as the sloshing period) and to the controlling design earthquakes.

REFERENCES

Joyner, W.B., and Boore, D.B. (1988). Measurement, characterization , and prediction of strong ground motion, in Earthquake Engineering and Soil Dynamics II, Proc. Am. Soc. Civil Eng. Geotech. Eng. Div. Specialty Conf., June 27-30, 1988, Park City, Utah, pp. 43-102.

Newmark, N.M., and Hall, W.J. (1982). Earthquake Spectra and Design, Earthquake Engineering Research Institute, 103 p.

APPENDIX B

FERC-NIST QUERIES FOR PUBLIC MEETING

ANCHORAGE, ALASKA, MAY 20, 1992

1. EARTHQUAKE

(a) The spectrum for the Maximum Design Earthquake (MDE) is based on an effective acceleration of 0.55 G. Yet, your probabilistic study cites an upper bound of 0.72 G and a conservative estimate of 0.62 G. A USGS map prepared in 1988 also shows higher values. Is the recommended spectrum conservative?

(b) The level of vertical acceleration recommended by Hall is 2/3 of the horizontal acceleration. While the likely source distance is greater than 10 miles, the assumed source could be directly under the site. Accordingly, wouldn't it be appropriate to make the vertical accelerations equal to the horizontal accelerations?

(c) The Hall report recommends a damping value of 7% and a ductility ratio of 1.2. Values for damping are normally less for prestressed concrete. The use of a ductility ratio greater than 1 is also questioned.

(d) We note that a more conservative spectrum was used in the CB&I evaluation study.

(e) The Newmark-Hall 1982 monograph on which the recommended spectra are based recommends more conservative values for long periods (such as those associated with hydrodynamic effects). The Uniform Building Code also recommends more conservative values for long periods.

(f) In the CB&I evaluations, sloshing effects were considered using NRC Report TID 7024, a 1963 document. More recent information on this phenomenon is available.

2. SNOW LOADS

(a) A ground snow load of 235 psf is cited in the design criteria, but the basis for this number is not explained.

(b) The design roof snow load of 169 psf for the LNG storage tanks is obtained from the specified ground snow load using an importance factor of 1.0. However, use of such a low value is inconsistent with the consequences of failure in the case of LNG storage tanks.

3. WIND LOADS

(a) The specified design wind speed is 110 mph, based on an importance factor of 1.05. This is less than the 100-yr wind for Valdez and substantially less than the 10,000-yr wind required by CFR.

4. DESIGN

(a) In the CB&I evaluation, ultimate earthquake loads are used in conjunction with average strengths (yield and ultimate). However, in present engineering practice, a strength reduction factor smaller than 1 is used in conjunction with ultimate loads. What is the justification for a strength reduction factor of 1?

(b) In your study, the outer container in the double (increased) integrity tank is designed to contain a spill and support the snow load. Potential seismic effects after a spill were not considered. Also, since a failure of the outer tank could also cause the inner tank to fail, there should be additional containment.

(c) There is no evidence that an anchored foundation to resist seismic forces was considered in the evaluation of the tanks proposed by Preload, Inc.

APPENDIX C

FERC-USGS QUESTIONS

1. Discuss how an intracycle M_w7¾ design earthquake on the Aleutian megathrust can be considered conservative. On the western Aleutian megathrust, an M_w8.0 earthquake in 1986 occurred in the rupture zone of the 1957 M_w9.1 earthquake, only 29 years after that great earthquake.

2. Does the available geologic data <u>require</u> or only <u>permit</u> your conclusions that the 1964 earthquake is characteristic of the major (M_w8.0 or larger) earthquakes on the Prince William Sound part of the Aleutian megathrust and that the average recurrence is about 7800 years? What other conclusions do the data permit? Explain the factors on which you conclude that the characteristic earthquake model is applicable to the Prince William Sound Region.

3. The approximately 700-year recurrence interval inferred for 1964-type earthquakes suggests that such shocks should generate about 40 m of slip on the megathrust if the average relative plate motion of 5-6 cm/yr were accommodated only by such shocks. The slip determined for the great 1964 earthquake was only about half that amount. How does your model account for the release of the remaining accumulated slip?

4. The ground motion attenuation relations for rock sites developed by Donovan appear to seriously underestimate the larger levels of motion in the data set from which the relations were derived (see Figures 3-4 through 3-7 in volume VII (Tab 4) of the application: Donovan, Neville; Seismic Hazard Studies for the Anderson Bay Terminal of the Trans-Alaska Gas System (Yukon Pacific Corporation Project), July 22, 1991). How does this problem affect the conclusion of that report?

5. Donovan states that the "Seismic response of the cryogenic product in LNG storage tanks is very sensitive to long period motions in the 8 to 12 second period range." The report does not address estimation of ground motion in that critical period range. Will there be subsequent reports that address this issue or will the level of long-period motions be specified only through the adoption of a fixed-shape response spectrum anchored to ground motion at high frequency?

6. An important factor in the damage potential of earthquakes is the duration of ground shaking. This factor is particularly important of the size that occur along the southern coast of Alaska. How is the effect of duration of shaking to be accounted for in the seismic design of the proposed facility?

APPENDIX B

PRELIMINARY LNG EXPORT FACILITY PRECONSTRUCTION CRYOGENIC DESIGN AND TECHNICAL REVIEW

CONFIDENTIAL
CONTAINS PROPRIETARY INFORMATION

Preliminary
LNG Export Facility Preconstruction
Cryogenic Design and Technical Review

Yukon Pacific Company L.P.
Valdez, Alaska

Docket No. CP88-105-001

March 17, 1993

Robert Arvedlund, Chris M. Zerby,
Alan F. Schmidt and Dudley B. Chelton

CONFIDENTIAL
CONTAINS PROPRIETARY INFORMATION

Office of Pipeline and Producer Regulation
Federal Energy Regulatory Commission
Washington, DC

Table of Contents

Preliminary
LNG Export Facility Preconstruction
Cryogenic Design and Technical Review

Yukon Pacific Company L.P.
Valdez, Alaska

Docket No. CP88-105-001

Introduction

The cryogenic design and technical review of preconstruction design of the proposed Yukon Pacific Company L.P. (YPLP) LNG export facility located near Valdez, Alaska is part of the regulatory review process of the Federal Energy Regulatory Commission (FERC). Additional reviews are anticipated as the facility design is further developed. The present review was performed jointly by FERC staff and cryogenics consultants. Areas of coverage include: materials in cryogenic environments, insulation systems, cryogenic safety, thermodynamics, heat transfer, instrumentation, cryogenic processes and other relevant safety systems. The present review is limited to the cryogenic aspects of the LNG facility and marine terminal. Emphasis has been placed on engineering design and safety concepts and on projected operational reliability. Vapor cloud generation, plume dispersion and seismic considerations are subjects beyond the scope of this report.

The recent technical review and site inspection was held on May 26, 1992 (see Appendix A for attendance list). In preparation for this review, the Company was requested to supply up-to-date technical information on the facility and to respond to specific questions relating to the proposed facility.

Portions of the following descriptive material have been excerpted from submissions made to the FERC and from other applicable documents.

Project Scope

YPLP is proposing to build a 797 mile chilled-gas pipeline to transport natural gas from Prudhoe Bay on Alaska's North Slope to Port Valdez on Alaska's southcentral coast. There it is to be converted to liquefied natural gas (LNG), loaded aboard ships at an adjacent marine terminal and transported to Pacific Rim markets. The entire project is known as the Trans-Alaska Gas System (TAGS). In addition to the above facilities described herein, a Gas Conditioning Facility would be required in the Prudhoe Bay area to deliver to the pipeline natural gas of a quality suitable for pipeline transportation and subsequent conversion to LNG at Anderson Bay.

At full development, the project would utilize 2800 MMSCFD of raw gas at the Prudhoe Bay site. An average of 2300 MMSCFD of conditioned feed gas is proposed for pipeline transportation to liquefaction facilities. After fuel gas utilization by system equipment, an average of 2100 MMSCFD would be converted to LNG. Approximately 14 million tons/yr of LNG is to be loaded into tankers.

Decisions on the Gas Conditioning Facility (GCF) are pending. The GCF would receive natural gas that is presently being reinjected into the oil-producing formation. Although decisions on the GCF have not been finalized, a proposed conceptual GCF could consist of multiple extraction trains schematically consisting of several elements: a low temperature separator to remove entrained liquid hydrocarbons from the feed gas; a treating unit to remove carbon dioxide; mechanical refrigeration for temperature control of dewpoint; and a system to reblend liquids to regulate the BTU value of the natural gas. The extracted impurities, including carbon dioxide which ranges to 12 percent or more, would be reinjected into the north slope fields.

The proposed Trans-Alaskan pipeline is to extend approximately 797 miles from Prudhoe Bay to Port Valdez, Alaska and generally follows the route adjacent to the Trans-Alaska Oil Pipeline System (TAPS). Operational characteristics of the pipeline entail chilled gas flowing through the northern portion and warmer gas flowing through the southern portion. The pipeline would be constructed primarily underground and would be elevated only at active fault and major river crossings that are considered geotechnically and environmentally sensitive.

Seasonal operating temperatures of the natural gas flowing through the pipeline would range from -10^{o} F (minimum) to $+32^{o}$ F for chilled gas operations and above $+32^{o}$ F (minimum) for warm gas operations. Operating pressures would range from 1100 psig to 2220 psig with the gas arriving at the LNG plant at a design condition of 1300 psig and between $30\text{-}40^{o}$ F.

Preliminary plans indicate three compressor stations spaced over the length of the pipeline. A typical compressor station would be equipped with natural gas-fueled turbines to drive centrifugal compressor units. In addition to refrigeration required to maintain chilled gas conditions, additional turbine/compressor units would be utilized to circulate freon or similar refrigerant.

At the southern terminus of the pipeline, LNG plant facilities would receive gas throughput at a design pressure of 1300 psig. After removal of residual moisture and impurities by separators, driers and filter equipment, the gas would be liquefied through a series of refrigeration steps at successively lower temperatures. It is proposed that LNG would be stored in 800,000 barrel aboveground storage tanks. Loading LNG into tankers would be accomplished by a system of cryogenic pumps, transfer lines and articulated loading arms. The transfer system would extend from the storage tanks to the tanker berths along dock trestle structures.

Marine terminal structures including trestles, mooring dolphins and two tanker berths would extend from shoreline to harbor area water depths of about 50 feet. These structures would be designed for berthing 125,000 cubic meter capacity LNG tankers. The tankers are approximately 940 feet long and would have a nominal loading capacity of 125,000 cubic meters. The tankers require about 40 feet of water. At full development, the project would require 15 vessels and an estimated 280 dockings per year at Anderson Bay.

Construction sequencing of major components of the liquefaction and marine facility would be determined by market forces. Although full development, as now conceived, would consist of four liquefaction trains, four 800,000 barrel LNG storage tanks and two marine loading docks, initial construction would be predicated upon market demands for the product. Initial construction, at minimum, would consist of one liquefaction train, one LNG storage tank and one marine loading dock. It is anticipated that a five to six year ramp-up period may occur from the time of initial deliveries to operation at full capacity with a fully developed facility. Expansion possibilities include one additional liquefaction train and one additional LNG storage tank.

In summary, at full development, the principal components of the project as presently conceived are: a 797-mile, 42-inch diameter, buried and chilled natural gas pipeline from Prudhoe Bay to Port Valdez with a design capacity of 2300 MMSCFD of natural gas; compressor stations strategically located along the pipeline; a liquefaction facility at Port Valdez that would include four LNG processing trains to remove impurities from incoming gas and to condense the natural gas to LNG for storage and shipping; four LNG storage tanks, each with an individual capacity of 800,000 barrels; a marine terminal to simultaneously berth and load two LNG tankers and ocean transport vessels having individual cargo capacities of a nominal 125,000 cubic meters.

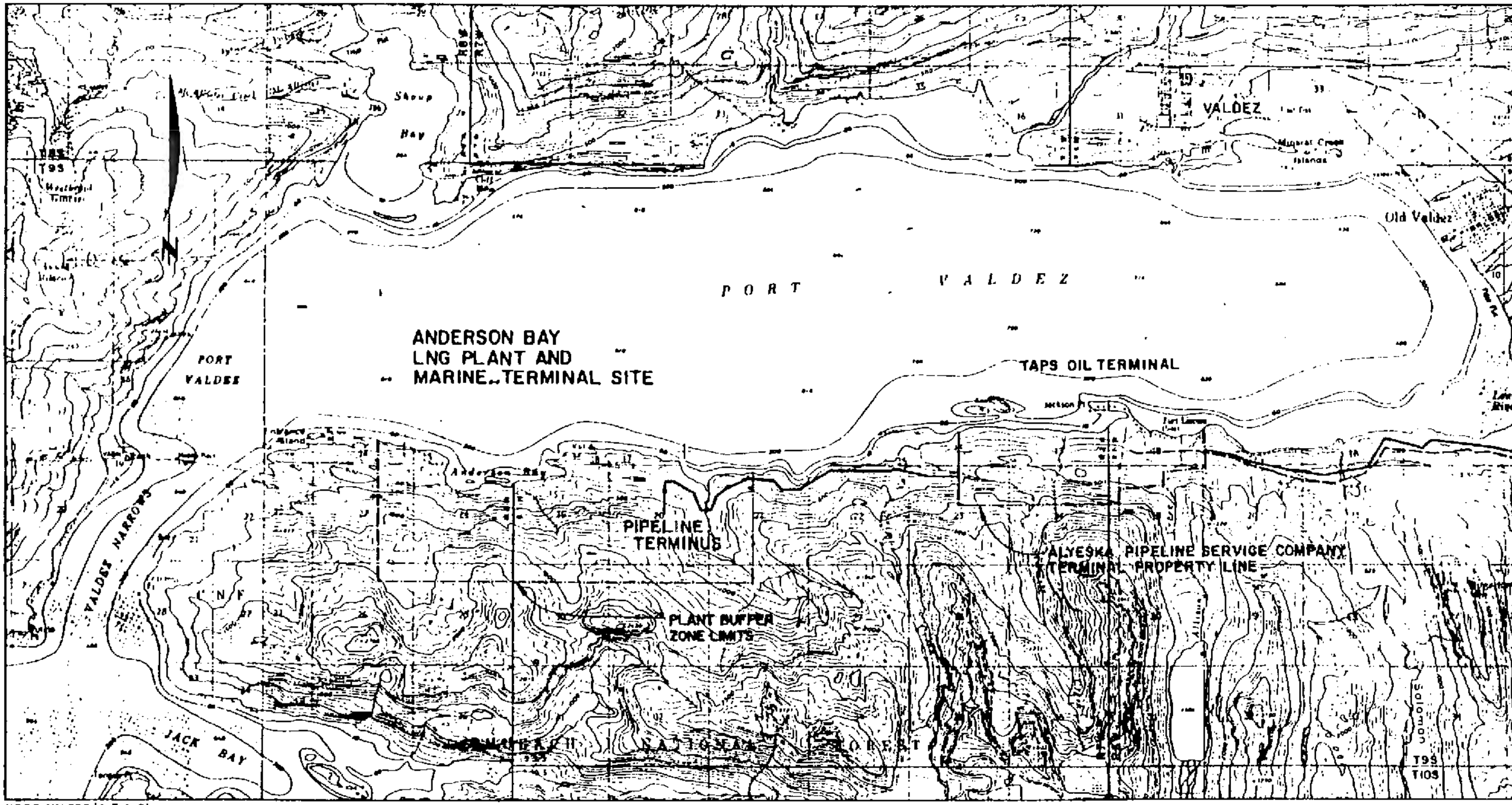
The present study is limited to the cryogenic aspects of the LNG facility and marine terminal.

Facility Location

The LNG facility and marine terminal would be located at the southern terminus of the gas pipeline at Anderson Bay in Port Valdez, Alaska. The facility would be constructed on approximately 300 acres of a 2500 acre site owned by the State of Alaska. The site is 5.5 miles southwest of the city of Valdez, 3.5 miles west of TAPS marine terminal and approximately 3 miles inside the Valdez Narrows. The following figures show the Port Valdez area and an overview of the proposed LNG facility and marine terminal.

The proposed location is the southern shore of Port Valdez near Anderson Bay at approximately 146^{o} 31′ west longitude and 61^{o} 05′ north latitude. Anderson Bay is an indentation on the southern shore of Port Valdez. There is no current or future planned access road to the projected LNG production plant and associated marine facilities. Consequently, all transportation of personnel, supplies and materials for construction and plant operation would be by air and waterborne traffic.

The proposed plant site is located on the northern slope of steep hills and is heavily wooded and intersected by small streams. The steep slope continues into the bay reaching 100 fathoms water depth at 1000 feet offshore.



U.S.G.S. VALDEZ (A-7, A-8)

LEGEND

- PROPOSED TAGS PIPELINE (BELOW GROUND)
- EXISTING TAPS PIPELINE (BELOW GROUND)
- PROPERTY LINE

SCALE 1:63360

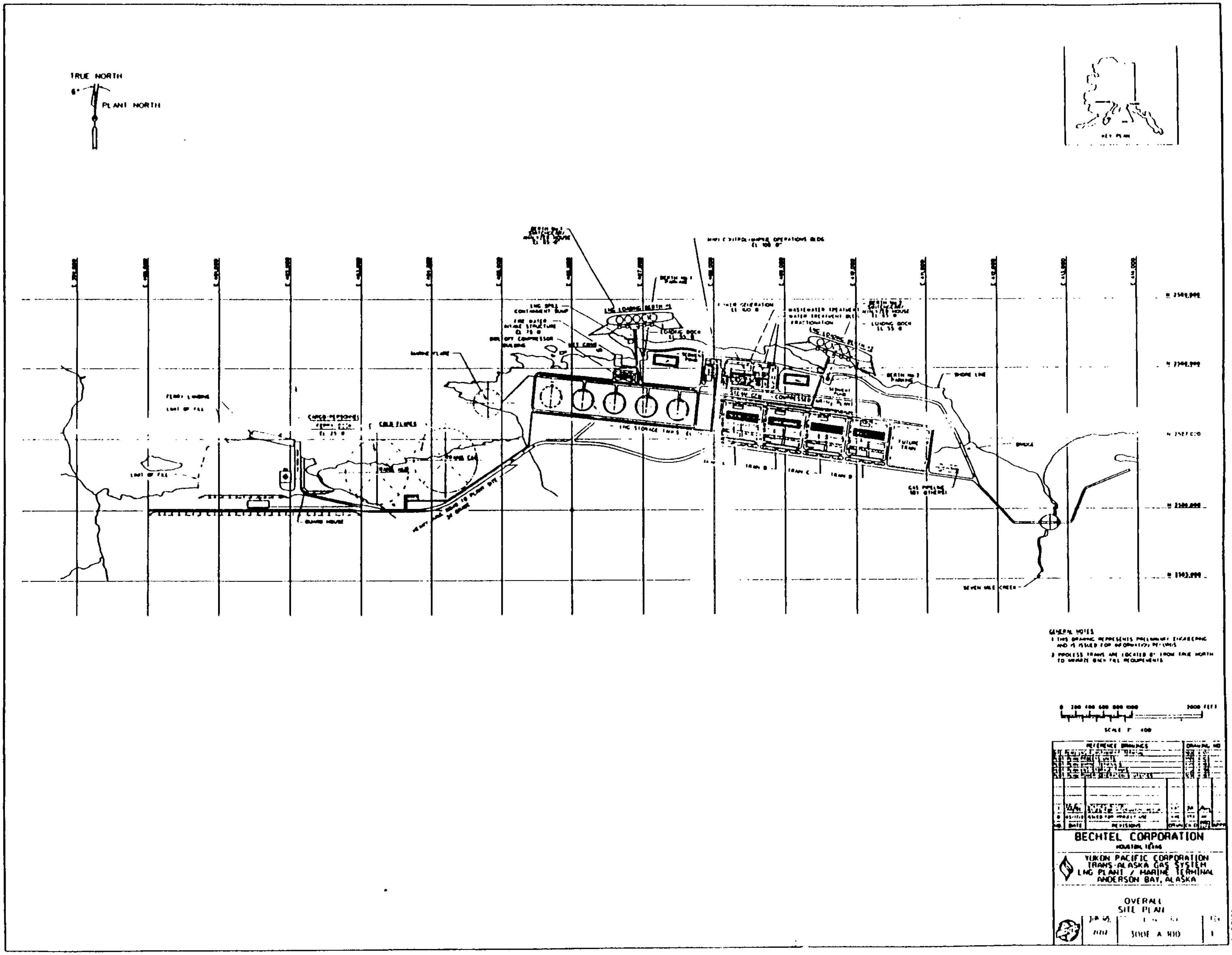
3000 0 3000 6000 9000 12000 15000 18000 21000

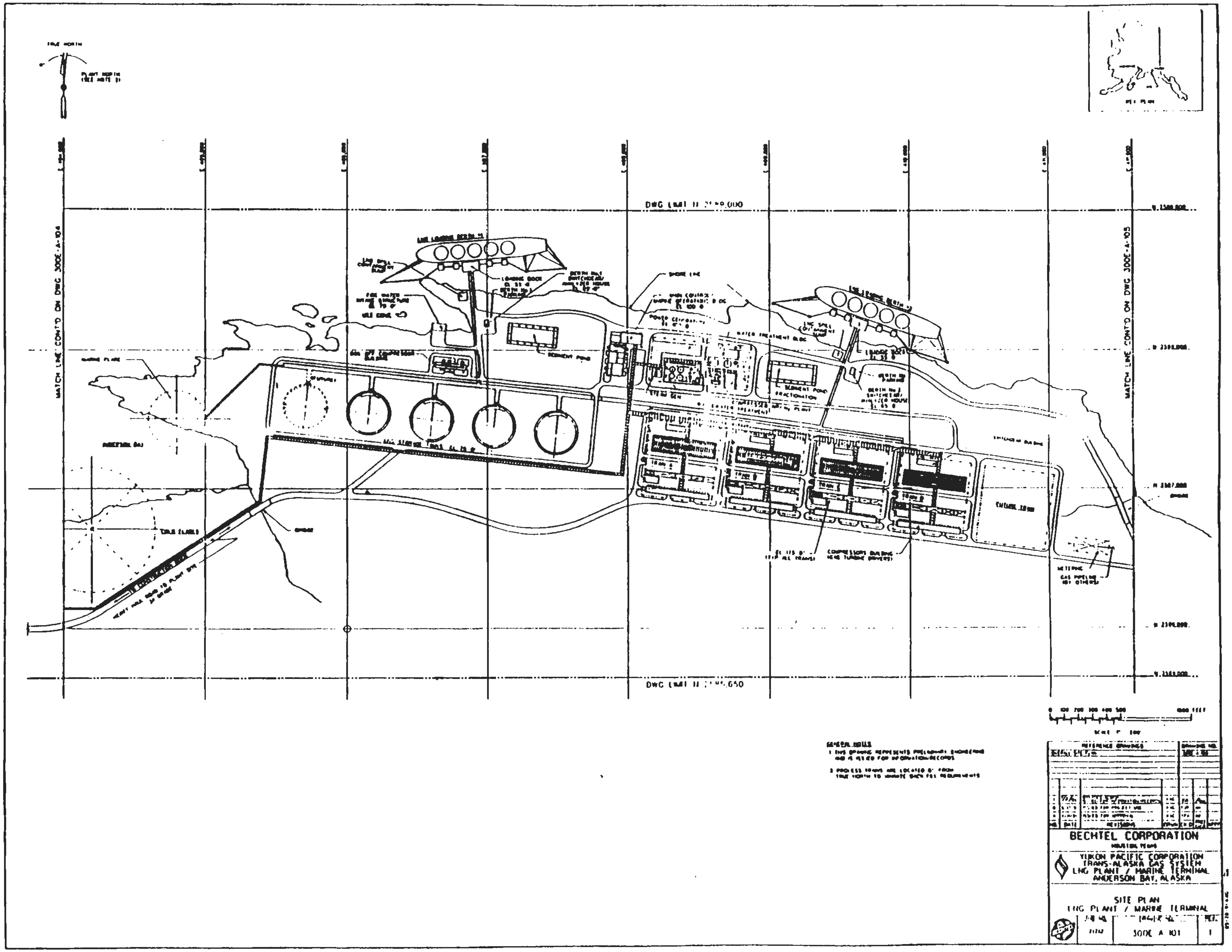
CONTOUR INTERVAL 100 FEET

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM

LNG PLANT / MARINE
TERMINAL SITE
LOCATION MAP

Figure B-1


TRUE NORTH
PLANT NORTH
LNG LOADING BERTH #1
LNG STORAGE TANKS
LNG LOADING BERTH #2
MARINE FLARE
FERRY LANDING
LIMIT OF FILL
GUARD HOUSE
SHORE LINE
FUTURE TRAIN
TRAIN B
TRAIN C
TRAIN D
GAS PIPELINE
SEVEN MILE CREEK
KEY PLAN
GENERAL NOTES
SCALE 1" = 400'
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
OVERALL
SITE PLAN

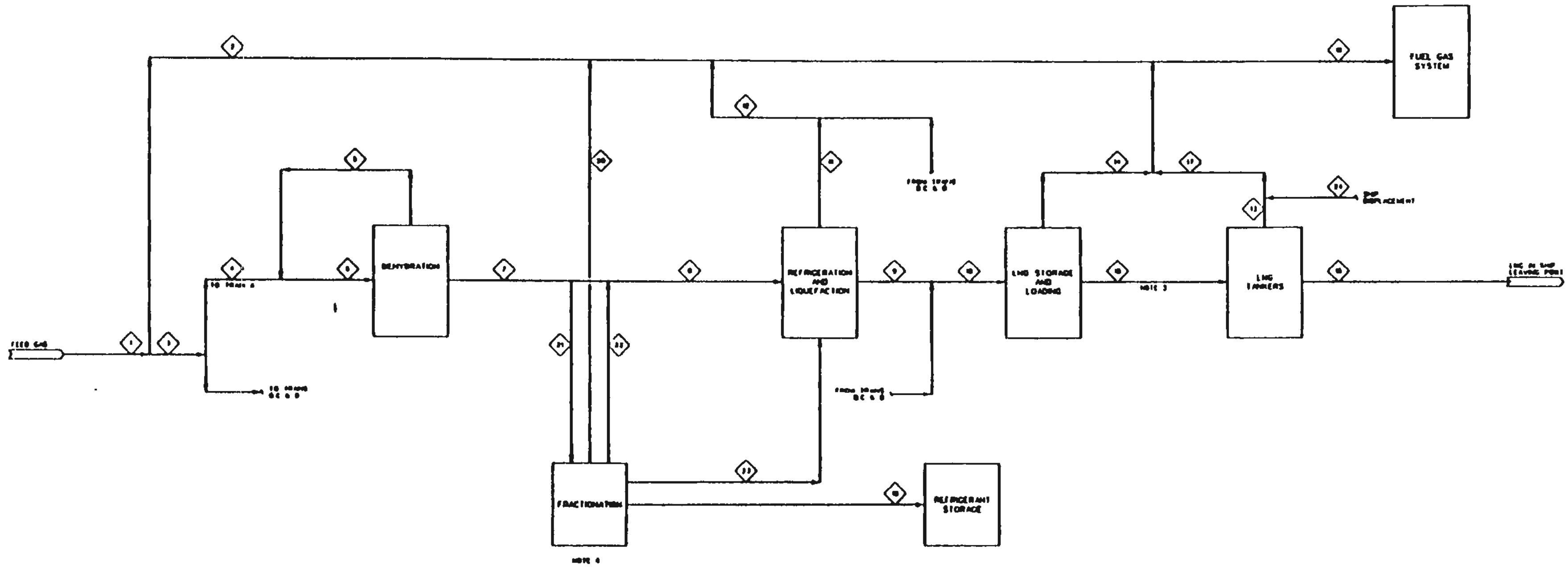

MATCH LINE CONT'D ON DWG 300E-A-104
MATCH LINE CONT'D ON DWG 300E-A-105
DWG LIMIT
LNG STORAGE TANKS
WATER TREATMENT BLDG
SEDIMENT POND
FRACTIONATION
COMPRESSOR BUILDING
SHORE LINE
SHORE
ANDERSON BAY
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
SITE PLAN
LNG PLANT / MARINE TERMINAL
300E A 101

Process Description

The major components of the fully developed proposed LNG facility would include four LNG trains (including dehydration, refrigerant separation and liquefaction systems), four 800,000 barrel aboveground LNG storage tanks, an LNG transfer system to load LNG tanker vessels and marine facilities to berth and load LNG tankers. A cargo dock and personnel ferry landing would be constructed at the west end of the site and would be connected to the LNG plant and marine terminal by a service road. Other facilities would include safety and control functions, power generation, water desalination, wastewater treatment and other utilities.

The total storage capacity of the four LNG storage tanks (3,200,000 barrels) is intended to provide 5.3 days of storage at the proposed LNG production rate of 2100 MMSCFD. The marine terminal is to be designed to simultaneously berth two tankers of nominal 125,000 cubic meter capacity approximately parallel to the shoreline in a minimum of 50 feet of water.

The proposed LNG Export Facility is in a preliminary design stage. Numerical values quoted in the present report are based on design conditions, anticipated performance, equipment specifications and/or material performance data as indicated by YPLP. Actual operating values or performance may differ. In many instances, information is only approximate and should be considered as representative of typical values. In some instances, conflicting numerical values have been reported in material submitted by YPLP - inconsistencies may therefore be present in the technical information presented herein.



NOTES:

1. THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS.
2. THE MATERIAL BALANCE IS BASED ON [illegible] OF THE TIME NON-LOADING AND [illegible] OF THE TIME LOADING ONE SHIP.
3. ◇ THE ACTUAL SHIP LOADING RATE IS [illegible]
4. THE SLIPSTREAM TO FRACTIONATION CAN BE TAKEN FROM ANY ONE OF THE FOUR TRAINS.

STREAM NO.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
DESCRIPTION	NATURAL GAS FEED	MAKE-UP FUEL	NATURAL GAS FEED	NATURAL GAS FEED (1 TRAIN)	REACTIVATION GAS (1 TRAIN)	FEED TO DEHYDRATION (1 TRAIN)	FEED AFTER DEHYDRATION (1 TRAIN)	FEED TO REFRIGERATION (1 TRAIN)	LNG TO TANK (1 TRAIN)	LNG TO TANK	PROCESS FLASH GAS (1 TRAIN)	PROCESS FLASH GAS	SHIP VAPOR RETURN	TANK VAPOR	COMBINED SHIP LOADING NON-LOADING AVERAGE	LNG TO SHIP	SHIP VAPOR & DISPLACEMENT	ETHANE AND PROPANE REFRIGERANT	VAPOR TO FUEL	DE-ETHANIZER OVERHEAD VAPOR TO FUEL	FEED TO FRACTIONATION	FRACTIONATION RETURN PROCESS STREAM	REINJECTION	SHIP DISPLACEMENT
MMSCFD	2,300.00	2.10	2,301.00	575.75	23.01	598.76	575.75	575.01	547.13	2,187.00	25.51	102.20	10.01	42.90	[illegible]	[illegible]	10.00	2.00	100.70	1.00	254.03	230.10	1.00	7.72
GPM	-	-	-	-	-	-	-	-	4,700	18,191	-	-		-	18,700	18,833	-	1,511	-	-	-	-	1,032	-
LB/HR TOTAL	4,000,000	4,357	4,004,100	1,146,000	45,047	1,191,000	1,146,000	1,127,000	1,004,000	4,000,000	47,070	191,300	20,151	70,000	4,310,000	4,290,000	24,240	8,703	303,000	2,305	450,100	419,200	7,410	14,141
MOL. WT.	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
COMPONENT, LB MOLE/HR																								
NITROGEN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]
METHANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ETHANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PROPANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0
i-BUTANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0
n-BUTANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	0
i-PENTANE	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	0	0	0	[illegible]	0	[illegible]	0
n-PENTANE	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	0	0	0	[illegible]	0	[illegible]	0
n-HEXANE	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]	[illegible]	0	0	0	0	[illegible]	0	[illegible]	0
WATER	[illegible]	0	[illegible]	[illegible]	1.0	[illegible]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	[illegible]
TOTAL LB MOLE/HR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DENSITY LB/FT³	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

REFERENCE DRAWINGS | DRAWING NO.

B | ISSUED FOR INFORMATION/RECORDS
A | ISSUED FOR REVIEW
NO. | DATE | REVISIONS

BECHTEL CORPORATION
HOUSTON, TEXAS

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

OVERALL BLOCK FLOW DIAGRAM

JOB NO. 21712 | DRAWING NO. 300E B 001 | REV. B

Dehydration System

The feed gas would enter the liquefaction facility via the 42-inch pipeline at approximately 1300 psig. Estimated total throughput is approximately 2300 MMSCFD. A side stream of approximately 2 MMSCFD would be removed from the feed gas stream for makeup for the fuel gas system (actual demand would depend on shortfall in fuel gas requirements and on the status of loading operations). The estimated composition of the feed gas (units in mole percent) is as follows:

Design Feed Gas Composition

Nitrogen	0.70
Methane	89.87
Ethane	5.94
Propane	1.88
i-Butane	0.75
n-Butane	0.82
i-Pentane	0.02
n-Pentane	0.01
n-Hexane	0.01

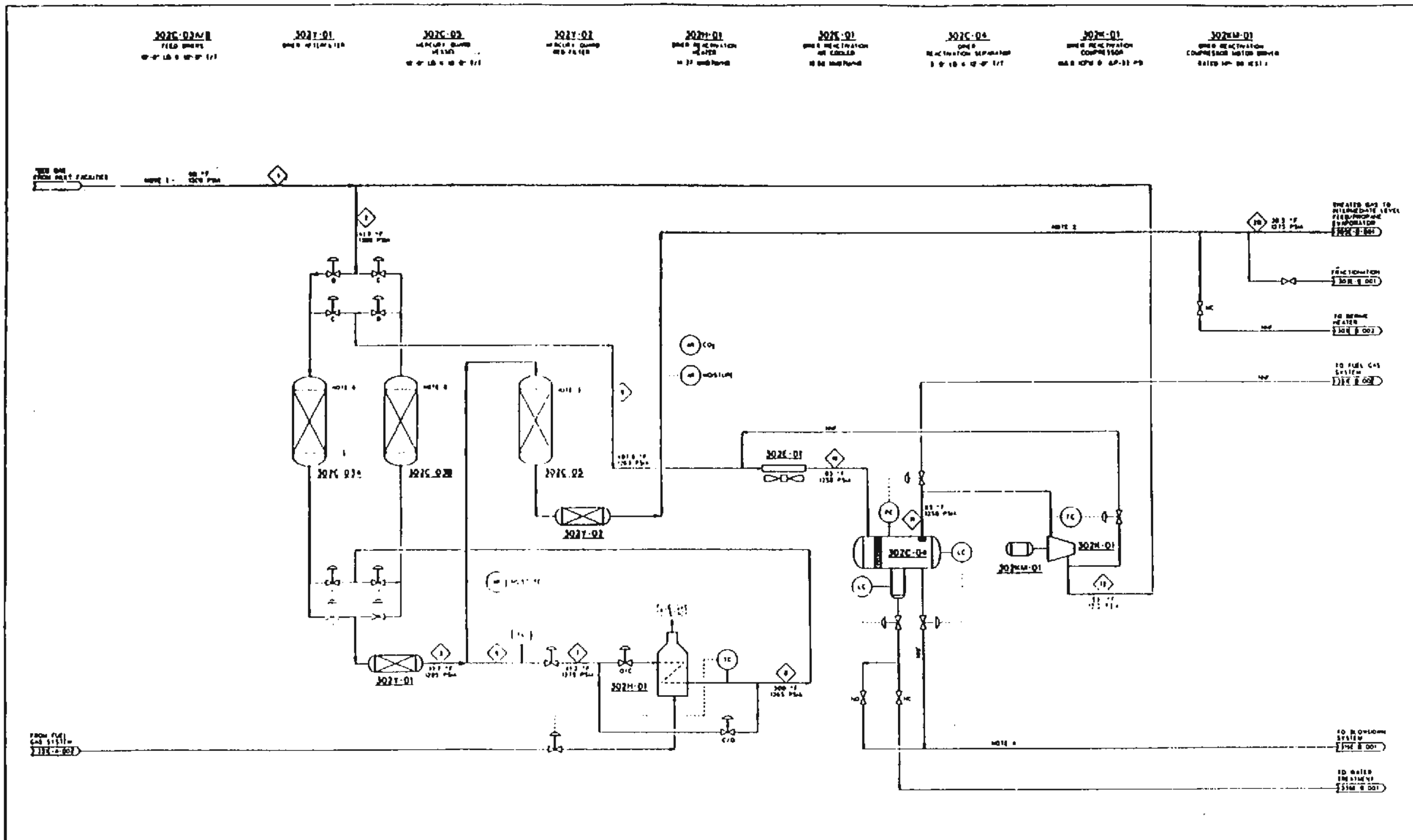
Feed gas water content is estimated to be 4.2 ppmv. Carbon dioxide, most of the water and heavier hydrocarbons are to be removed from the natural gas at the Gas Conditioning Facility (GCF) located at Prudhoe Bay prior to entering the pipeline transmission system. However, for design purposes, a carbon dioxide concentration of 120 ppmv has been assumed. Although construction and operation of the GCF is not presently considered a part of the TAGS application, decisions remain pending.

The feed gas in the 42-inch pipeline would enter the liquefaction system where the first stage of pretreatment is dehydration. Prior to entering the dehydration process, the feed gas would be divided into four 20-inch lines, each going to separate but identical parallel trains ultimately leading to liquefaction and storage. Each train would receive natural gas at a design flow rate of 576 MMSCFD. The description that follows represents typical anticipated characteristics of each of the four trains.

The feed gas would first enter a Feed Separator to remove pipeline liquids - accumulated liquids being removed from the separator via a 2-inch blowdown line utilizing liquid level regulated control. (The proposed dehydration system is shown in the following schematic diagrams.) Exiting the feed gas separator, the feed gas would enter one of two parallel Feed Driers. Each drier is to contain molecular sieves with an anticipated active drying time of 48 hours and an anticipated regeneration time of four hours (two hours heating and two hours cooling). Parallel operation permits reactivation of the offline saturated drier. The water impurity exiting the active drier is anticipated to be one ppmv. Following the drier towers, a Drier Afterfilter would be utilized to remove adsorbent dust from the feed gas.

Reactivation of the saturated drier (offline) column would be performed by a side stream taken from the dried feed gas stream exiting the active drier. The side stream reactivation gas would have a flow rate of approximately 23 MMSCFD. The reactivation gas would be heated to approximately 500^{o} F at a pressure of approximately 1265 psia and would reenter the saturated drier to be reactivated in reverse flow direction. Exiting the top of the drier, the reactivation gas would be cooled in a Drier Reactivation Air Cooler (fin-fan type) followed by a Drier Reactivation Separator to remove liquid water and condensed hydrocarbons. The gas leaving the separator would 1) be compressed to feed gas pressure by a 60-horsepower motor-driven non-lubricated centrifugal Drier Reactivation Compressor and would be piped to the feed gas stream entering the active drier, or 2) be sent to the fuel gas distribution system.

The dried feed gas leaving the Drier Afterfilter would enter a single Mercury Guard Vessel followed by a Mercury Guard Vessel Filter. The presence of elemental mercury in the feed gas stream has been estimated to be 0 ppbv (normal) and 20 ppbv (maximum) pending final analysis of the supply gas. The purpose of the mercury guard system is to adsorb mercury to protect subsequent components (primarily aluminum heat exchangers) of the liquefaction train from the potential of mercury induced corrosion. Such corrosion might occur with the existence of elemental mercury, particularly in the presence of water vapor. The Mercury Guard Vessel is to contain sulfur-impregnated activated carbon with an anticipated operational life of 3-5 years depending on the mercury content of the feed gas. The guard vessel material would be non-regenerative. The saturated adsorbent material would be returned to the manufacturer for reclamation and/or proper disposal. Sample connection points are to be provided at several locations on the vessel to monitor for possible mercury breakthrough.



NOTE 5

STREAM NO	1	2	3	6	7	8	9	10	11	12	20
DESCRIPTION	FEED GAS	FEED GAS TO DRYER	FEED GAS FROM DRYER	REACTIVATION GAS	REACTIVATION GAS TO HEATER	REACTIVATION GAS TO DRYER	REACTIVATION GAS TO AIR COOLER	COOLED REACTIVATION GAS	REACTIVATION GAS TO COMPRESSOR	REACTIVATION GAS TO FEED	FEED GAS AFTER MERCURY REMOVAL
MMSCFD	575.75	600.77	600.73	33.00	33.00	33.00	33.05	33.04	33.01	33.01	575.75
BPD	-	-	-	-	-	-	-	0.1520	-	-	-
LB/HR TOTAL	1,148,700	1,184,600	1,184,000	65,000	65,000	65,000	65,094	65,094	65,917	65,917	1,148,700
MOL WT	18.17	18.17	18.17	18.17	18.17	18.17	18.17	18.17	18.17	18.17	18.17
COMPONENT LB MOLE/HR											
NITROGEN	443.50	460.15	460.15	17.00	17.00	17.00	17.00	17.00	17.00	17.00	443.50
METHANE	56,083.43	56,070.00	56,070.00	3,300.45	3,300.45	3,300.45	3,300.45	2,300.00	2,300.00	3,300.45	56,083.43
ETHANE	3,734.01	3,004.01	3,004.01	100.00	100.00	100.00	100.00	100.00	100.00	100.00	3,734.01
ETHYLENE	0	0	0	0	0	0	0	0	0	0	0
PROPANE	1,180.43	1,035.90	1,035.90	47.47	47.47	47.47	47.47	47.43	47.47	47.47	1,180.43
i-BUTANE	414.11	403.04	403.04	10.94	10.94	10.94	10.94	10.94	10.94	10.94	414.11
n-BUTANE	510.36	330.00	330.00	30.71	30.71	30.71	30.71	30.71	30.71	30.71	510.36
i-PENTANE	12.64	13.15	11.15	0.34	0.34	0.31	0.31	0.34	0.31	3.37	12.64
n-PENTANE	6.33	0.57	0.51	0.25	0.25	0.25	0.25	0.25	0.25	0.25	6.12
n-HEXANE	6.32	0.57	0.57	0.25	0.25	0.25	0.25	0.25	0.25	0.25	6.12
WATER	0.37	1.05	0	0	0	0	5.05	5.05	1.50	1.50	0
TOTAL LB MOLE/HR	63,3[illegible]	65,7[illegible]	65,750.10	3,575.25	3,575.25	3,575.15	3,5[illegible]	3,5[illegible]	3,510.6[illegible]	3,510.6[illegible]	65,311.0[illegible]
DENSITY LB/FT3	5.01	5.02	5.01	5.01	5.01	3.14	3.27	[illegible]	4.90	5.01	5.70
VISCOSITY CP	0.01	0.01	0.01	0.01	0.01	0.02	0.02	[illegible]	0.01	0.01	0.01
SURF TENSION DYNE/CM		-	-		-	-	-	71.51			

NOTES

1. A FEED SEPARATOR UPSTREAM OF THE FEED DRYERS MAY BE REQUIRED IF KNOCK OUT DRUM AT THE INLET FACILITIES IS NOT SUFFICIENT TO REMOVE THE BULK OF THE CONDENSED HYDROCARBON AND WATER.
2. TRACE COMPONENTS IN TREATED GAS ARE AS FOLLOWS:
   - WATER - 1 PPMV (MAX)
   - MERCURY - 0.01 PPBV (MAX)
   - CARBON DIOXIDE - 100 PPMV
   - BENZENE - 3 PPMV
3. THREE SAMPLE CONNECTIONS AT TOP MIDDLE AND BOTTOM PORTIONS OF THE BED ARE TO BE PROVIDED ON THE MERCURY REMOVAL VESSEL FOR MERCURY CONTENT ANALYSIS.
4. WATER FLOW IS 3.30 LB MOLE/HR DURING DRYER REACTIVATION CYCLE.
5. EQUIPMENT SIZING AND MATERIAL BALANCE BASED ON PRODUCTION FROM ONE TRAIN. THERE ARE FOUR TRAINS TOTAL.
6. THERMOWELLS ARE TO BE PROVIDED AT TOP MIDDLE AND BOTTOM PORTIONS OF THE FEED DRYERS TO MONITOR THE REACTIVATION GAS TEMPERATURE.

REFERENCE DRAWINGS	DRAWING NO

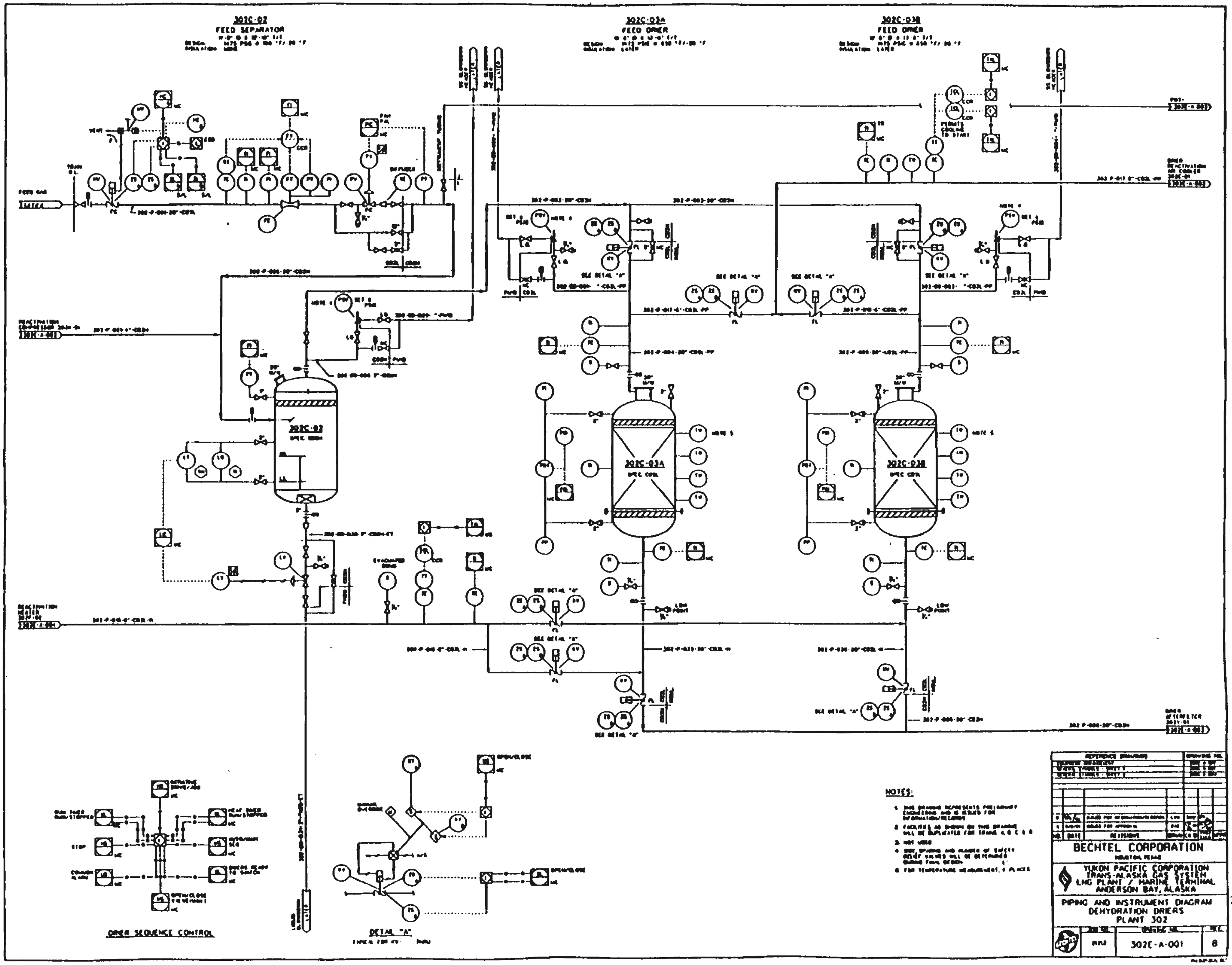
NO	DATE	REVISIONS
7		[illegible]
6		[illegible]
5		ISSUED FOR [illegible]
4		ISSUED FOR REVIEW

BECHTEL CORPORATION
HOUSTON, TEXAS

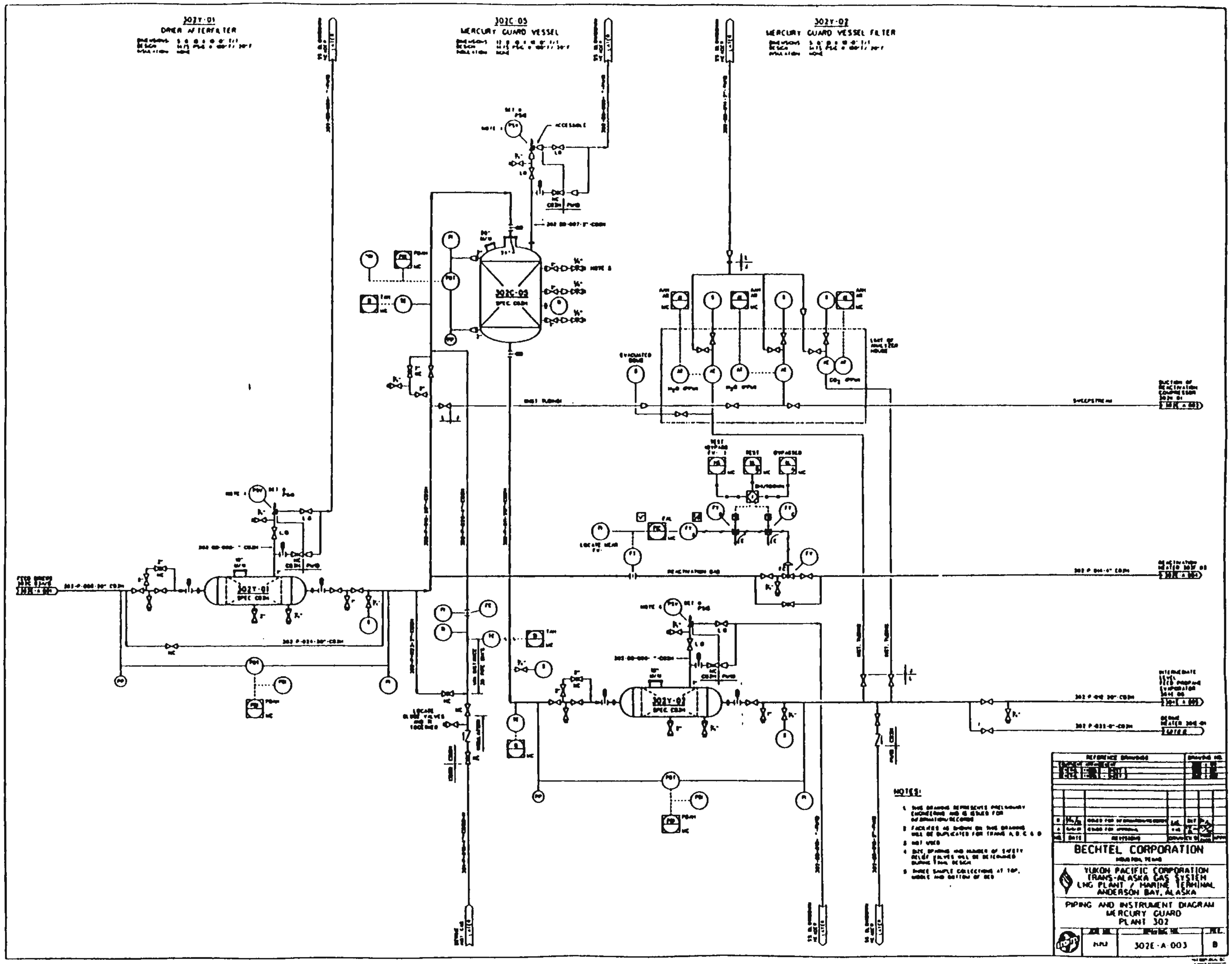
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
DEHYDRATION & MERCURY REMOVAL
PLANT 302

JOB NO.	DRAWING NO.	REV.
[illegible]	302C-B 001	F



302C-02
FEED SEPARATOR
302C-03A
FEED DRIER
302C-03B
FEED DRIER
302C-02
302C-03A
302C-03B
DETAIL "A"
DRIER SEQUENCE CONTROL
NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PIPING AND INSTRUMENT DIAGRAM
DEHYDRATION DRIERS
PLANT 302
302E-A-001
8


302Y-01
302C-05
MERCURY GUARD VESSEL
302Y-02
MERCURY GUARD VESSEL FILTER
302C-05
302Y-01
302Y-02
NOTES:
BECHTEL CORPORATION
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TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PIPING AND INSTRUMENT DIAGRAM
MERCURY GUARD
PLANT 302
302E-A-003

Fractionation System

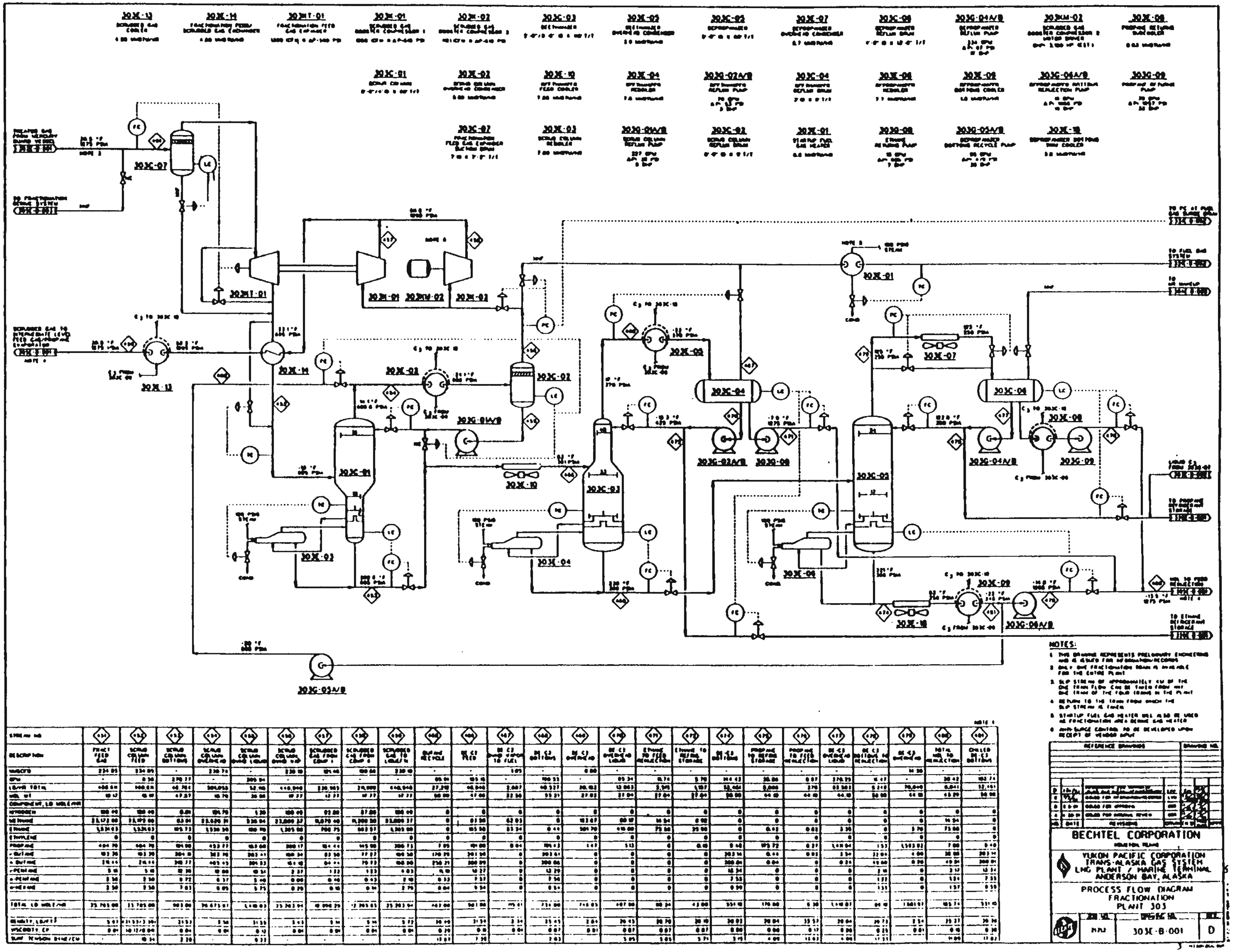
Refrigerants required in the proposed refrigeration system for the natural gas liquefaction portion of the facility would consist of nitrogen, methane, ethane and propane. Nitrogen would be obtained from an onsite air separation plant while methane would be obtained from the feed gas process stream. The other hydrocarbon refrigerants (ethane and propane) are to be extracted from the feed gas by a fractionation system. Only one fractionation system would be provided for the entire facility but would have the capability of utilizing treated feed gas following the dehydration system from any one of the proposed four trains.

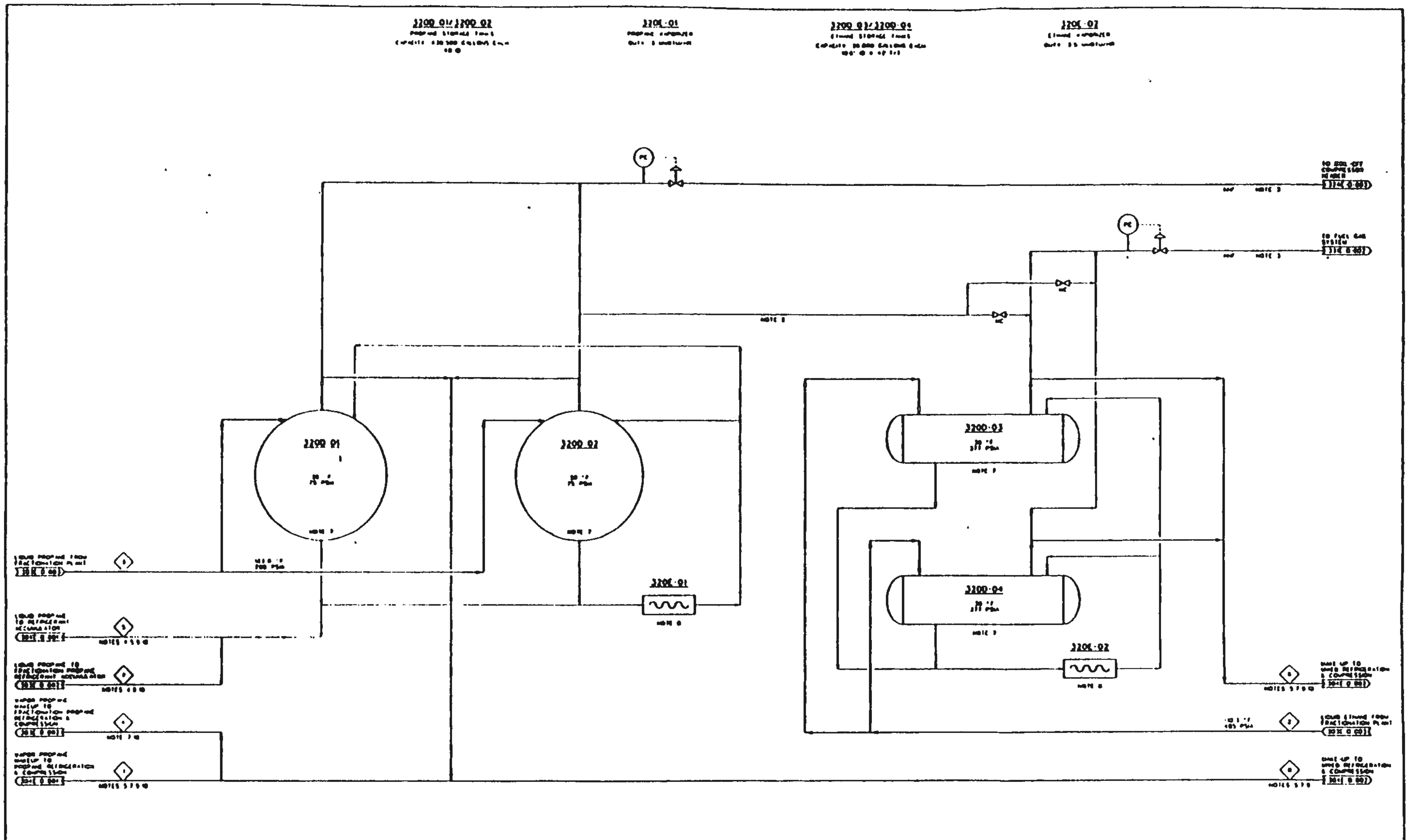
Feed gas for the fractionation system would be taken as a slipstream consisting of approximately 235 MMSCFD (41 percent of the total single train flow rate). During the process of extracting ethane and propane, effluent gases consisting primarily of the remaining feed gas components flow back to the liquefaction train from which it was taken (98 percent of the slipstream; thus flow through the liquefaction train is not appreciably reduced). The composition of the return flow to the main feed gas line is estimated at 0.71 percent nitrogen, 91.40 percent methane, 5.41 percent ethane, 1.19 percent propane and 1.29 percent heavier hydrocarbons. Minor quantities of noncondensed gases are to be rejected to the fuel gas system and to the liquefaction system. The extracted refrigerants, ethane and propane, would amount to about one percent of the total slipstream. Ethane would be produced at about 5.7 gallons per minute (1197 pounds per hour) and propane would be produced at about 35.86 gallons per minute (8064 pounds per hour). Onsite refrigerant storage tanks would consist of two insulated 26,000 gallon ethane tanks (design conditions 38^{0} F and 377 psia) and two uninsulated 430,500 gallon propane tanks (design conditions of 38^{o} F and 75 psia).

Schematic diagrams for the proposed fractionation system are shown in the following drawings. The slipstream would enter the system through a Feed Gas Expander Suction Drum for possible fluid separation and would be expanded in the Fractionation Feed Gas Expander from inlet conditions to a design discharge pressure of 695 psia (1309 icfm, 580 psi differential pressure). Following expansion, the cooled gas would enter a Scrub Column, where the more volatile components, primarily nitrogen and methane, would be separated from the heavier hydrocarbons. The effluent gases would be compressed and ultimately returned to the liquefaction train from which it was taken by two parallel compressors: Scrubbed Gas Booster Compressor 1 utilizing power from the Fractionation Feed Gas Expander and Scrubbed Gas Booster Compressor 2 utilizing an independent electric-motor drive.

The condensibles from the Scrub Column would be removed and sent to a Deethanizer column. Gaseous ethane is to be extracted from the top of the column, condensed and transferred to the ethane storage tanks. The bottoms from the Deethanizer column would flow to the Depropanizer column wherein propane would be separated from the remaining hydrocarbons. Propane is to be extracted from the top of the column, condensed and transferred to the propane storage tanks.

Refrigeration in the fractionation system required for condensers and coolers would be provided by a propane refrigeration loop. Circulation within the loop would be provided by the Fractionation Propane Compressor having an anticipated flow rate of 10,251 icfm and providing a differential pressure of 136.4 psi (158.2 psia discharge pressure). Propane for the refrigeration loop would be derived from the propane storage tanks.


NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PROCESS FLOW DIAGRAM
FRACTIONATION
PLANT 303
303C-B-001
D



STREAM NO.	1	2	3	4	5	6	7	8
DESCRIPTION	PROPANE MAKEUP TO C_3 REFRIG	ETHANE FROM FRACTIONATION	PROPANE FROM FRACTIONATION	PROPANE MAKEUP TO FRACT C_3	LIQUID INVENTORY TO 320E-01	C_2 MAKEUP TO MR REFRIG	LIQUID INVENTORY TO 320E-02	C_2 MAKEUP TO MR REFRIG
MMSCFD	0.33			0.02	[illegible]	0.05		0.05
GPM	-	0.90	35.01	-	130.04		[illegible]	-
LB/HR TOTAL	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MOL WT	44.10	[illegible]	44.1	44.10	44.10	30.07	44.10	44.10
COMPONENT, LB MOLE/HR								
NITROGEN	0	0	0	0	0	0	0	0
METHANE	0	[illegible]	0	0	0	0	0	0
ETHANE	0	[illegible]	[illegible]	0	0	[illegible]	0	0
ETHYLENE	0	0	0	0	0	0	0	0
PROPANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]
i-BUTANE	0	0	[illegible]	0	0	0	0	0
n-BUTANE	0	0	[illegible]	0	0	0	0	0
i-PENTANE	0	0	0	0	0	0	0	0
n-PENTANE	0	0	0	0	0	0	0	0
n-HEXANE	0	0	0	0	0	0	0	0
TOTAL, LB MOLE/HR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
DENSITY (LB/FT3)	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VISCOSITY, CP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SURF. TENSION, DYNE/CM		[illegible]	[illegible]		[illegible]		[illegible]	

NOTES:

1. THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS.
2. TEMPORARY PRESSURING LINE. ONLY USED PRIOR TO INITIAL ETHANE CHARGE TO TANK.
3. MAXIMUM VAPOR RATE IS PRODUCED BY FLASHING, VAPOR DISPLACEMENT AND BOIL OFF AS A RESULT OF HEAT LEAK DURING FILLING MODE.
4. MAXIMUM FLOW TO 320E-01 BASED ON [illegible] FILLING TIME AT AVERAGE AMBIENT TEMPERATURE.
5. FLOW RATE IS TYPICAL FOR LINE [illegible]
6. MAXIMUM FLOW TO 320E-02 BASED ON [illegible] FILLING TIME AT AVERAGE AMBIENT TEMPERATURE.
7. CONDITIONS AT AVERAGE AMBIENT TEMPERATURE.
8. VAPORIZER OPERATES INTERMITTENTLY FOR LOW PRESSURE CONDITIONS.
9. DISTRIBUTION SHOWN IS TYPICAL FOR LINE [illegible]
10. [illegible] AS PURE COMPONENT ONLY.

REFERENCE DRAWINGS | DRAWING NO.

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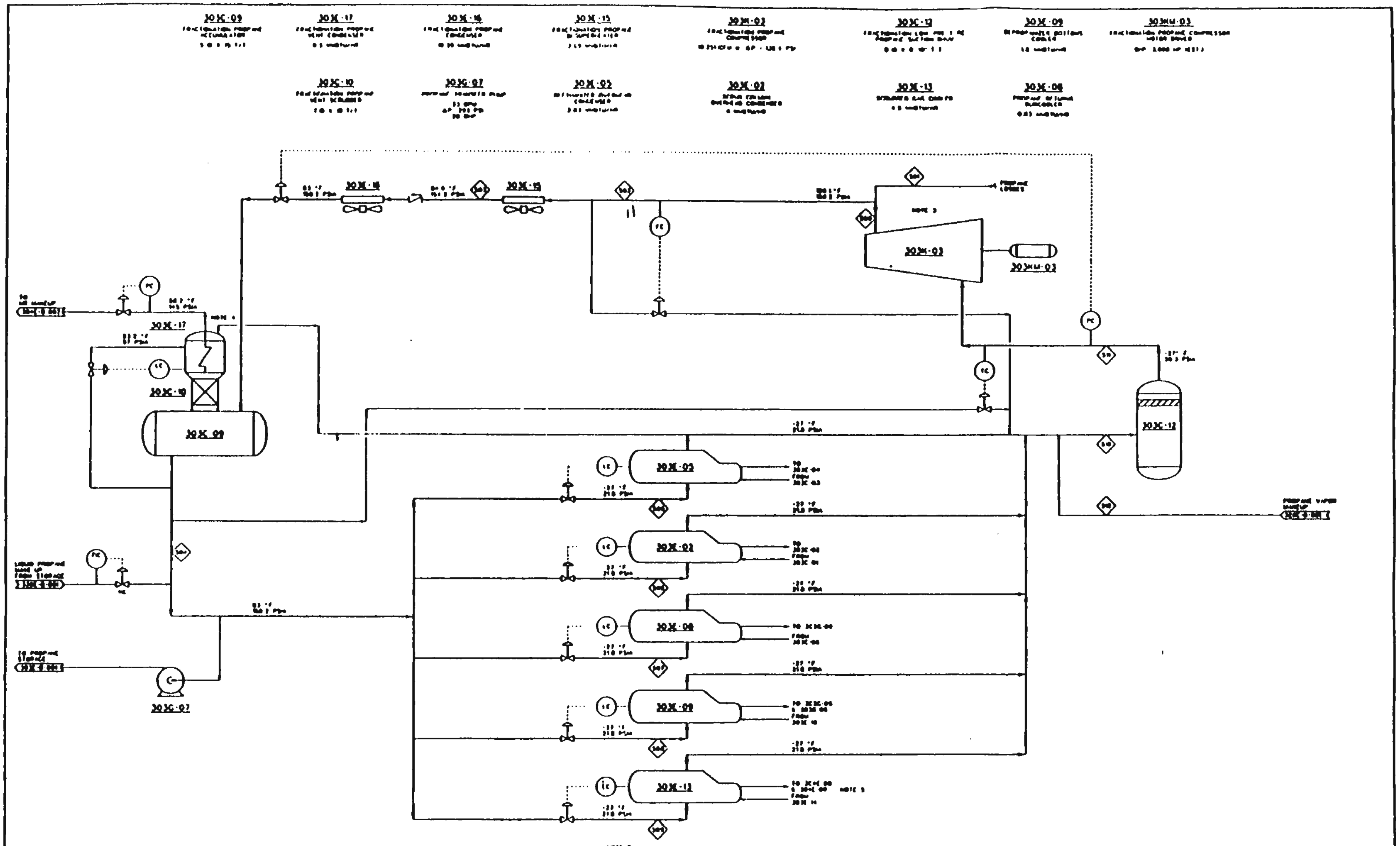
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
REFRIGERANT STORAGE
PLANT 320

DRAWING NO. 320C-B-001 REV. B



STREAM NO	300	301	302	303	304	305	306	307	308	309	310	311	312
DESCRIPTION	PROPANE COMPRESSOR DISCHARGE	PROPANE LOSS	PROPANE TO DESUPERHEATER	PROPANE TO CONDENSER	LIQUID PROPANE FROM ACCUMULATOR	PROPANE TO DE C3 OVERHEAD CONDENSER	PROPANE TO SCRUB COL OVERHEAD CONDENSER	PROPANE TO C3 REFLUX SUBCOOLER	PROPANE TO DE C3 BOTTOMS COOLER	PROPANE TO SCRUBBED GAS COOLER	VAPOR C3 TO LOW PRESS C3 SUCT DRUM	PROPANE COMPRESSOR INLET (NOTE 3)	PROPANE MAKE UP FROM STORAGE
MSCFD	27.93	0.02	27.93	27.93	-	[illegible]	[illegible]	0.03	[illegible]	1.00	27.93	27.93	0.02
GPM	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-	-	-
LB/HR TOTAL	[illegible]	70	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70
MOL WT	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1	44.1
COMPONENT, LB MOLE/HR													
NITROGEN	0	0	0	0	0	0	0	0	0	0	0	0	0
METHANE	0	0	0	0	0	0	0	0	0	0	0	0	0
ETHANE	0	0	0	0	0	0	0	0	0	0	0	0	0
PROPANE	[illegible]	1.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7
i-BUTANE	0	0	0	0	0	0	0	0	0	0	0	0	0
n-BUTANE	0	0	0	0	0	0	0	0	0	0	0	0	0
i-PENTANE	0	0	0	0	0	0	0	0	0	0	0	0	0
n-PENTANE	0	0	0	0	0	0	0	0	0	0	0	0	0
n-HEXANE	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL LB MOLE/HR	[illegible]	1.7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.7
DENSITY LB/FT3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
VISCOSITY CP	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
SURF TENSION DYNE/CM	-	-	-	-	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

NOTES:

1. [illegible]
2. [illegible]
3. [illegible]
4. [illegible]
5. [illegible]

BECHTEL CORPORATION

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
FRACTIONATION PROPANE REFRIG
& COMPRESSION - PLANT 303

DRAWING NO. 303E-B-002 | REV. 0

Liquefaction System

Pretreated feed gas from the Dehydration System would enter the Liquefaction System. Four individual trains are to be provided, each with its individual pretreatment system. The composition of the feed gas remains the same as that entering the facility with approximately 89.87 percent methane, water having been removed in the Dehydration System. The feed gas ultimately would be liquefied utilizing a Mixed Refrigerant (MR) Cycle. The constituents of the mixed refrigerant fluid would be nitrogen, methane, ethane and propane in appropriate proportions to achieve the desired result. Multi-stage precooling both for the MR refrigerant and for the feed gas would be provided by a closed-cycle propane refrigeration system.

Pretreated feed gas would enter the individual liquefaction trains via 20-inch lines at design conditions of 38.5° F and 1275 psia with a flow rate of 576 MMSCFD. The feed gas would be precooled in successive propane evaporators prior to entering the MR refrigeration portion of the system. The final stages of cooling and liquefaction would be achieved in the Main Cryogenic Heat Exchanger.

The source of refrigeration within the Main Cryogenic Heat Exchanger would be the MR fluid. The refrigerant in the closed-cycle MR system would be circulated by three centrifugal compressors each driven by 37,000 horsepower GE Frame-5 turbine. The compressors would be operated in series with individual suction drums and aftercoolers. A proposed plot plan and block diagrams indicating major components of the composite system are presented in the following drawings.

The high pressure MR fluid would be cooled in successive stages by propane evaporators. The precooled high pressure refrigerant then would flow to a liquid/vapor separator. The separated streams would provide refrigeration and ultimately liquefaction and subcooling of the feed gas stream within the Main Cryogenic Heat Exchanger. The combined warmed low pressure MR stream would exit the heat exchanger to reenter the suction of the Low Pressure MR Compressor.

The subcooled LNG exiting the Main Cryogenic Heat Exchanger would be expanded to a pressure of about 18 psia. An LNG Flash Drum is to separate flash gas that then would be warmed in the MR/Flash Gas Heat Exchanger and compressed to the Fuel Gas Distribution Header. Compression of the flash gas to the distribution header line pressure would be accomplished by a 6400 horsepower turbine-driven Flash Gas Compressor. Control of the degree of LNG subcooling in the Main Cryogenic Heat Exchanger is considered critical to preventing overall fuel gas supply imbalance caused by the additional fuel gas generated from ship loading operations with resultant vapor recovery.

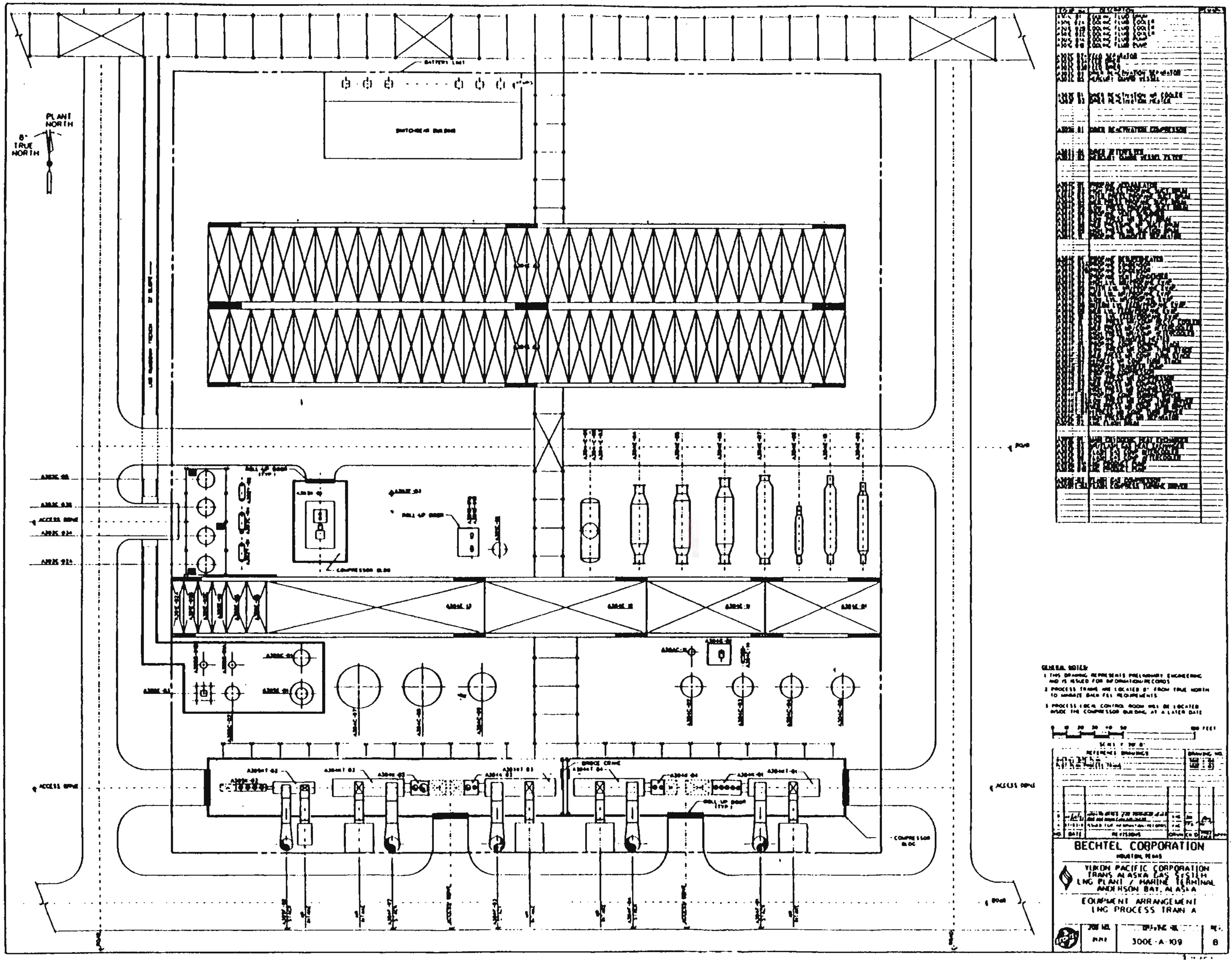
LNG from the LNG Flash Drum of each train would be pumped to the proposed 800,000 barrel LNG storage tanks at a design flow rate of 550 MMSCFD. Final expansion of the LNG reduces the pressure to storage tank conditions. The design density of the LNG to be transferred to the storage tanks is estimated to be 28.6 pounds per cubic foot. Based on the proposed system parameters, the design LNG composition is estimated to be as follows:

<u>Design LNG Composition</u>

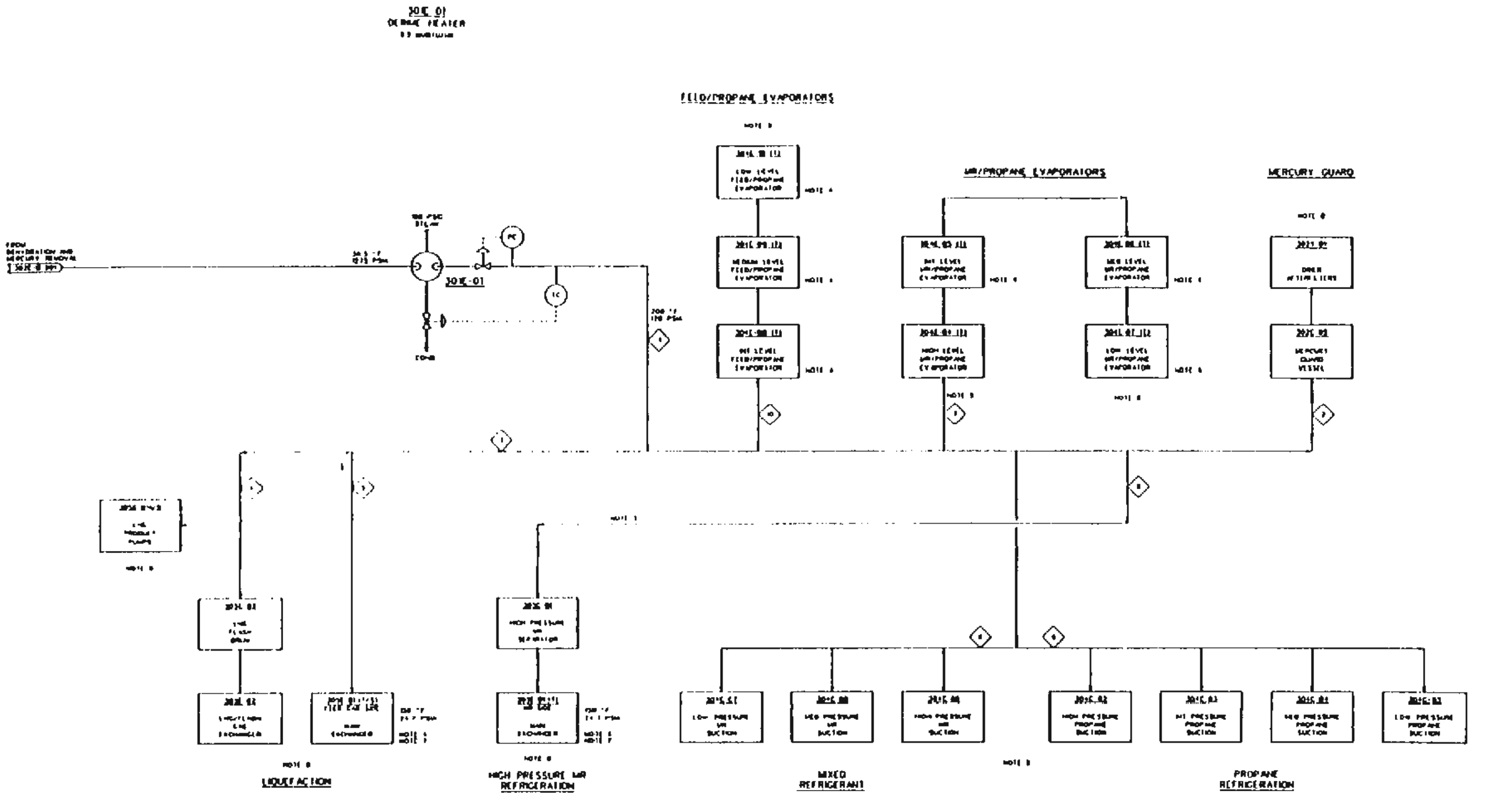
Nitrogen	0.33
Methane	89.81
Ethane	6.20
Propane	1.97
i-Butane	0.79
n-Butane	0.86
i-Pentane	0.02
n-Pentane	0.01
n-Hexane	0.01

The propane refrigeration system to be used for precooling both the feed gas and the MR streams would utilize a single four-stage propane compressor driven by a 37,000 horsepower GE Frame-5 turbine. Refrigerant fluid makeup systems would be provided for both the propane refrigeration system and the MR refrigeration system. The Propane Accumulator is to be designed to retain the propane system contents during system shutdown. The entire propane system (suction drums, evaporators, piping, etc.) is to be designed to retain propane at its vapor pressure at maximum ambient temperature to provide storage for extended shutdown periods without flaring. (It should be noted that the propane refrigerant system contains considerable quantity-estimated to be of the order of 50,000 gallons.)

Retention of the fluids in the MR refrigeration system is to be accommodated primarily by the MR Suction Drum and the Main Cryogenic Heat Exchanger to prevent loss during extended shutdown periods.



PLANT NORTH
8° TRUE NORTH
BATTERY LIMIT
SWITCHGEAR BUILDING
ROLL UP DOOR
COMPRESSOR BLDG
ACCESS DRIVE
BRIDGE CRANE
GENERAL NOTES:
1 THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS
2 PROCESS TRAINS ARE LOCATED 8° FROM TRUE NORTH TO MINIMIZE BACK FILL REQUIREMENTS
3 PROCESS LOCAL CONTROL ROOM MAY BE LOCATED INSIDE THE COMPRESSOR BUILDING AT A LATER DATE
100 FEET
REFERENCE DRAWINGS
DRAWING NO.
DATE
REVISIONS
BECHTEL CORPORATION
HOUSTON, TEXAS
YUKON PACIFIC CORPORATION
TRANS ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
EQUIPMENT ARRANGEMENT
LNG PROCESS TRAIN A
JOB NO.
DRAWING NO.
REV.
300E-A-109
B



NOTES [illegible]

STREAM NO		1	2	3	4	5	6	7	8	9	10
CASE		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
PROPANE REFRIGERATION SYSTEM	LB/HR	[illegible]	0	0	0	0	0	0	0	[illegible]	0
	SCFM	[illegible]	0	0	0	0	0	0	0	[illegible]	0
MIXED REFRIGERANT SYSTEM	LB/HR	[illegible]	0	0	0	0	[illegible]	[illegible]	[illegible]	0	0
	SCFM	[illegible]	0	0	0	0	[illegible]	[illegible]	[illegible]	0	0
LIQUEFACTION	LB/HR	[illegible]	0	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]
	SCFM	[illegible]	0	[illegible]	[illegible]	[illegible]	0	0	0	0	[illegible]
MIXED REFRIGERANT & LIQUEFACTION	LB/HR	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]
	SCFM	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]
MERCURY GUARD	LB/HR	[illegible]	[illegible]	0	0	0	0	0	0	0	0
	SCFM	[illegible]	[illegible]	0	0	0	0	0	0	0	0

NOTES:

1. THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS
2. EQUIPMENT SIZING AND MATERIAL BALANCE [illegible] DISTRIBUTION FOR ONE LNG TRAIN
3. [illegible]
4. (S) DENOTES SHELL SIDE OF HEAT EXCHANGER (T) DENOTES TUBE SIDE OF HEAT EXCHANGER
5. DENOTES LONG RUNS OF MAJOR PROCESS PIPING WHICH REQUIRE DERIMING
6. [illegible]
7. TEMPERATURE OF DERIME GAS TO MAIN CRYOGENIC HEAT EXCHANGER NOT TO EXCEED [illegible]
8. EXHAUST GAS FLOWS TO THE FLARE SYSTEM

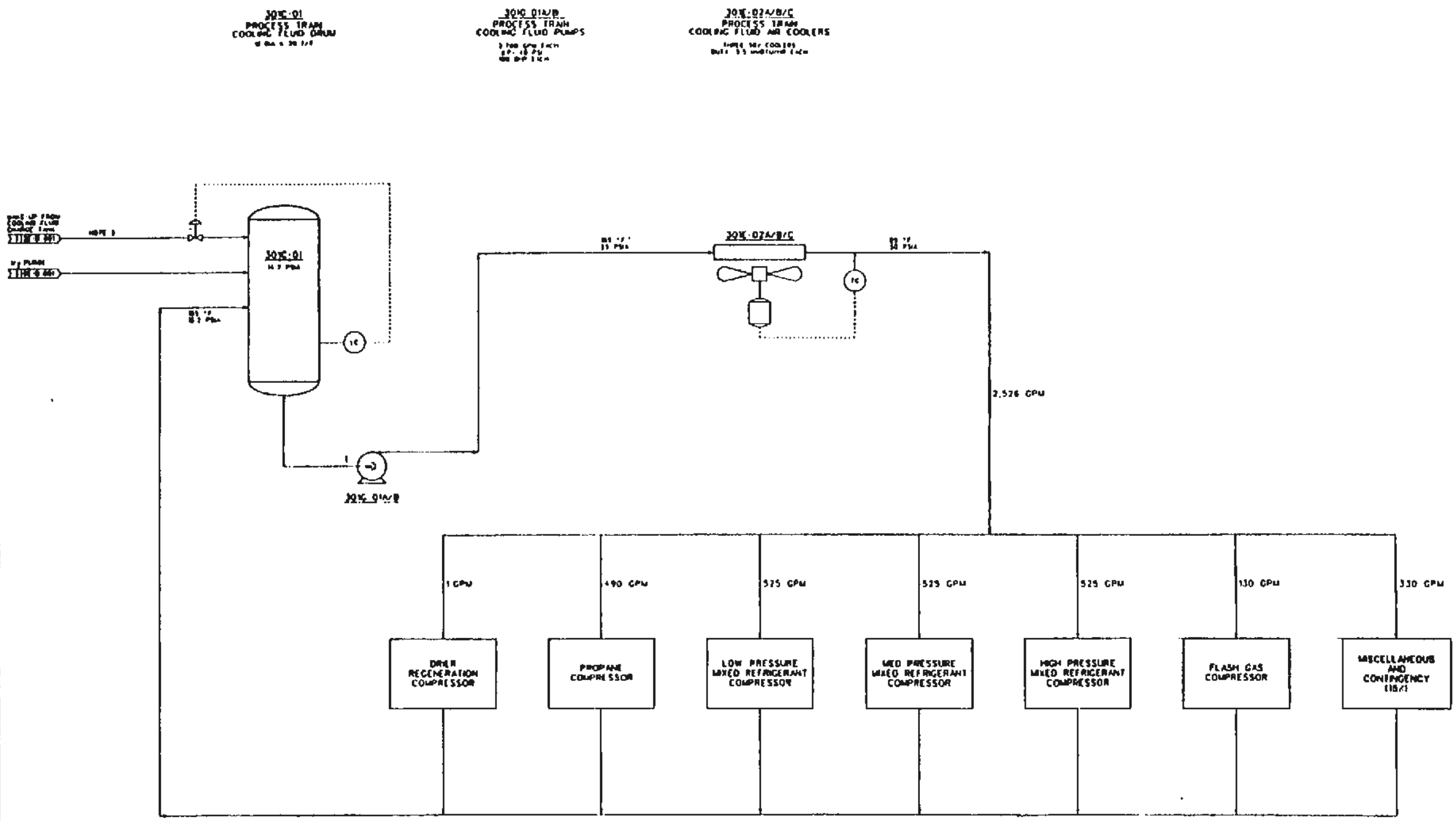
REFERENCE DRAWINGS	DRAWING NO.

BECHTEL CORPORATION

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
DERIME SYSTEM
PLANT 301

301E FI 002 — REV. C



NOTES:

1. THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS
2. DRAWING TYPICAL FOR 4 PROCESS TRAINS
3. COOLING FLUID TO BE AN ETHYLENE GLYCOL SOLUTION OR EQUIVALENT

REFERENCE DRAWINGS | DRAWING NO. | NO. | DATE | REVISIONS

BECHTEL CORPORATION
HOUSTON, TEXAS

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
PROCESS TRAIN
COOLING FLUID SYSTEM - PLANT 301

JOB NO.	DRAWING NO.	REV.
21752	301E-B-001	A

LNG Storage Tanks

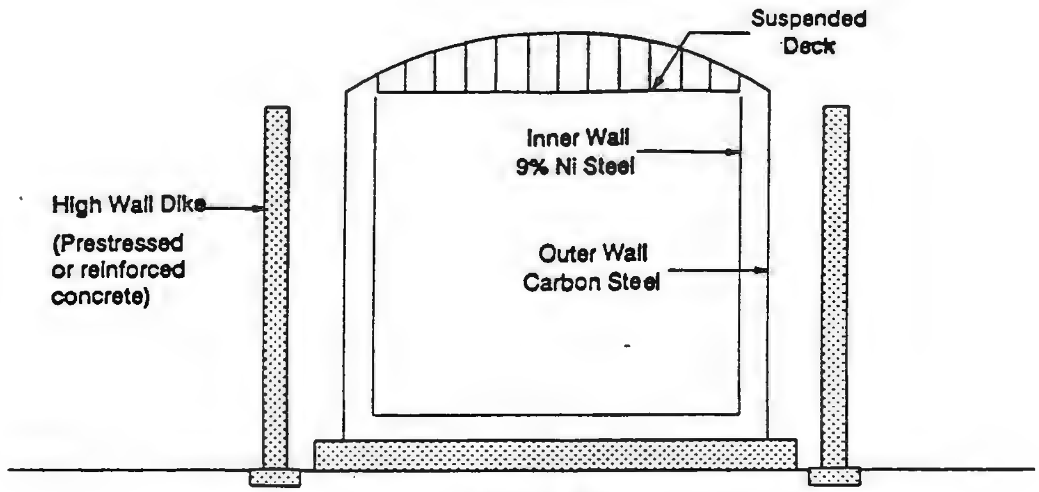
Four LNG storage tanks with a nominal capacity of 800,000 barrels each are planned for the facility with provision made for addition of one storage tank of the same capacity at a later date. The proposed plant site is a hilly area on the bay which will require a significant amount of site clearing, cutting, filling and spoil disposal. The storage tanks are to be located on cut bedrock. The seismic zone classification is Zone 4 UBC. For YPLP study purposes, a 0.6 g critical ground acceleration was adopted. A ground snow load of 235 psf was selected with an estimated equivalent flat-roof conversion loading of 169 psf.

Recognition of the fact that the LNG storage tanks, together with their impoundment systems, constitute a major portion of capitol expenditure for the LNG plant and that federal regulations and construction codes dictate certain minimum design and safety requirements, YPLP conducted a study in which seven types of LNG storage tanks and impoundments were identified for evaluation. Considering project requirements and site specific conditions, the field of systems to be evaluated in detail was reduced to four types. Design and estimated cost information was developed for each of these systems. Chicago Bridge and Iron Company (CBI) provided a design and relative cost study of conventional metal LNG storage tanks with low and high external concrete wall dikes (termed single-integrity since the outer tank shell of carbon steel is not designed to contain LNG spills from the inner tank should it leak or rupture). CBI also studied a metal inner wall and a prestressed concrete outer wall LNG storage tank (designated by the designers to be double-integrity since both walls are to be capable of containing LNG). Preload Incorporated (Preload) was selected to provide similar information for a configuration having prestressed concrete inner and outer wall LNG storage tanks of the double-integrity type, the walls either being precast or cast-in-place. An evaluation of each system on several important parameters led to a tank/impoundment system ranking which indicated advantages in most categories of the double-integrity tanks. The conventional metal double wall tank with a separate high external concrete wall dike was also selected as a possible design configuration. Other design configurations were eliminated for the specific site for various technical and/or economic reasons. Basic selected configurations receiving additional study are shown in the following drawing. It was concluded by YPLP that final selection among the three LNG storage tank design configurations would best be made after further analysis and competitive bidding (including cost and construction schedule).

The following provides a brief description of each of the three selected tank designs based on the limited information available to the FERC at this time. It was indicated that all tanks are to be designed, fabricated, erected, inspected and tested in accordance with Federal Regulation 49 CFR Part 193 - 1989 Edition, API Standard 620, Appendix Q - 1990 Edition and NFPA 59A - 1990 Edition.

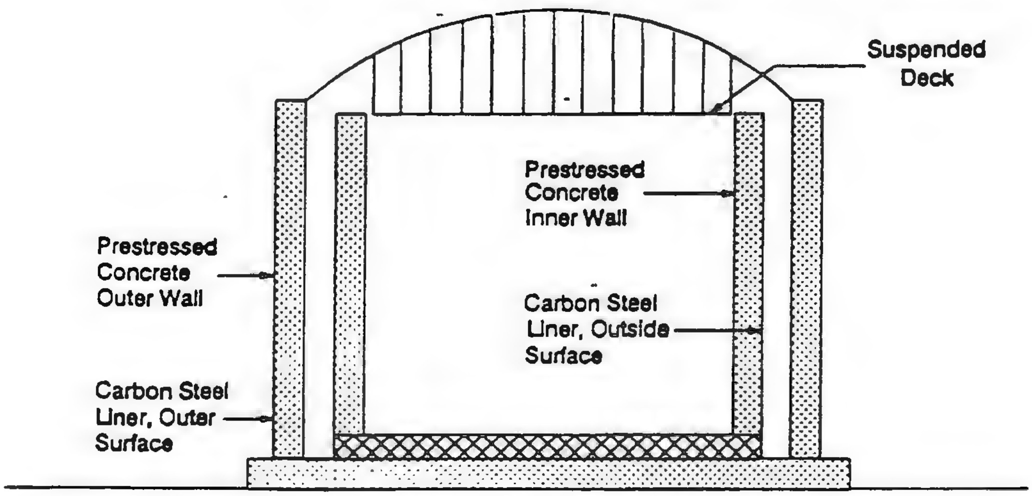
Additional information on the proposed design configurations and partial construction details can be found in the YPLP original material submitted to the FERC - Volume II, Response 7, Tab O.

Type T-2 CBI Conventional Metal Double Wall Tank - The proposed Type T-2 conventional metal double wall tank would be constructed with metal inner and outer walls, a flat bottom and a suspended horizontal inner tank roof deck. The 87′-6" high by 270′ diameter inner shell is to be fabricated with 9 percent nickel steel and the outer shell - 96′ high by 280′ diameter is to



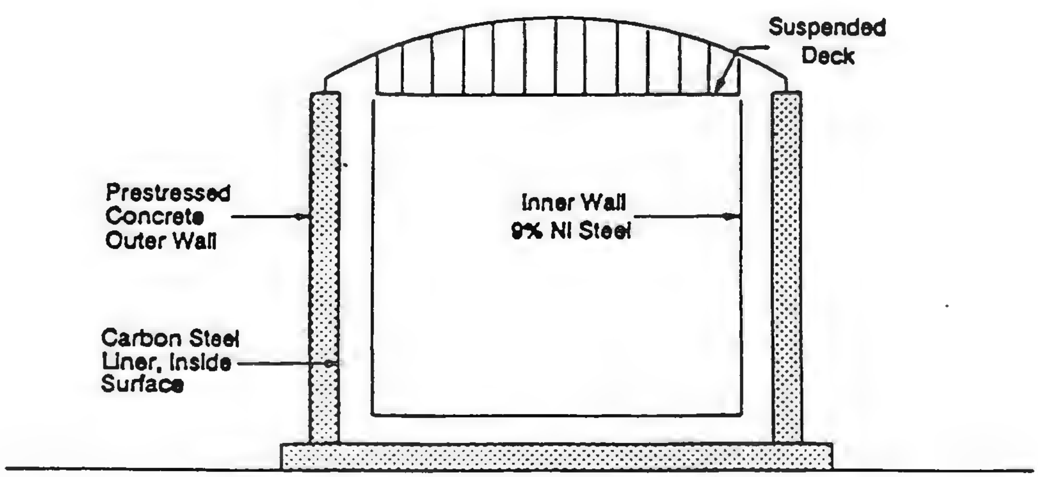
TYPE T-2

CONVENTIONAL METAL TANK, HIGH WALL DIKE



TYPE T-4

DOUBLE INTEGRETY TANK, DOUBLE CONCRETE WALL



TYPE T-6

DOUBLE INTEGRETY TANK, CARBON STEEL ROOF be ASTM A553 - type 1 or ASTM A353 carbon steel. The umbrella type roof is to be fabricated with ASTM A516-70 carbon steel.

Within the inner tank, a distance of 7'-9" is to be provided between the maximum liquid level and the aluminum horizontal suspended deck (which is to support 24 inches of perlite insulation) to allow for calculated internal sloshing wave that may be induced by an earthquake plus 12-inch wave runup. Anchorage of the inner tank against earthquake uplift loads is to be provided by 148 stainless steel straps welded to the inner tank and imbedded in the ringwall foundation which supports the tank.

The annular space between the shells of the double wall LNG storage tank is to be a composite insulation system with a total thickness of 60 inches (48 inches of loose fill expanded perlite and 12 inches of resilient fiberglass blanket insulation fixed to the outside of the inner tank). The resilient fiberglass blanket is designed to control compaction of the perlite insulation due to expansion and contraction of the insulation space.

The suspended deck insulation system is to consist of 24 inches of loose fill perlite supported by a 0.1875-inch aluminum alloy lap welded deck. The deck is to be secured by a series of rods or bars attached to the outer tank roof. Sufficient breathing area is to be provided through the deck to prevent differential pressure from occurring across the suspended deck. The space between the outer roof and the suspended deck is to contain natural gas remaining at essential ambient temperature under normal operating conditions. The inner tank bottom load-bearing insulation is specified as 20 inches of foamglass. In combination the described insulation system is designed to provide a maximum calculated LNG storage tank boiloff rate of 0.05 percent per day of full contents.

The foundation design for the conventional tank is to consist of an annular ringwall (12' wide by 7'-6" thick concrete slab) resting on bedrock. The outer tank is secured to the ringwall by 360 anchor bolts. Rock anchors extending from the ringwall to bedrock are to be designed to resist the uplift forces caused by potential seismic loads; during normal operation there is no uplift acting on the foundations. The rock anchors are to be 1.375 inches in diameter and are to have an imbedded length of 15 feet into the underlying sound bedrock and are to be grouted with a cementitious grout. Bedrock is assumed by CBI to be 6 feet below finished grade. An electrical foundation heating system is to be installed beneath the outer tank in the underlying 10-inch sand cushion to eliminate freezing of the subgrade and prevent frost heave.

Type T-6 CBI Double-Integrity LNG Storage Tank - The proposed Type T-6 double- or increased-integrity LNG storage tank is to be a double wall, horizontal suspended deck tank similar to a conventional double metal wall tank in that the design consists of a double bottom, double shell and single pressure roof - the difference being that the outer wall of the proposed tank is to be prestressed concrete, which is also intended to serve as impoundment for any liquid spill or leakage from the primary inner vessel.

Similar to the previously described conventional metal double wall tank, the 9% nickel steel (ASTM A553 - Type 1 or ASTM A353) inner tank dimensions are 270' outside diameter x 87'-6" high with a maximum liquid height of 79'-9" with similar freeboard above the maximum liquid level to accommodate calculated internal sloshing wave that may be induced by an earthquake plus 12-inch wave runup. Anchorage of the inner tank against earthquake uplift loads is to be provided by 148 stainless steel straps welded to the inner tank and imbedded in the ringbeam foundation which supports the tank. The ringbeam consists of a concrete ringwall and a center concrete slab poured on in-situ material or compacted backfill.

The load-bearing insulation beneath the inner tank is specified as 20 inches of foamglass. High loading beneath the inner tank shell due to tank weight and potential seismic overturning is to be carried by a concrete bearing ring 18 inches thick supported on 12 inches of high strength foamglass.

The annular space between the shells of the double wall LNG storage tank is to be a composite insulation system with a total thickness of 60 inches (48 inches of loose fill expanded perlite and 12 inches of resilient fiberglass blanket insulation) similar to the previously described conventional storage tank.

The suspended deck insulation system is also to be of similar construction consisting of 24 inches of loose fill perlite supported by a 0.1875-inch aluminum alloy lap-welded deck.

The outer container consisting of carbon steel roof, prestressed concrete wall (285′ outside diameter x 96′ high) with carbon steel liner and outer bottom is to comprise a gas-tight boundary for the LNG storage tank. The concrete wall and outer bottom also are intended to provide for containment of LNG in the event of liquid spillage from the inner vessel. The outer concrete wall is to be prestressed both vertically and circumferentially to resist liquid pressure from the full contents of LNG from the inner tank and the coincident thermal gradients through the wall. The carbon steel liner is to be attached to the inside of the concrete wall for vapor tightness. The outer 9% nickel steel bottom is to be connected to the concrete wall by a flexible expansion joint. The joint is intended to accommodate wall movements and bottom shrinkage if a spill occurs. Insulation is to be provided beneath the outer bottom in the region of the wall-to-slab connection to reduce thermal shock from sudden exposure to LNG.

The concrete wall is to be fully fixed to the foundation after it is prestressed. The prestressed concrete wall is intended to be part of the outer container during normal tank operation and is to provide secondary containment in the event of an LNG spill from the inner vessel. The following figures show details of the prestressed concrete wall as well as other tank details.

The top of the outer concrete wall is to be set at the same elevation as the top of the inner tank to provide a minimum net containment volume of 110 percent of the tank contents.

The thickness of the outer wall and the percentage of normal reinforcement is to be governed by earthquake sheer forces that might occur during normal operation. Prestressing steel is to be designed to provide a minimum concrete compression stress of 250 psi with a full product spill, after all prestress losses have occurred. The 250 psi prestress is designed to control cracking caused by thermal gradients induced by spilled LNG.

The ringbeam foundation design for the double- or increased-integrity tank is to consist of an annular concrete ringwall (7′- 2" thick) resting on bedrock and a 2′-thick concrete center slab poured on in-situ material or compacted backfill. Rock anchors extending from the ringwall to bedrock are to be designed to resist the uplift forces caused by potential seismic loads; during normal operating there is no uplift acting on the foundations. The rock anchors are to be 1.375 inches in diameter and are to have an embedded length of 19 feet into the underlying sound bedrock and are to be grouted with a cementitious grout. The center slab is to provide a passive environment to minimize corrosion on the underside of the secondary steel bottom and is an additional barrier in the event of a spill. An electrical foundation heating system is to be installed beneath the outer tank within the center concrete slab to eliminate freezing of the subgrade and prevent frost heave.

The concrete ringwall is to be built in two stages. Stage I concrete is to be placed after the rock anchors are installed. Stage II concrete is to be placed after completion of the horizontal prestressing and prior to construction of the steel expansion joint.

Type T-4 Preload Double-Integrity LNG Storage Tank - The second proposed type of double-integrity LNG storage tank is the double concrete wall tank. Both the inner and outer tank walls would be of prestressed concrete, separated by a perlite-filled annular space. The outer tank would consist of a prestressed concrete wall, a carbon steel subfloor and a 0.3125-inch carbon steel plate roof (with or without a concrete overlay) supported by a framework of radial ribs and the outer tank concrete wall. The inner tank would consist of a prestressed concrete wall, a 9% nickel steel floor and an outer roof-suspended insulation deck.

It is reported that the double concrete wall option is practicable in two alternative construction modes. One is field installed precast concrete; the other is cast-in-place concrete. The precast panels would be full height x 8′ width - manufactured in the Seattle, WA area and barged to the site. If cast-in-place on site, the walls would be constructed in successive rings 6.5′ to 10′ in height. Proposed designs by Preload are presented following the CBI drawings. For either mode, the outer wall height is 111′-6.5"; the inner wall height is 107′-1.5"; and the maximum stored liquid height is 101′. Other wall dimensions depend upon the particular construction mode (precast shown in parenthesis): inner wall outside diameter - 240′-9" (240′-5"); outer wall outside diameter - 251′-2" (250′-7"); inner wall maximum thickness - 16" at base; outer wall maximum thickness - 19" at base. (Top wall thickness of both inner and outer precast walls is to be 12".)

Both the inner and outer prestressed concrete walls would be cast integrally with a 0.25" (ASTM A131 Grade C) carbon steel liner on the outside face. This composite wall would be subject to biaxial compression by means of circumferential and vertical prestressing. Preload indicates that load-resisting capacity derives mainly from this compression and that it would equal or exceed the tensile stresses imposed by the service loads and would be sufficiently large to limit the tensile stresses and concrete cracking imposed by accidental loads. The liner is to be tested by vacuum box or by dye penetrant methods before concrete is placed, depending on mode of erection. It is to form an inseparable and composite part of the wall and is to provide a permanent barrier against vapor and liquid penetration. The bottom 12" to 20" of the barrier is to be 9% nickel steel which is to be welded to the 9% nickel sketch plates that lie under the tank walls.

Horizontal prestressing is to be applied by means of high-strength wires which are to be wound in a continuous helix around the tank. Pneumatic mortar (gunite) applied on each layer of wires is to bond the wires onto the wall and is intended to result in a uniform, monolithic concrete shell. A final covercoat of pneumatic mortar is intended to provide positive protection against wire corrosion. The magnitude of hoop compression (and hence the number of wires) required at a given level is to be equal to or greater than the hoop tension to be induced in the wall by the contained liquid. The profile of the post-tensioning force is to be designed to correspond closely to the hydrostatic pressure as it varies with liquid depth. Vertical prestressing is to be applied by means of linear multi-strand tendons spaced uniformly around the tank circumference either by pretensioning of the precast panels or by post-tensioning in the case of cast-in-place wall construction.

The inner wall is to be designed only for hydrostatic loads, controlled thermal loads (during cooldown) and seismic loads. The outer wall is to be designed for imposed environmental conditions (snow, wind, etc.), the full hydrostatic load of the tank contents, the internal vapor pressure and the specified earthquake loads. The design is to provide for thermal shock from an inner tank spill with crack penetration limited to one-half the concrete wall thickness. Each wall is to have a sliding base which is intended to permit radial movement (i.e., symmetrically with the tank center) in relation to the foundation.

The tank insulation system is to be comprised of a 44" average thickness of perlite in the annular space between inner and outer prestressed concrete walls, a 12" thickness of load-bearing cellular glass blocks beneath the inner tank floor, a balsa block footing beneath the inner concrete wall and a 26" thickness of fiberglass blankets supported by the inner tank insulation deck. The insulation system design is to limit storage tank boiloff to 0.05 percent per day of full tank content. Present design information does not specify the desirability or necessity of a resilient fiberglass blanket within the insulation space to prevent compaction of the perlite insulation.

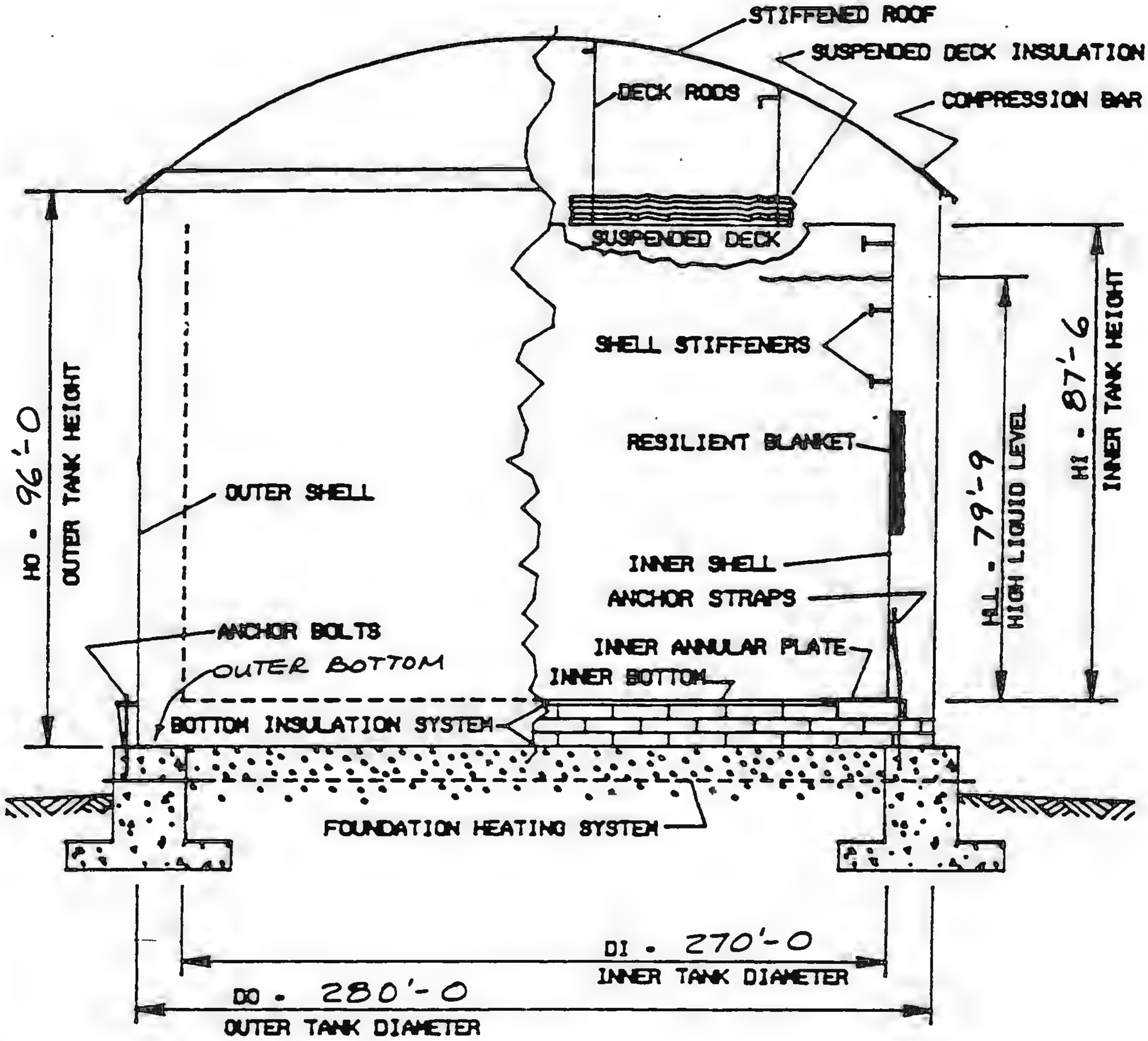
LNG Storage Tank Process Description - Although a decision has not been made on the final selection of storage tank design, certain common factors and operational characteristics exist. The 800,000 barrel storage tanks are to have a design pressure of 2.0 psig with a normal operating pressure of 0.5 psig. Vacuum design is to be 0.05 psig - replacement pad gas being automatically supplied by a four-inch line from the fuel gas header. Pressure and vacuum relief valves have not yet been specified. No process piping is to penetrate the sidewalls of the storage tank - all piping is to enter or exit through the roof. Selected schematic drawings follow proposed LNG storage tank design configurations.

The liquid bottom fill line to the storage tank is to be a 24-inch line terminating at the top of an open-topped standpipe within the inner vessel. The flash break at the top of the standpipe is to be provided to release vapor from the incoming liquid while providing bottom fill of the liquid which has been equilibrated at tank ullage pressure. Capability also is to exist to discharge liquid to the top center of the inner vessel by use of a 24-inch line terminating above an inverted funnel-shaped splash plate. The line may also be used for circulation, recirculation, thermal relief and cooldown functions. Vapor generated from tank boiloff and flash losses is to be removed from the storage tank ullage by a 30-inch line.

Liquid withdrawal and liquid circulating pumps are to be submerged centrifugal units located internal to the storage tanks within individual pump columns. Each storage tank is to contain four LNG loading pumps - each with a flow rate of 7500 gpm. Discharge from the loading pumps is accommodated by separate 16-inch lines combining with a 24-inch header. Additionally, each tank is to have a single liquid circulating pump with a flow rate of 500 gpm. Piping provisions are to be made to provide for circulation through the marine loading lines and for recirculation within the storage tank. Intertank transfer capability also is to be provided.

Specific internal storage tank instrumentation is pending. Temperature elements are to be attached to the shell and floor of the inner vessel, in the annular space and in the vapor space between the storage tank roof and the suspended deck - the number and type of elements are to be determined. Liquid level is to be determined by a differential pressure instrument and by redundant combined traveling level, density and temperature measuring systems. Alarms and shutdown features on the level gauges are to include low-level alarm, pump shutdown, high-level alarm and fill valve closure.

Linear and rotational inner tank movement indicators are to be provided within the annular space of each storage tank.

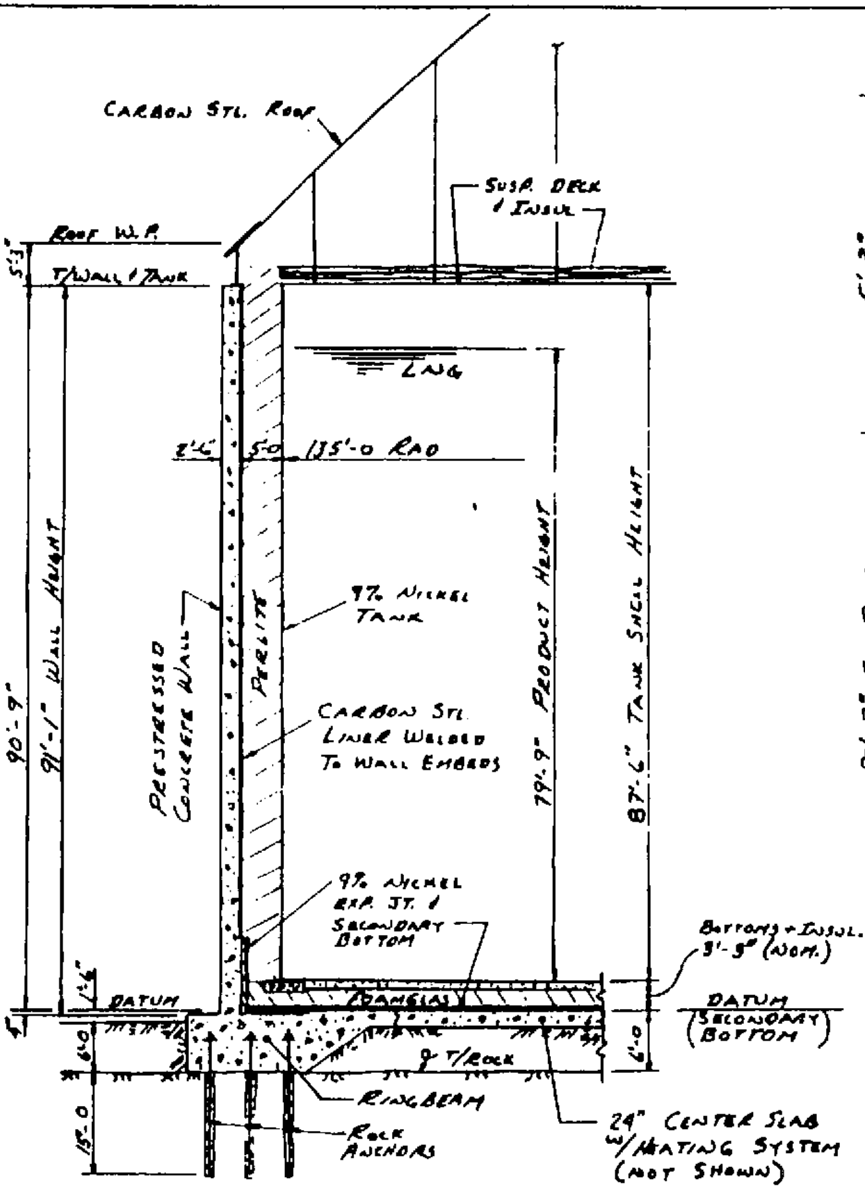


DOUBLE WALL TANK WITH SUSPENDED DECK

SUBJECT	CBI OFFICE		REVISION		REFERENCE NO.
	MADE BY	CHKD BY	MADE BY	CHKD BY	Fig. 3.1-1
	DATE	DATE	DATE	DATE	

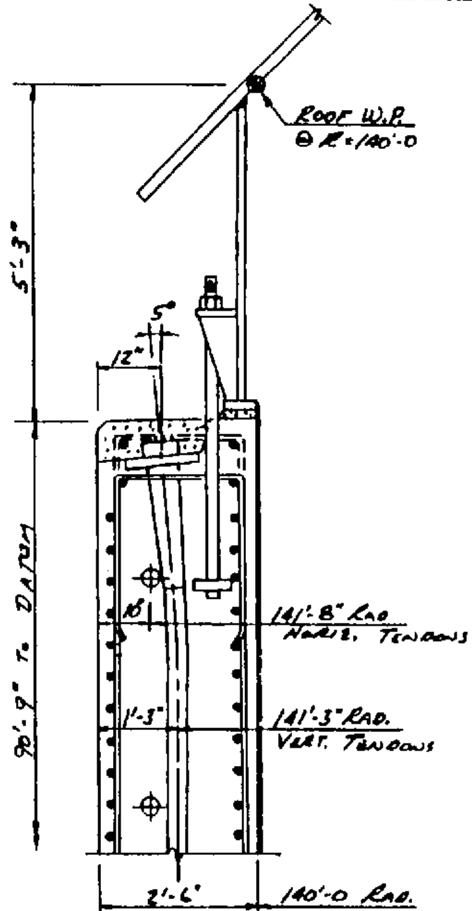
Printed in USA

GO 84 REV SEP 84



TYPICAL SECTION

(Scale: 1/16" = 1'-0)



DETAIL AT TOP OF WALL

(Scale: 1/2" = 1'-0)

GENERAL NOTES

1) CONCRETE DESIGN PER ACI 318-89.
2) CONCRETE COMPRESSIVE STRENGTH, f'c = 4000 PSI, EXCEPT AS NOTED.
3) ALLOWABLE BEARING PRESSURE ON BEDROCK IS ASSUMED TO BE 10,000 PSF.
4) ROCK ANCHORS TO BE DWIDAG ANCHOR SYSTEM WITH DOUBLE CORROSION PROTECTION.

ASTM MATERIALS

REINFORCING STEEL	
- FOUNDATIONS	A615 GR60
- PRESTRESSED WALL	A706
PRESTRESSING STEEL	A416, LOW-RELAX.
ROCK ANCHORS	A722, GR150, TY II

Indicates change from previous issue

By	Chkd	Date	By	Chkd	Date	Revisions	Remarks

CBI

Supplier's/Purchaser's No

INCREASED INTEGRITY TANK
800 MB LNG TANK
YUKON PACIFIC CORP, ALASKA

Customer's No

Contract No. S 14520

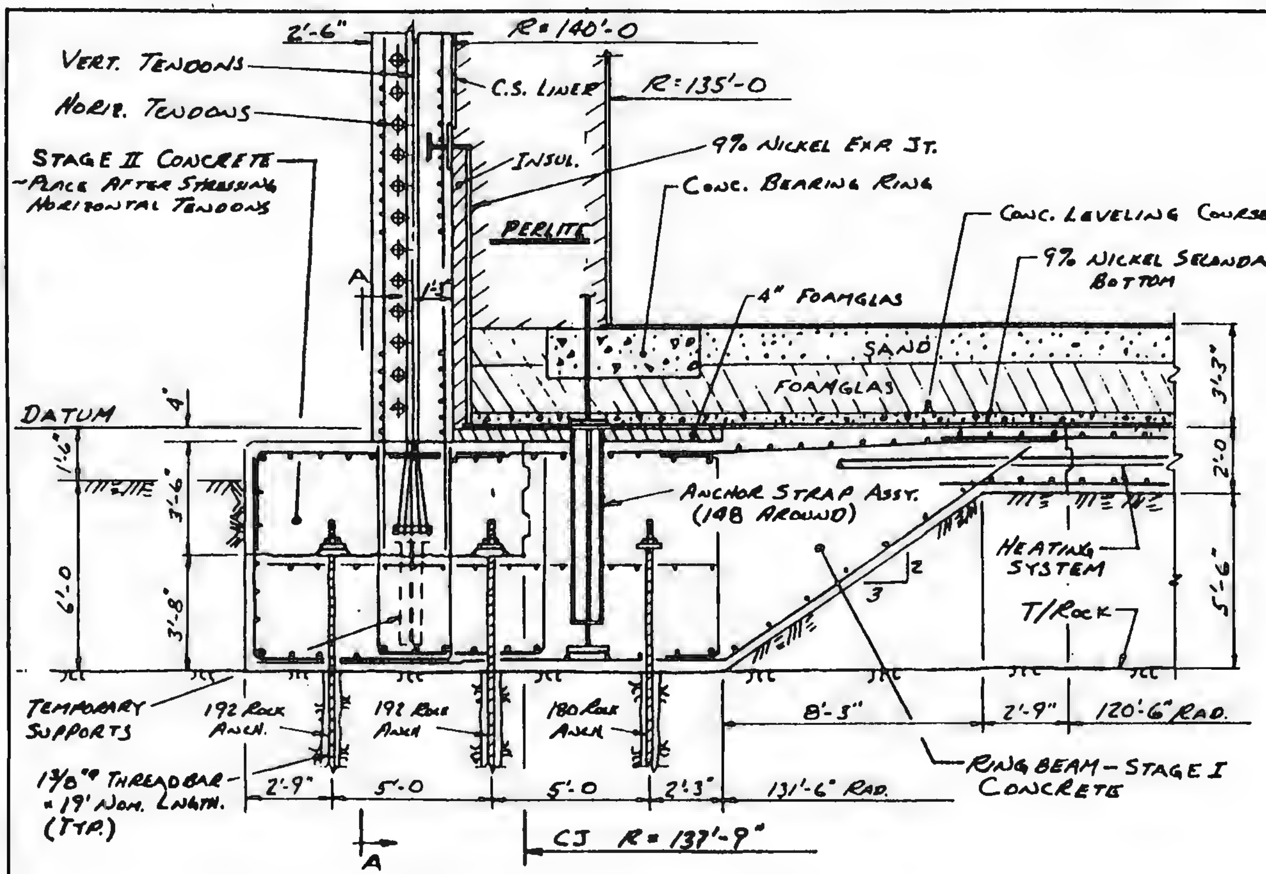
By RP Chkd ______ Date 5-21-91

Dwg 4.0-1 Rev

Engineering Supervisor

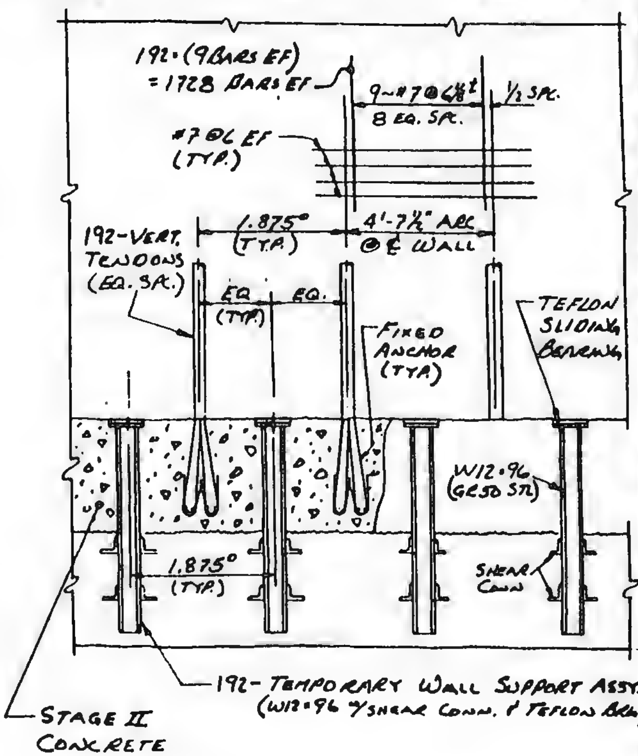
Sheet

FORM DR 33 A REV OCT 86



DETAIL AT BOTTOM OF WALL

(Scale:



SECTION A-A

CONCRETE & REINF. STEEL QUANTITIES PER TANK

ITEM	CONCRETE		REINFORCING STEEL	
	QUANTITY CY	COMP. STR. f'c	WEIGHT Lbs.	ASTM SPEC.
CENTER SLAB	3379	4000 PSI	456,000	A615 GR60
RINGBEAM - STAGE I	3789	↓		↓
" - STAGE II	1013		540,000	
PRESTRESSED WALL	7893		1,550,000	A706
TOTALS	16,074 CY		2,546,000 #	

ROCK ANCHORS

PER ASTM A722, GR 150, TYPE II

SIZE — 1 3/8"Φ × 19' LONG

EST. QTY — 564 EACH PER TANK

Indicates change from previous issue

By	Chkd	Date	By	Chkd	Date	Revisions / Remarks

CBI

Supplier's/Purchaser's No

INCREASED INTEGRITY TANK
800 MB LNG TANK
YUKON PACIFIC CORP., ALASKA

Customer's No ____

Contract No. S 14520

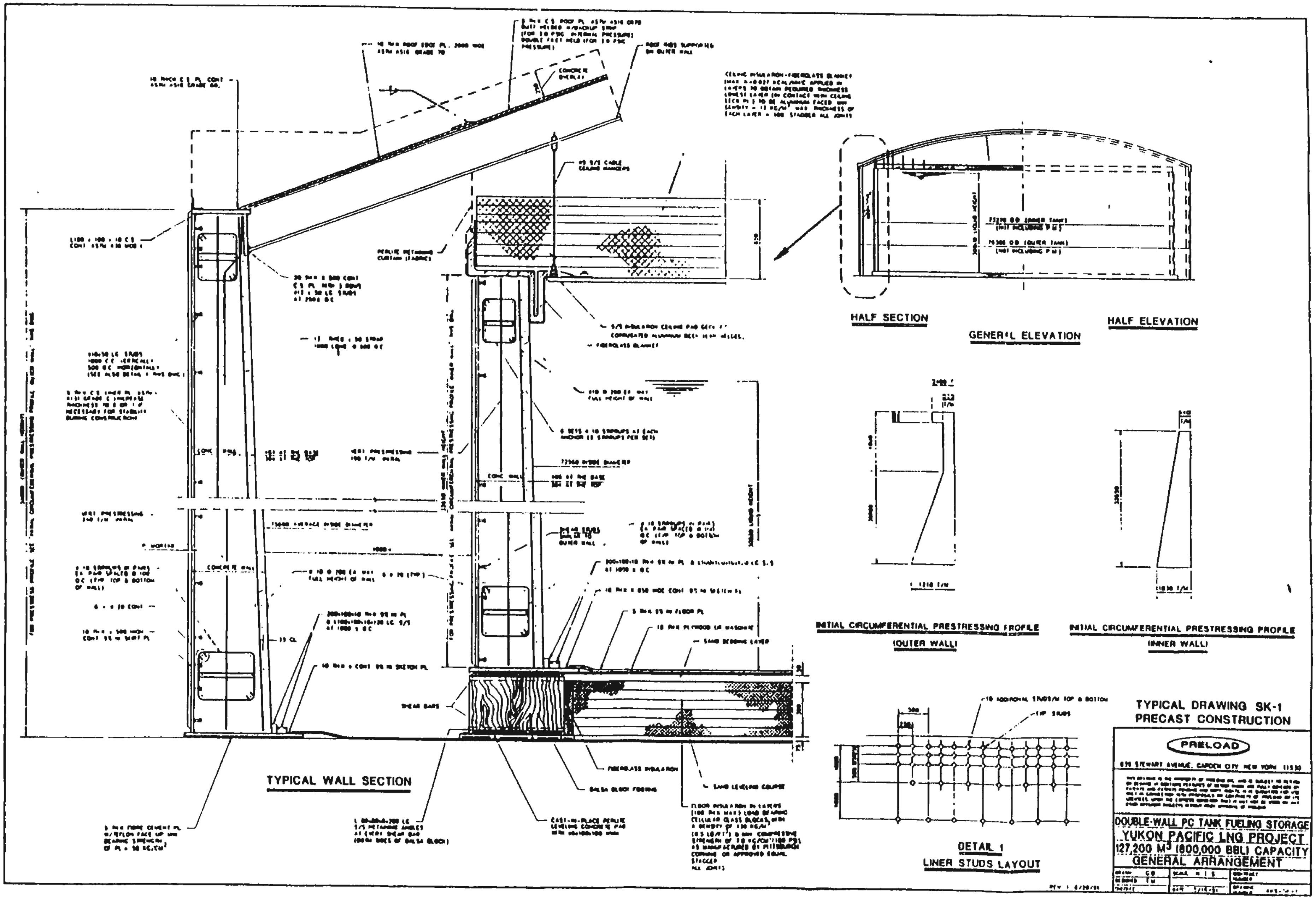
By RP Chkd ____ Date 5-21-91

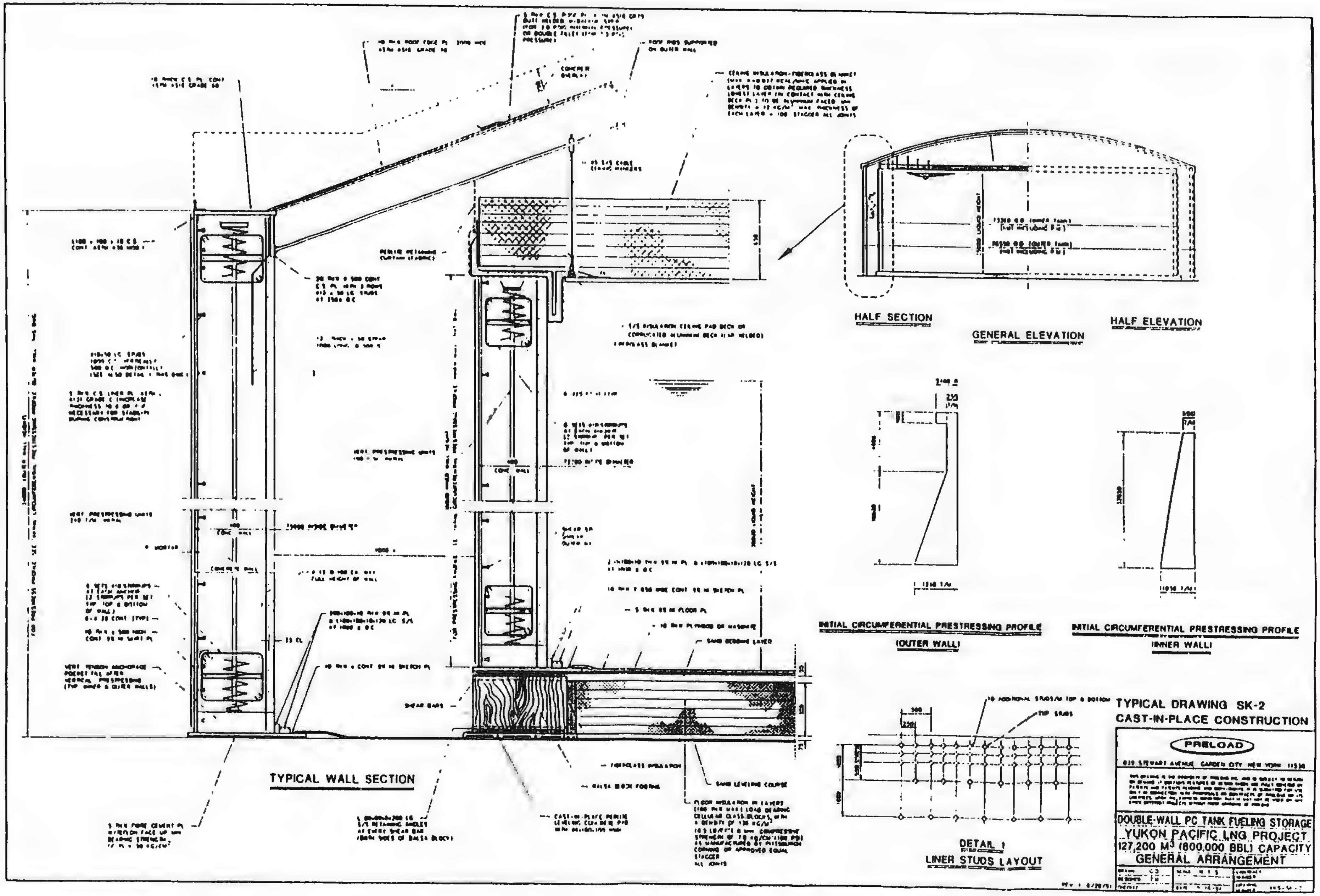
Dwg. 4.0-2 Rev

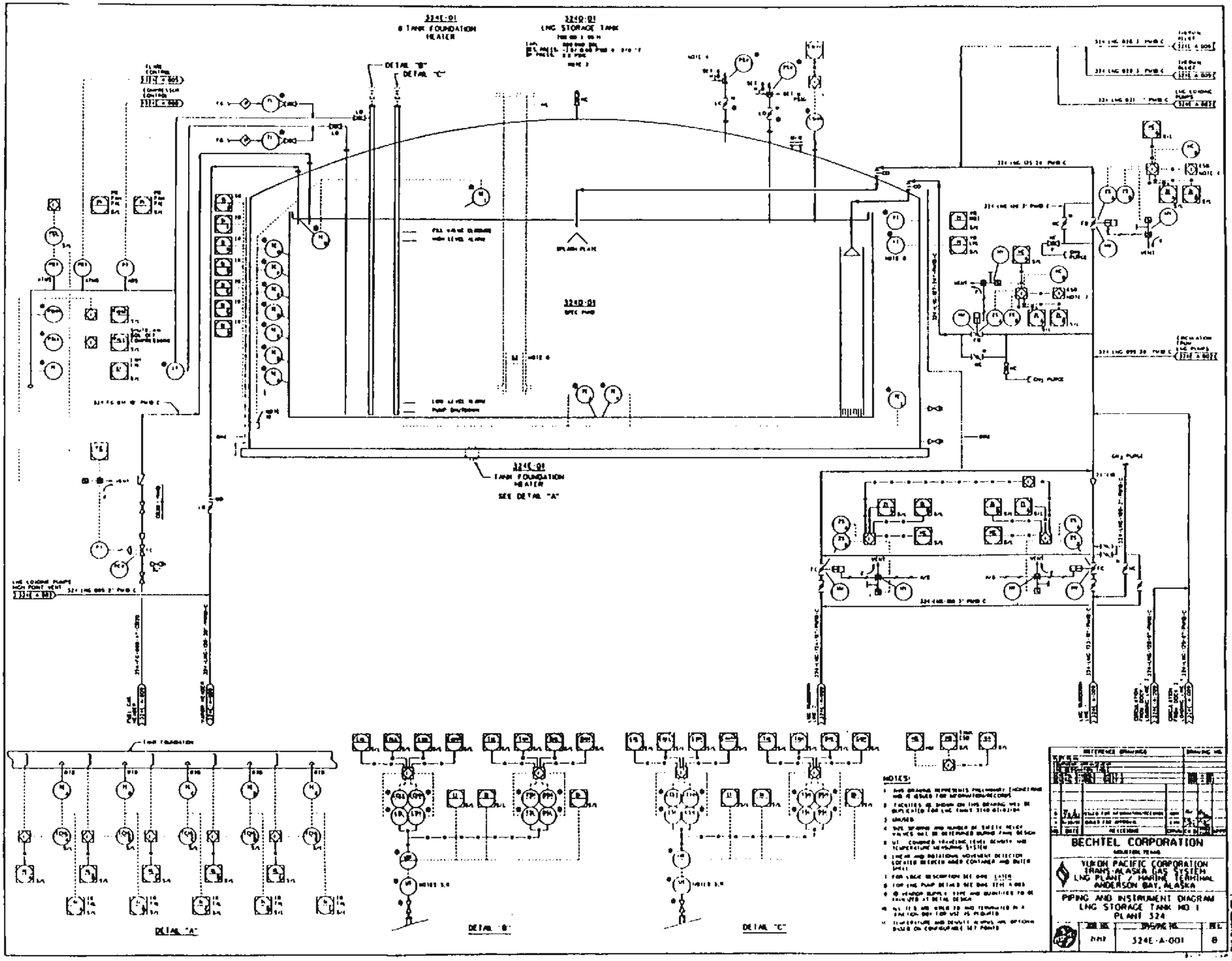
Engineering Supervisor

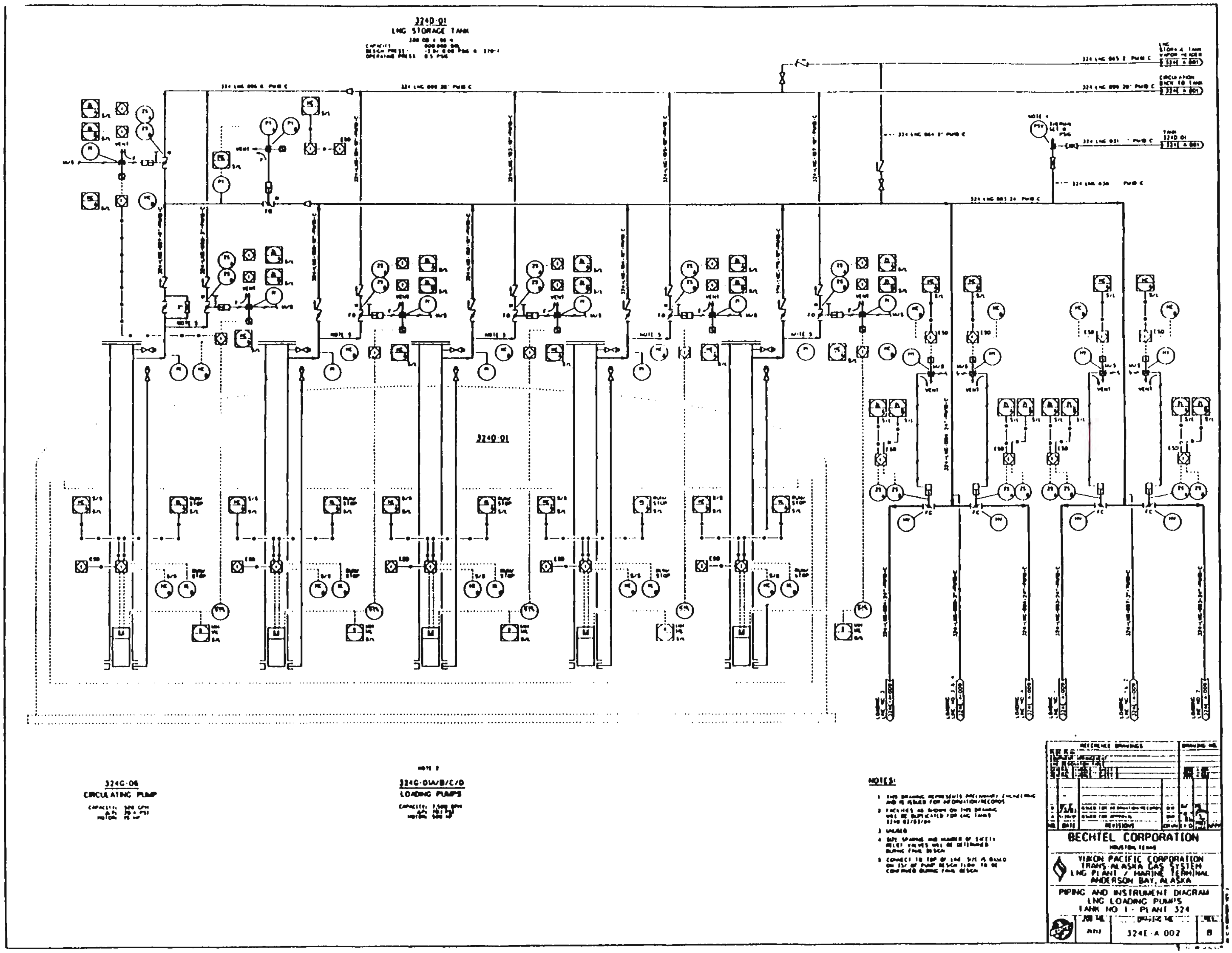
Sheet

FORM DR 33 A REV OCT 86


TYPICAL WALL SECTION
HALF SECTION
GENER'L ELEVATION
HALF ELEVATION
INITIAL CIRCUMFERENTIAL PRESTRESSING PROFILE
(OUTER WALL)
INITIAL CIRCUMFERENTIAL PRESTRESSING PROFILE
(INNER WALL)
DETAIL 1
LINER STUDS LAYOUT
TYPICAL DRAWING SK-1
PRECAST CONSTRUCTION
PRELOAD
DOUBLE-WALL PC TANK FUELING STORAGE
YUKON PACIFIC LNG PROJECT
127,200 M3 (800,000 BBL) CAPACITY
GENERAL ARRANGEMENT


TYPICAL WALL SECTION
HALF SECTION
GENERAL ELEVATION
HALF ELEVATION
INITIAL CIRCUMFERENTIAL PRESTRESSING PROFILE
(OUTER WALL)
INITIAL CIRCUMFERENTIAL PRESTRESSING PROFILE
(INNER WALL)
DETAIL 1
LINER STUDS LAYOUT
TYPICAL DRAWING SK-2
CAST-IN-PLACE CONSTRUCTION
PRELOAD
DOUBLE-WALL PC TANK FUELING STORAGE
YUKON PACIFIC LNG PROJECT
127,200 M3 (800,000 BBL) CAPACITY
GENERAL ARRANGEMENT


324E-01
TANK FOUNDATION
HEATER
324D-01
LNG STORAGE TANK
DETAIL "B"
DETAIL "C"
324C-01
TANK FOUNDATION
HEATER
SEE DETAIL "A"
DETAIL "A"
DETAIL "B"
DETAIL "C"
NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PIPING AND INSTRUMENT DIAGRAM
LNG STORAGE TANK NO 1
PLANT 324
324E-A-001
B


324D-01
LNG STORAGE TANK
324D-01
324G-06
CIRCULATING PUMP
324G-01A/B/C/D
LOADING PUMPS
NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PIPING AND INSTRUMENT DIAGRAM
LNG LOADING PUMPS
TANK NO 1 - PLANT 324
324E-A 002
B

LNG Ship Loading Facilities

The proposed fully developed marine facilities are to include two LNG loading docks. The primary function of the LNG loading facilities would be to transfer LNG from the LNG storage tanks into LNG ships for export purposes. In addition, a liquid nitrogen loading system is to be available at LNG Loading Dock 1 (only). Other services, including supply of potable water, boiler makeup water and bunker fuels are not to be provided at the berths. The LNG loading facilities are to provide access to 55 foot water depth suitable for berthing of LNG ships ranging from 125,000 to 135,000 cubic meters and presumably suitable for next generation LNG ships with capacities of up to 165,000 cubic meters.

Typically, an LNG berth would consist of the following components: a loading platform carrying all piping and equipment required for operating the berth, breasting dolphins, mooring dolphins, an access trestle to shore with roadway and pipeway and interconnecting walkways between dolphins and loading platform. The marine facilities are to include two LNG berths. Under one scenario, construction of Dock 1 would be part of the initial development. The proposed Dock 1 would be suitable for port side or for starboard side berthing to provide maximum operating flexibility. Dock 2 would be built as market requirements indicate.

Facilities at the proposed LNG docks are to include: an LNG loading system, an LNG vapor recovery system, instrument air, gaseous nitrogen, liquid nitrogen (Dock 1 only since supply is normally obtained at the receiving terminal), safety systems and a Dock Operations Building. Loading operations would be controlled from the Main Control/Marine Operations Building.

The proposed LNG loading platform would consist of an upper deck at an elevation of 55 feet above MLLW and a lower deck, providing access to LNG and utility piping, at an elevation of 43 feet above MLLW. (The upper and lower deck configuration is to be determined on the ability to accommodate potential LNG spills at the dock.)

LNG would be transferred from the LNG storage tanks using the internally mounted LNG pumps. Each storage tank is to be provided with four 7500 gpm pumps used for transfer and one 500 gpm pump for circulation. The design ship loading rate is 10,000 cubic meters per hour (44,000 gpm), typically resulting in a 12-hour filling time using seven LNG loading pumps at design flow. LNG would be transferred to the docks using two parallel 24-inch cryogenic insulated loading lines for each dock. During non-loading periods, LNG would be circulated from storage through one of the parallel lines to the dock and return by the other parallel line to storage using the 500 gpm circulation pump to maintain operating conditions within the lines.

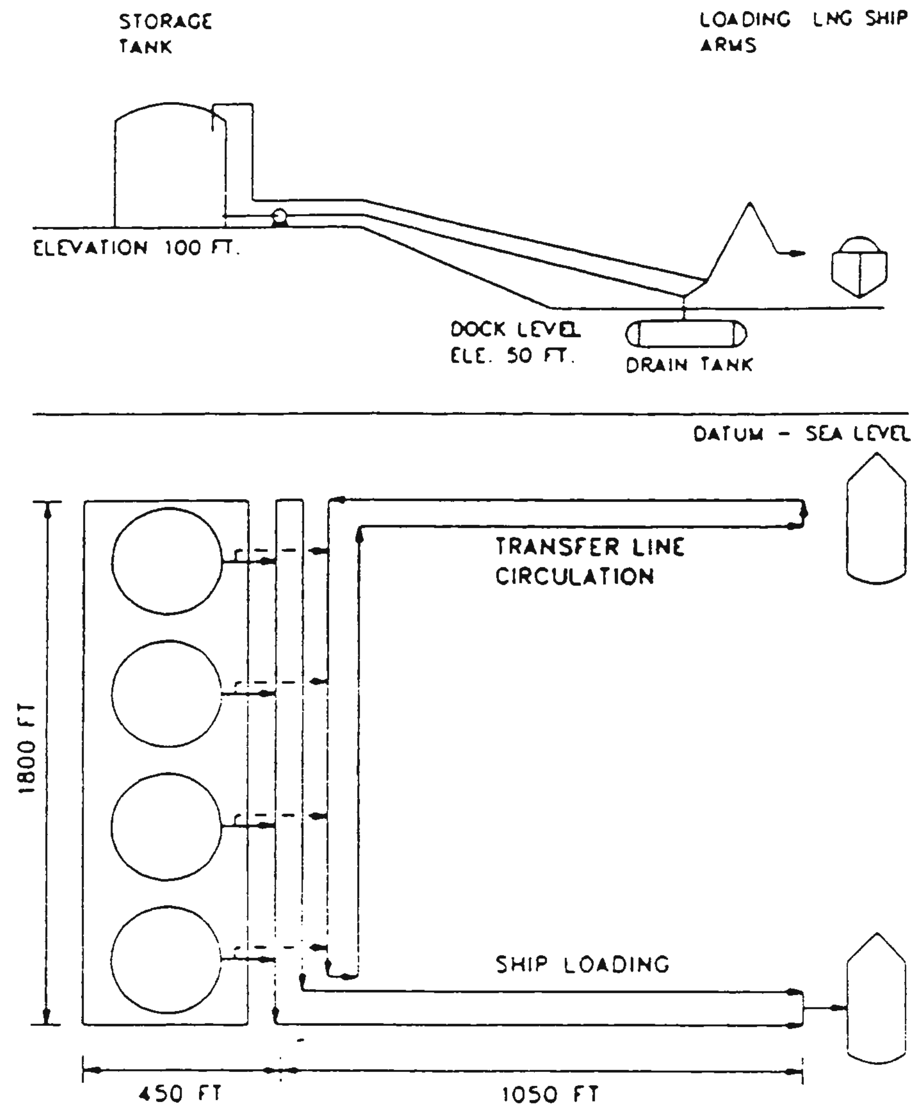
Articulated marine loading arms on each dock are to consist of four 16-inch liquid loading lines and one 16-inch vapor recovery line. Shutoff valves would be located in the 24-inch loading lines both onshore and at the docks. Additionally, each articulated arm would be provided with a hydraulically-operated Powered Emergency Release Coupling (PERC) consisting of double ball shutoff valves and an emergency release coupler. The PERC system would be utilized in emergency situations and not for routine connection/disconnection of the loading arm from the LNG ship during normal operations.

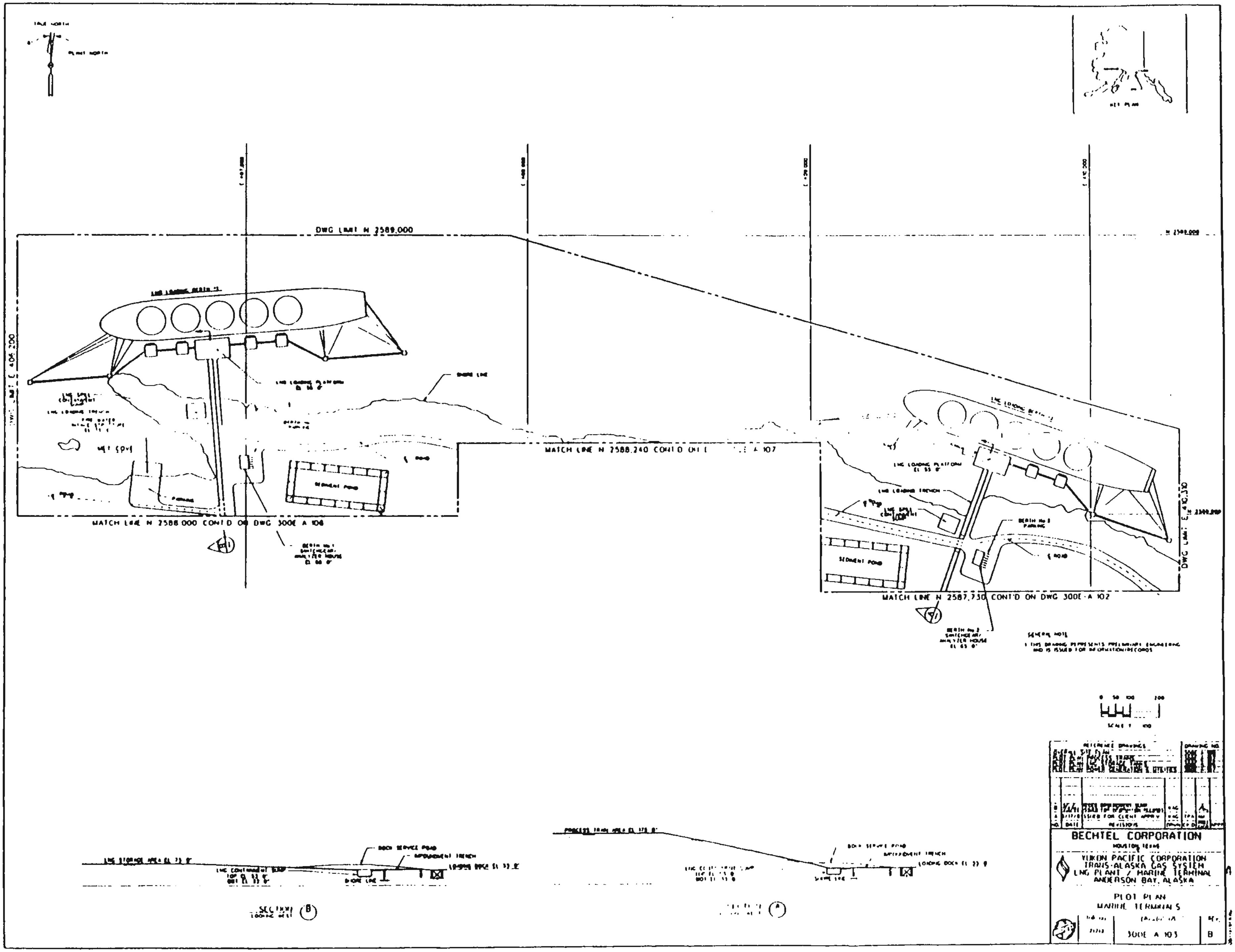
A hydraulically-operated quick connect/disconnect coupler (QC/DC) on each arm may be used to provide connecting and disconnecting with the LNG ship during normal operations. Consideration also is being given to use of bolted flanges. Loading arm controls are to be installed at a strategic location at the upper deck. In addition, a portable remote control unit would be provided for manipulation of the loading arms from locations other than the primary control console.

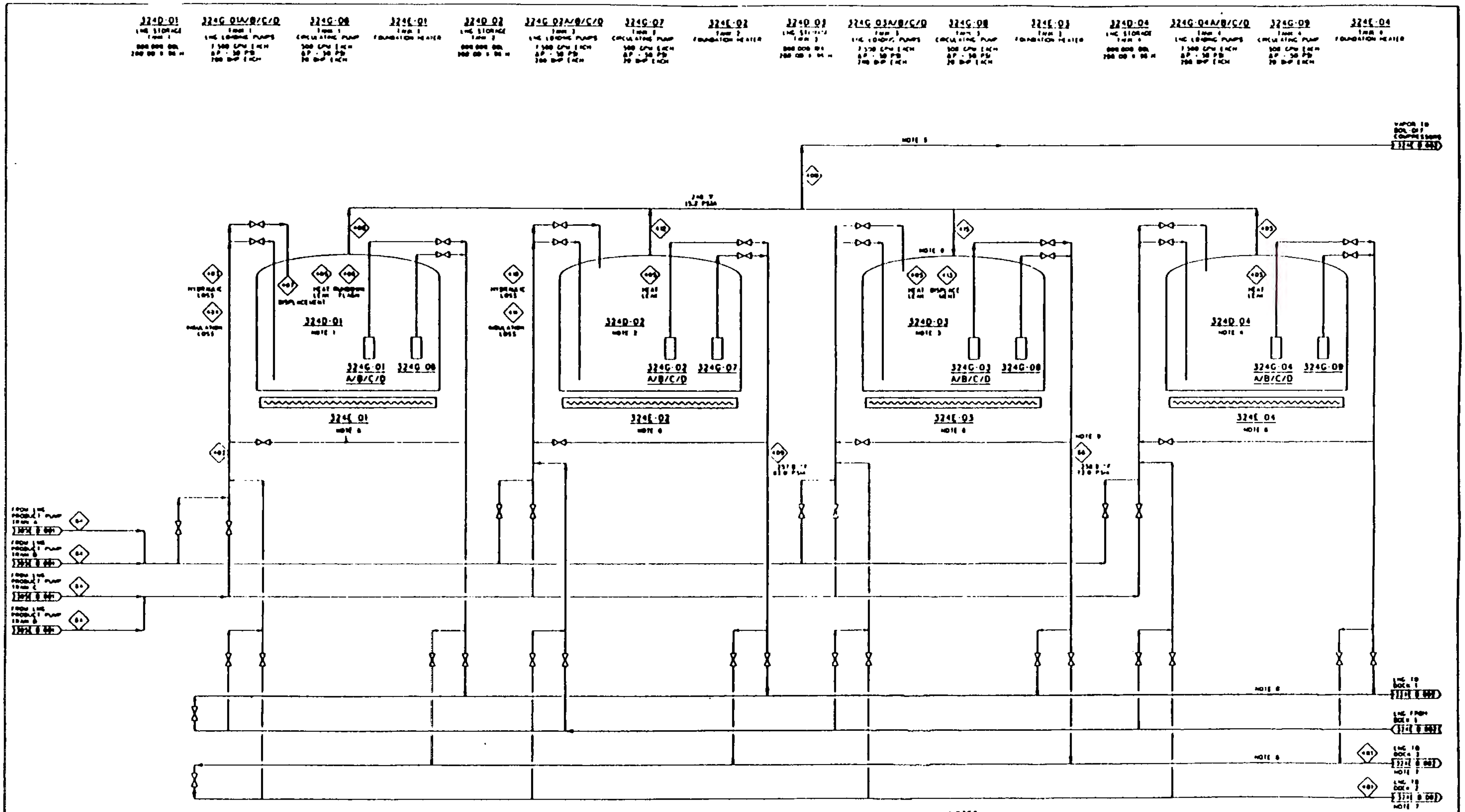
A vapor recovery system would be provided to accommodate vapor evolved from the loading process (and from the normal boiloff vapor from the four LNG storage tanks). Vapor from the loading process would be transported onshore by a 24-inch cryogenic insulated line, combined with boiloff vapor from the LNG storage tanks and compressed in Boiloff Compressors. A Boiloff Vapor Desuperheater would be used to maintain cold temperatures entering the compressors. The boiloff compressors would consist of three 6400 horsepower turbine-driven centrifugal units. Discharge from the compressors is to be sent to the facility Fuel Gas Header at a pressure of 370 psia. One compressor would be required during non-loading operations (to accommodate boiloff from storage tanks), while an additional compressor would be required for each ship being loaded.

Proposed dock facilities and schematic diagrams of the loading and vapor recovery systems are shown in the following drawings.

BASE CASE


STORAGE TANK
LOADING ARMS
LNG SHIP
ELEVATION 100 FT.
DOCK LEVEL
ELE. 50 FT.
DRAIN TANK
DATUM - SEA LEVEL
TRANSFER LINE
CIRCULATION
SHIP LOADING
1800 FT
450 FT
1050 FT


DWG LIMIT N 2589,000
MATCH LINE N 2588,240 CONT'D ON DWG 300E-A 107
MATCH LINE N 2588,000 CONT'D ON DWG 300E-A 106
MATCH LINE N 2587,730 CONT'D ON DWG 300E-A 102
SEDIMENT POND
SHORE LINE
LNG LOADING PLATFORM
LNG LOADING TRENCH
PARKING
BERTH No 1 SWITCHGEAR/ ANALYZER HOUSE EL 66 0'
BERTH No 2 SWITCHGEAR/ ANALYZER HOUSE EL 65 0'
BERTH No 2 PARKING
GENERAL NOTE
1 THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS
LNG STORAGE AREA EL 75 0'
LNG CONTAINMENT SUMP
DOCK SERVICE ROAD
IMPOUNDMENT TRENCH
SHORE LINE
PROCESS TRAIN AREA EL 175 0'
SECTION B
SECTION A
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PLOT PLAN
MARINE TERMINALS
300E A 103
B



STREAM NO	64	66	400	401	402	403	404	405	406	407	408	409	410	411	412	413	415
DESCRIPTION	LNG FROM PLANT (1 TRAIN)	LNG TO SHIP	VAPOR TO/FROM STORAGE (TANK 1)	LNG TO SHIP	LNG TO TANK (4 TRAINS)	HYDRAULIC LOSS	INSULATION LOSS	TANK HEAT LEAK	TANK FLASH	TANK DISPLACE VENT	TANK VAPOR	LNG CIRCULATION	HYDRAULIC LOSS	INSULATION LOSS	TANK VAPOR	TANK DISPLACE VENT	VAPOR TO TANK
MMSCFD	540.2	2,039.1	24.200	2,456.4	2,102.0	3.3700	0.10375	15.90	20.210	9.0360	44.210	53.03	0.44300	0.55400	2.5307	14.567	13.055
GPM	4,752	20,207	-	22,031	18,000	-	-	-	-	-	-	465	-	-	-	-	-
LB/HR	1,097,300	4,090,300	45,347	5,320,500	4,300,000	6,327.1	331.73	3,703.0	53,004	10,176	81,710	100,100	850.54	1,017.6	4,507.0	29,070	23,004
MOL WT	18.2	18.75	16.07	18.35	18.2	16.03	16.03	16.03	16.03	16.03	16.03	18.75	18.71	18.71	16.10	16.01	16.07
COMPONENT, LB MOLE/HR																	
NITROGEN	187.9	704.2	205.30	616.2	751.6	24.37	2.03	18.00	210.44	70.05	318.49	12.44	2.05	3.40	17.14	[illegible]	10.04
METHANE	54,039.2	200,427.5	3,400.15	282,040	218,750.0	345.60	20.98	155.00	2,007.21	1,009.04	4,536.03	5,314.37	40.05	37.49	260.03	[illegible]	1,700.05
ETHANE	2,734.5	21,131.3	0.37	18,410.0	18,000.0	0.04	0	0.02	0.32	0.0	0.40	374.90	0.04	0.04	0.03	[illegible]	[illegible]
ETHYLENE	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROPANE	1,180.4	8,890.3	0	5,054.4	4,753.7	0	0	0	0	0	0	90.45	0	0	0	0	0
I-BUTANE	474.1	2,870.0	0	2,336.4	1,090.4	0	0	0	0	0	0	47.30	0	0	0	0	0
N-BUTANE	590.4	2,910.3	0	2,553.8	2,073.4	0	0	0	0	0	0	51.53	0	0	0	0	0
I-PENTANE	12.6	71.4	0	62.5	50.6	0	0	0	0	0	0	1.10	0	0	0	0	0
N-PENTANE	6.3	36.9	0	29.0	25.3	0	0	0	0	0	0	0.50	0	0	0	0	0
N-HEXANE	6.3	36.1	0	20.0	25.3	0	0	0	0	0	0	0.39	0	0	0	0	0
TOTAL LB MOLE/HR	60,407.0	233,676.1	3,655.0	291,901.7	240,751.3	370.0	21.0	46.0	5,200.0	1,080.0	4,855.0	5,972.0	50.5	62.0	277.4	[illegible]	1,433.4
HEAT GAIN MM BTU/HR						3.31	0.17	0.45					0.30	0.34			
DENSITY LB/CU FT	26.16	26.55	0.171	26.60	26.60						0.127	26.90			0.1		0.121
VISCOSITY CP	0.145	0.151	0.0047	0.15	0.143						0.0047	0.151			[illegible]		0.0043
SURF TENSION DYNE/CM	11.81	11.44		11.16	12.01							15.36					

NOTES:

THE HEAT AND MATERIAL BALANCE INFORMATION IS RELATED TO FOUR DIFFERENT MODES OF OPERATION AS SHOWN IN NOTES 1, 2, 3 AND 4 WITH STREAM NO SHOWN IN PARENTHESIS.

1. LNG STORAGE TANK 1 IS RECEIVING LNG FROM LIQUEFACTION TRAINS
STREAMS (64) (402) (403) (404) (405) (406) (407) (408)

2. LNG STORAGE TANK 2 IS CIRCULATING LNG TO/FROM DOCK
STREAMS (405) (409) (410) (411) (412)

3. LNG STORAGE TANK 3 IS LOADING LNG TO SHIP
STREAMS (66) (401) (413) (415)

4. LNG STORAGE TANK 4 IS IDLE

5. [illegible]

6. [illegible]

7. [illegible]

8. DOCK 1 TRANSFER LINES ARE CIRCULATING LNG. DOCK 2 TRANSFER LINES ARE LOADING LNG TO SHIP

9. STREAMS (66) (413) & (415) ARE BASED ON THE MAXIMUM LOADING RATE FROM 1 TANK USING 4 PUMPS. THE ACTUAL LOADING RATE TO 1 SHIP IS 18,000 M³/HR USING 7 LOADING PUMPS

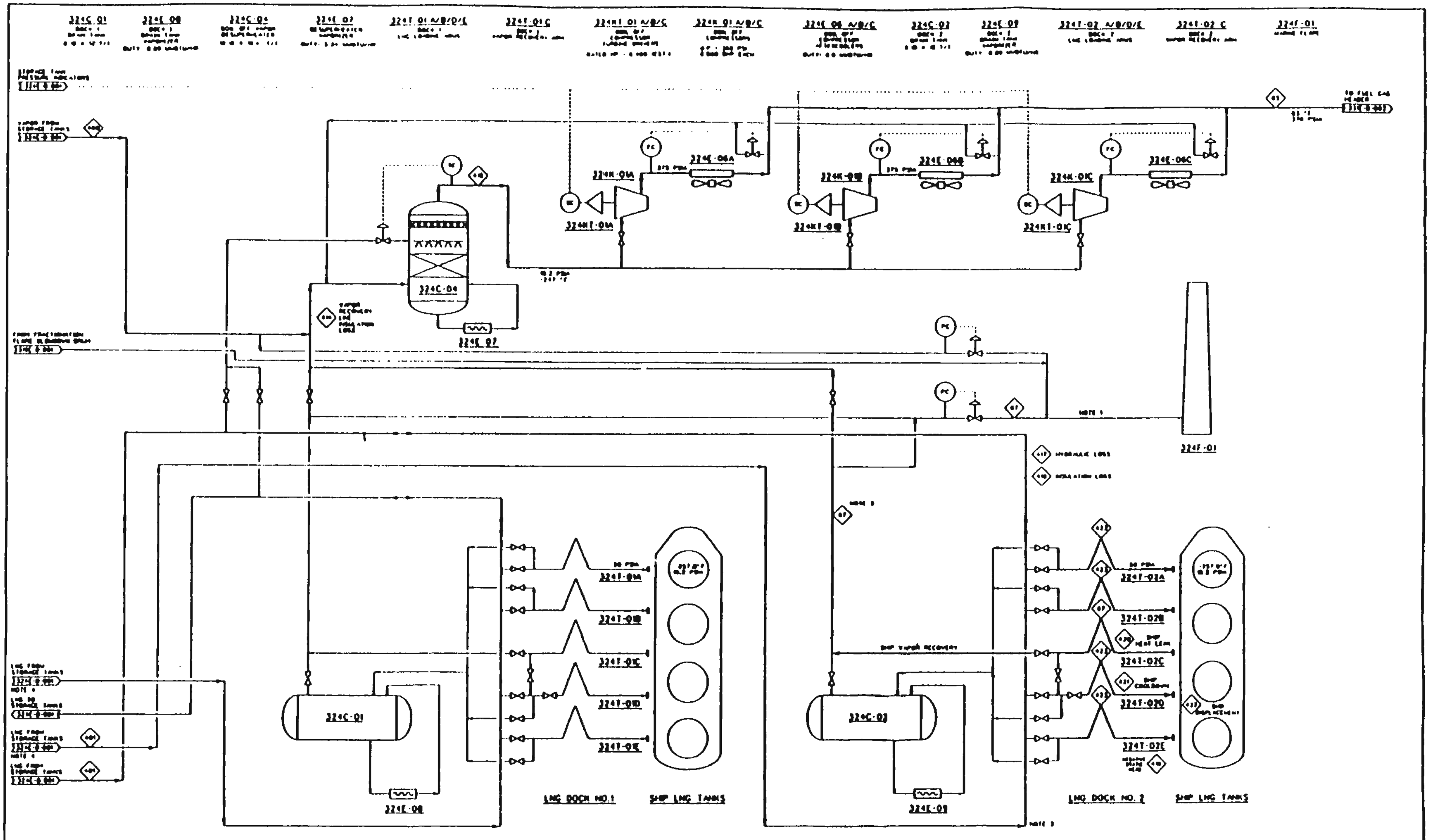
REFERENCE DRAWINGS	DRAWING NO.
[illegible]	[illegible]

BECHTEL CORPORATION
HOUSTON, TEXAS

YUKON PACIFIC CORPORATION
TRANS ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
LNG STORAGE/LOADING PUMPS
PLANT 324

JOB NO.	DRAWING NO.	REV.
[illegible]	324E-B-001	0



STREAM NO	03	07	400	401	414	415	417	418	419	420	421	422	423
DESCRIPTION	VAPOR TO FUEL GAS HEADER	SHIP VAPOR RETURN	VAPOR TO/FROM STORAGE TANKS	LNG TO SHIP	VAP RECOV LINE INSULATION LOSS	COMPRESSOR INLET	HYDRAULIC LOSS	INSULATION LOSS	NEGATIVE STATIC HEAD LOSS	SHIP HEAT LEAK	SHIP COOL DOWN	SHIP DISPLACEMENT	LNG LOADING ARM
MMSCFD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
BPD	-	-	-	[illegible]	-	-	-	-	-	-	-	-	[illegible]
LB/HR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
MOL WT	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
COMPONENT, LB MOLE/HR													
NITROGEN	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
METHANE	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ETHANE	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
ETHYLENE	0	0	0	0	0	0	0	0	0	0	0	0	0
PROPANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
i-BUTANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
n-BUTANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
i-PENTANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
n-PENTANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
n-HEXANE	0	0	0	[illegible]	0	0	0	0	0	0	0	0	[illegible]
TOTAL LB MOLE/HR	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
HEAT GAIN MM BTU/HR	-	-	-	-	[illegible]		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		-
DENSITY LB/FT3	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]			-				[illegible]
VISCOSITY CP	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]							[illegible]
SURF TENSION DYNE/CM	-		-	[illegible]					-				[illegible]

NOTES:

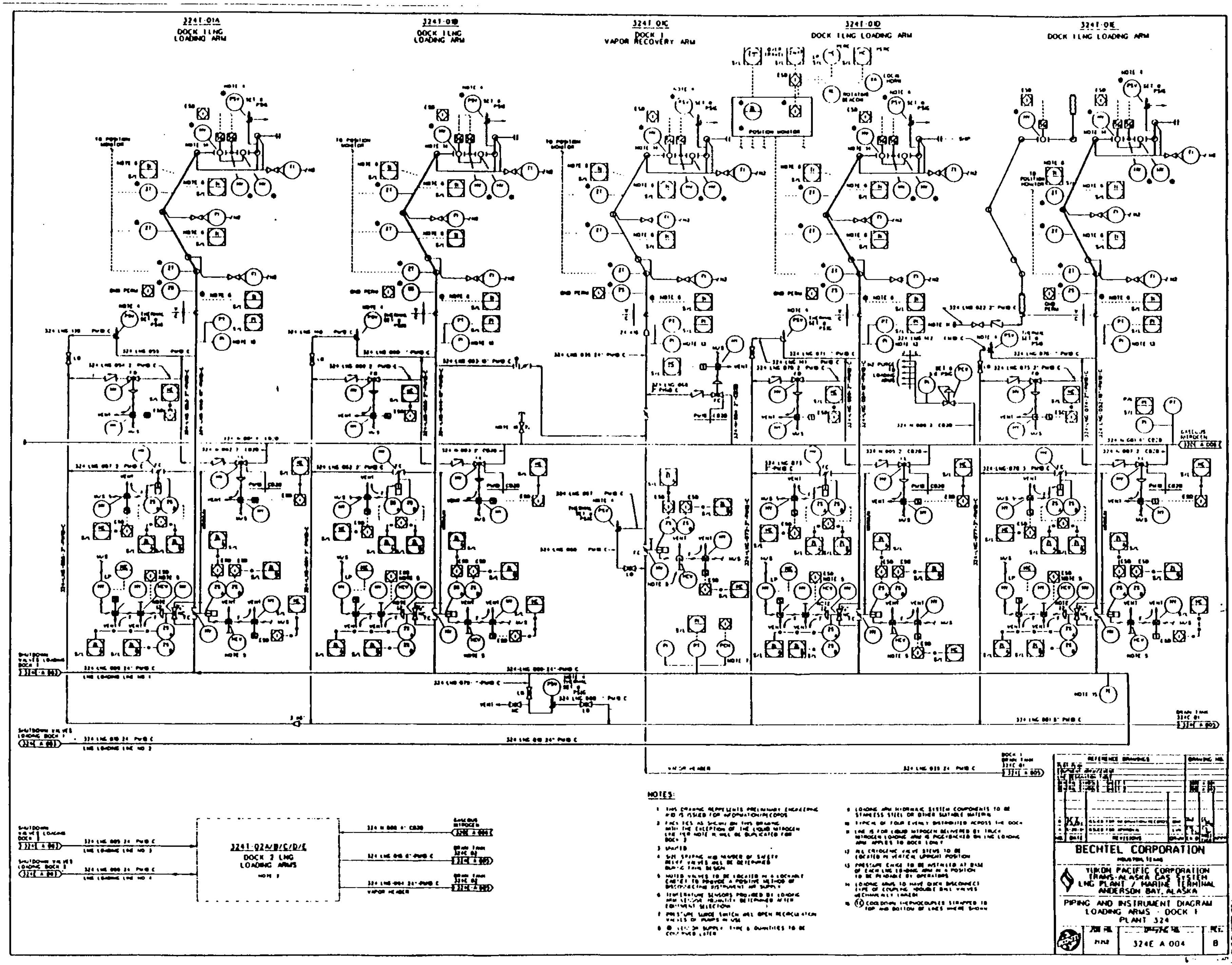
1. NORMALLY NO FLOW TO FLARE. ONLY EMERGENCY FLARE IS ALLOWED. FINAL DESIGN PENDING RELIEF STUDY
2. THIS CONDITION IS FOR LOADING LNG TO ONE SHIP
3. LNG LOADING RATE IS 10,000 M³/HR
4. AS SHOWN, DOCK 1 LOADING LINES ARE CIRCULATING LNG. DOCK 2 LOADING LINES ARE LOADING LNG TO THE SHIP. DESIGN PERMITS SIMULTANEOUS LOADING OR CIRCULATING TO BOTH DOCKS

BECHTEL CORPORATION
HOUSTON, TEXAS

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

PROCESS FLOW DIAGRAM
LNG SHIP LOADING/BOIL-OFF
COMPRESSORS PLANT-324

JOB NO.	DRAWING NO.	REV.
[illegible]	324E B 002	1


324T-01A
DOCK 1 LNG LOADING ARM
324T-01B
DOCK 1 LNG LOADING ARM
324T-01C
DOCK 1 VAPOR RECOVERY ARM
324T-01D
DOCK 1 LNG LOADING ARM
324T-01E
DOCK 1 LNG LOADING ARM
POSITION MONITOR
324T-02A/B/C/D/E
DOCK 2 LNG LOADING ARMS
NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PIPING AND INSTRUMENT DIAGRAM
LOADING ARMS - DOCK 1
PLANT 324
324E A 004
B

Instrumentation and Control System

The control system for the facility is to be based on distributed control and sequential logic hardware using microprocessor technology in the control of continuous analog loops, on/off commands such as start/stop of pumps or open/close of remotely operated valves and alarming of off-normal operating conditions. Normal interlocking and sequencing functions also are to be accomplished with the system. A programmable logic control system (PLC) is to be used for all shutdown logic and hazard controls.

A distributed control system (DCS) design is to be designed to provide continuous operation and to furnish control emergency shutdown logic for the facility. (It also is to provide selected monitoring and control of associated pipeline compressor stations and main line valves.) In addition to providing operators with the ability to monitor and control plant processes and utilities, the control system is to allow shutdown safety and security functions from central consoles located in the plant control centers. The system is to have full-custom graphics and reporting capability.

Initially, under one scenario, the DCS and the PLC systems are to be designed for two process trains, associated utilities, two LNG storage tanks and two marine terminals. Hazard detection and control for all facilities also is to be included in the design. The systems are to be of modular construction and be capable of handling future expansion up to a total of five process trains and associated utilities, storage facilities and hazard detection and control.

The DCS and PLC includes the following control and monitoring areas: Main Control/Marine Operations Building; Dock Operations Building; compressor control rooms; Turbine-Generator Control Room; and the Fire

Station. The DCS is to interface with the PLC and is to include redundant data communication (data highways) which communicate by means of redundant local control networks through highway gateways. The PLC is to transfer data to the DCS using fault-tolerant communication modules and data highway ports. The following overall reliability criteria are intended to apply to the DCS:

No single failure of an operator station control unit (processor) is to jeopardize the function of the operator console or other device on the data highway;

In the event of a control or process interface unit failure, the control system is to be designed to provide for transfer of that units monitoring and control function to a secondary backup unit with identical capabilities;

Sufficient equipment is to be provided to give a fully redundant communication system. Transfer from primary to secondary channels is to be automatic with no disruption in monitoring or control capabilities;

All power supplies within each DCS are to contain redundant power supplies with automatic switchover on failure;

The unit is to have redundant control and communication devices and is to be double ported so it may connect to a redundant data highway system.

A supervisory computer is to be provided as an auxiliary system to the DCS. The auxiliary system is to provide the following:

Access to real-time data acquisition
Advanced control implementation
Expanded data retrieval
Detailed report generation
Process/utilities studies
Process modeling
High speed information transfer
Predictive maintenance
Emergency procedure instructions

The PLC is to consist of state-of-the-art microprocessor-type processing and communication modules that interface fully with the DCS. The system is to be of stand-alone type having its own power supplies, termination racks and fault-tolerant processing modules to provide high reliability. The control and emergency shutdown philosophy is to be based on a "deenergize to trip" scheme which represents what is considered by YPLP to be the safest approach to operations. (It is recognized by YPLP that this philosophy may increase the opportunity for nuisance trips and therefore adversely affect "on-line" time to some extent but its intention is to ensure that the plant is to revert to a safe condition in the event of equipment or instrument failure.) The system is to incorporate fault-tolerant PLC capabilities for shutdown, alarm and critical control logic functions. Field input and output signals for DCS and PLC, both analog and discrete, are to be terminated in racks located at specified locations in the plant.

A more detailed review of the facility control system, including discussion of a Sequence of Events Recorder, an enhanced vibration Machinery Monitoring System (for major rotating equipment), a Management Information (Computer) System, a Supervisory Control and Data Acquisition System and various other items, is provided in the YPLP original material submitted to the FERC - Volume V, Response 10.

Control Centers

The Distributed Control System and the Programmable Logic Control System includes the following control and monitoring areas:

Main Control/Marine Operations Building - The purpose of the centrally located building is to control and monitor the process and utilities areas as well as to provide the same functions for the two marine terminals, the LNG storage tank area and the marine flare. Five four-station and one three-station operator consoles are to be furnished to implement the above. Provisions are to be made for a Management Information System to telemeter facility operations data to Anchorage. The control and information capability also is to provide for Remote Terminal Unit data interchange between the LNG facility, the Gas Conditioning Facility, pipeline compressor stations and mainline valve stations. Shutdown control of compressor stations and mainline valves also is to be included.

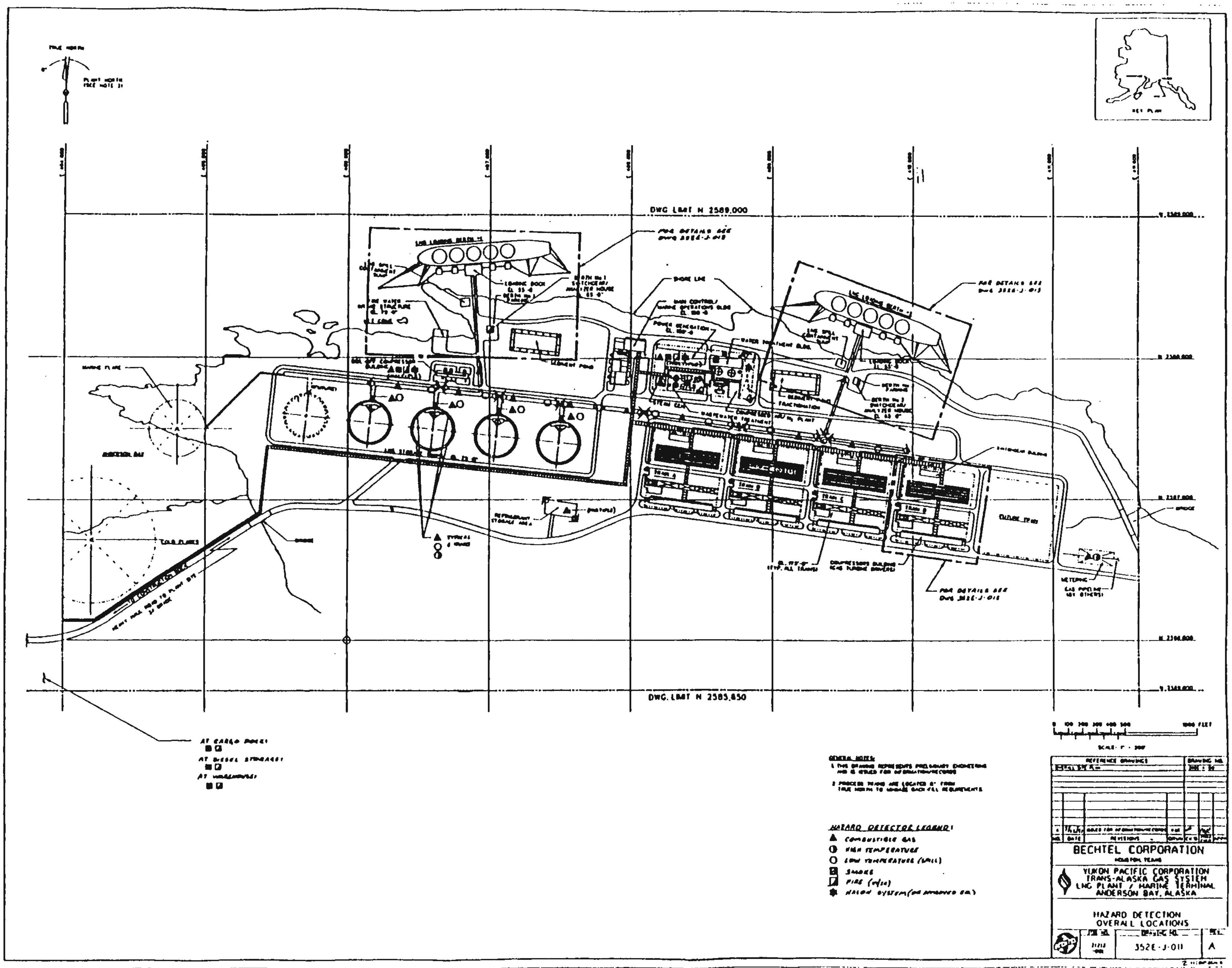
Compressor Control Room - Each liquefaction train includes a Compressor Building that is to contain five turbine-driven process refrigerant compressors and an associated control area, the buildings being located on the south end of each train. These control areas are to provide fully equipped two-station operator consoles for startup, monitoring and control of the turbine machinery equipment.

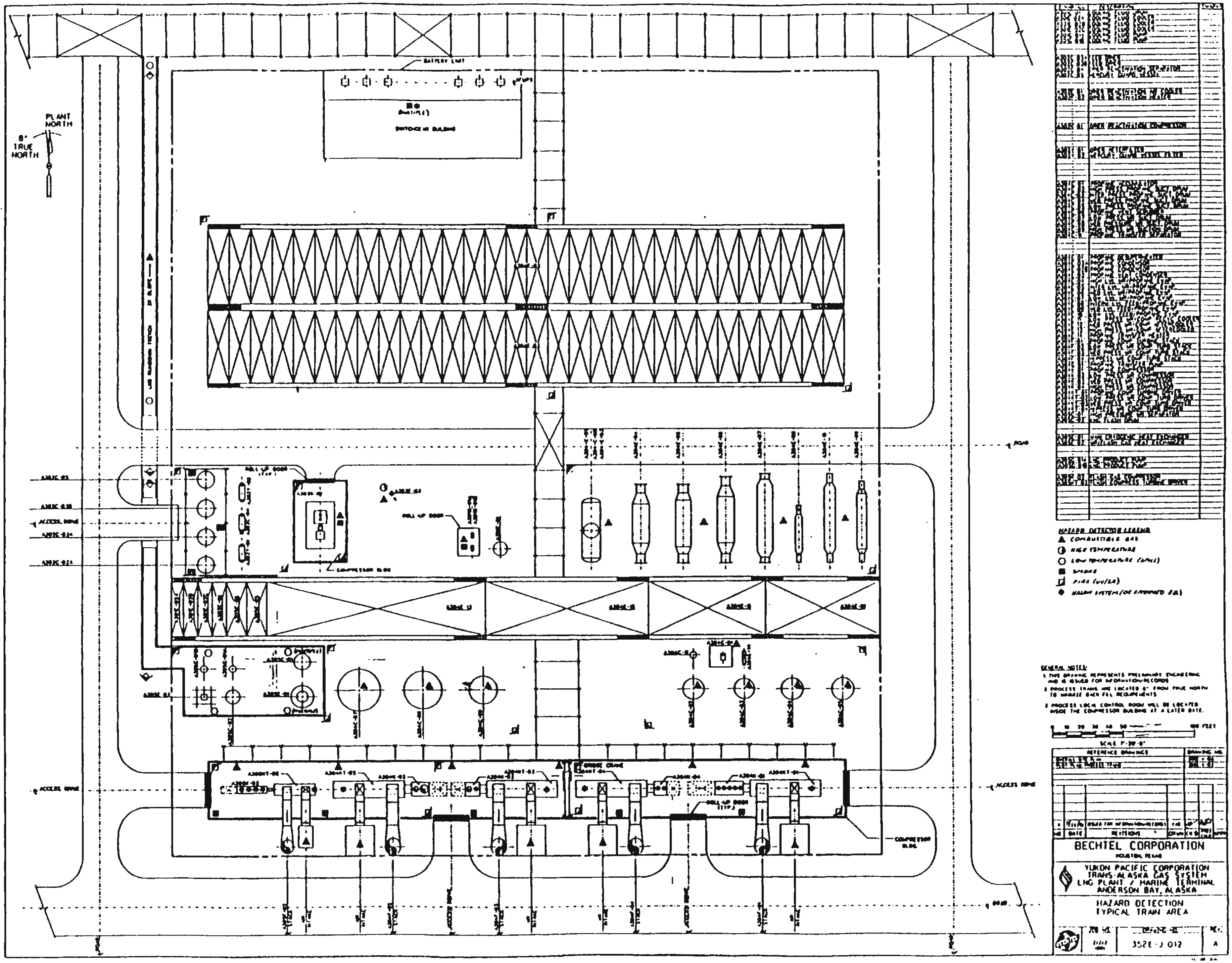
Turbine-Generator Control Room - The facility Power Generation Building is to be located east of the Main Control/Marine Operations Building and north of Liquefaction Train A. To be included in the building is the Turbine/Generator Control Room for control and monitoring of the power generation, utilities, effluent treatment, firewater intake structure, cold flares and refrigerant storage area. The two-station operator console also is to be used for backup control of the utilities facilities.

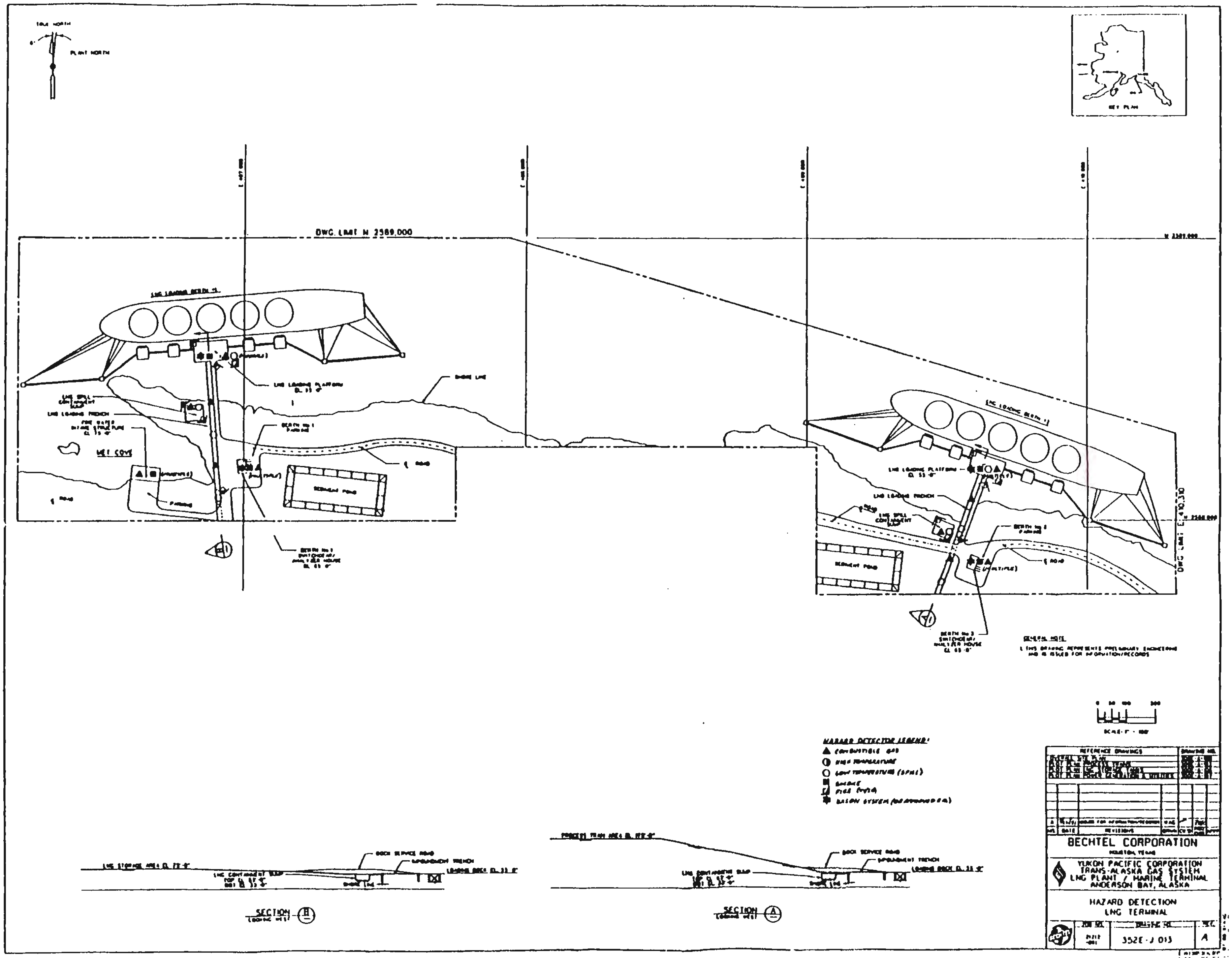
Dock Control Room - Each dock is to be provided with a Dock Operations Building. The control portion is to be equipped with visual display units and alarms only. Systems are to include hard wire connections for data transfer to the LNG ship computer system.

Dock Operator Shelter - The operator shelters to be located on the loading docks are to be used to facilitate connecting and disconnecting the ship to and from the loading arms. Once accomplished, all monitoring and control is to be from the Main Control/Marine Operations Building.

Fire Station - The facility Fire House is to be attached to the west side of the Main Control/Marine Operations Building. This structure is to house a single reduced function operator station for monitoring the plant hazard detection and control system. Presently it is envisioned that the Fire Station would not be manned by full-time staff.


DWG. LMT N 2589,000
DWG. LMT N 2585,850
HAZARD DETECTOR LEGEND:
COMBUSTIBLE GAS
HIGH TEMPERATURE
LOW TEMPERATURE (SPILL)
SMOKE
FIRE
HALON SYSTEM
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
HAZARD DETECTION
OVERALL LOCATIONS
352E-J-011
A


PLANT NORTH
8° TRUE NORTH
BATTERY LIMIT
SWITCHGEAR BUILDING
ROLL UP DOOR
COMPRESSOR BLDG
ACCESS DRIVE
BRIDGE CRANE
COMPRESSOR BLDG.
ROAD
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
HAZARD DETECTION
TYPICAL TRAIN AREA
352E-J-012
A



DWG. LIMIT N 2589,000
WET COVE
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
HAZARD DETECTION
LNG TERMINAL
352E-J 013
A
SECTION B
SECTION A

Hazard Detection System

Hazard detectors are to be positioned in strategic locations throughout the facility. The detectors are to consist of combustible gas, ultraviolet/infrared (UV/IR), smoke (ionization), high temperature and low temperature units. Precise numbers and locations are to be determined in the final design. The general philosophy of detection devices and logic systems stipulated by YPLP is outlined below.

Hazard detectors are to be installed to provide operating personnel with early indication of releases of flammable fluids and fires; to indicate the general location of the release or fire; to initiate automatic shutdown of equipment in the affected portion of facility; and to initiate automatic discharge of selected fire control systems. Each hazard detector is to actuate visible and audible alarms in the Main Control Room and in the Fire Station. In most cases, automatic shutdown and/or automatic discharge of fire control systems is to occur only if two or more hazard detectors in a given area are in alarm mode simultaneously. See the following figures for preliminary hazard detector locations.

Combustible gas detector installation is to include the following locations:

- Air inlets to all pressurized buildings
- Inside all enclosed buildings
- Air inlets to all fired heaters and gas turbines
- Each flammable liquid pump
- Each flammable gas compressor
- Inside each gas turbine enclosure
- Refrigerant storage area
- Near LNG ship loading arms
- Liquefaction trains
- Fin-fan coolers/condensers
- Fractionation area

Low temperature detectors are to be a minimum of two point-type detectors or one continuous strip-type detector - installation to include each of the following areas:

Each LNG impounding area and spill drainage trench
LNG flash drum, product pumps and main liquefaction heat exchanger for each train
Below LNG loading arms on both docks

It was indicated that the low temperature detectors are to have a factory set point of -40° F with a field adjustment to -50° F.

Smoke detectors (ionization) are to be installed inside all buildings within the plant complex.

Ultraviolet/infrared (UV/IR) fire detectors are to be installed in the following areas:

Each LNG storage tank
LNG loading arms on each dock
Refrigerant storage area
Liquefaction trains
LNG impounding areas
Fractionation area
Diesel firewater pumps
Diesel fuel storage tanks
Natural gas and refrigerant compressors/turbines
Fin-fan coolers/condensers
Compressor lube oil skids

In all cases, UV/IR detectors are to be installed in pairs.

High temperature detectors are to have a set point of +248° F.

Hazard Control Systems

Several different types of chemical agents are to be available for fighting fires within the facility. The type of agent to be used in a specific situation is to depend on the characteristics of a particular event and on the relative effectiveness of the various agents on that particular type of fire. See the following figures for preliminary hazard control locations.

Low-expansion foam is effective for extinguishing fires of ordinary liquid hydrocarbons. Semi-fixed low-expansion foam systems are to be installed on all diesel storage tanks with capacities greater than 200 barrels. Fluoroprotein foam concentrate suitable for use with either fresh water or seawater is to be used to produce the low-expansion foam. Portable devices for producing and dispersing low-expansion foam also would be available.

High-expansion foam is to be applied to unignited pools of LNG to reduce downwind travel of the flammable vapor cloud. When applied to a pool of burning LNG, high-expansion foam is to be used to decrease the size of the flame and thus reduce the amount of radiated heat. Installation of fixed location high-expansion foam generators is to include the following areas:

Beneath the LNG loading arms on both LNG loading docks
Curbed area around the Main Cryogenic Heat Exchanger and the LNG Flash Drum in each train
LNG drainage trench beneath each LNG storage tank piping run to main transfer line impoundment
Two LNG impounding areas (onshore) for holding dock spills

The number of generators to be installed in each location is to be determined during detailed design. The overall design intent is to provide sufficient generators to produce a six-foot thick blanket of foam over the protected area within two minutes. Portable high-expansion foam generators are to be available to apply foam to other impounding areas. The foam concentrate to be used is to be suitable for use with both fresh water and seawater. The nominal expansion ratio of the foam would be from 400:1 to 600:1.

Gaseous extinguishing/inerting agents are to be used for extinguishing fires in enclosed spaces to limit the access of oxygen to the fuel and to inhibit the combustion process. Approved gaseous extinguishing systems are to be installed in all gas turbine enclosures, in certain control room areas and in other enclosures housing critical electrical/electronic equipment.

Dry chemical powders are to be used for extinguishing LNG fires and fires of other hydrocarbons. Potassium bicarbonate dry chemical agent is to be used on hydrocarbon fires. Monoammonium phosphate is to be used in dry chemical extinguishers intended for fighting Class A fires (wood, paper, cloth). Skid-mounted, fixed dry chemical extinguishers are to be installed on both LNG docks. These fixed systems are to supply dry chemical to close-coupled and remote hose reels. All other plant areas are to be protected by portable or mobile dry chemical extinguishers.

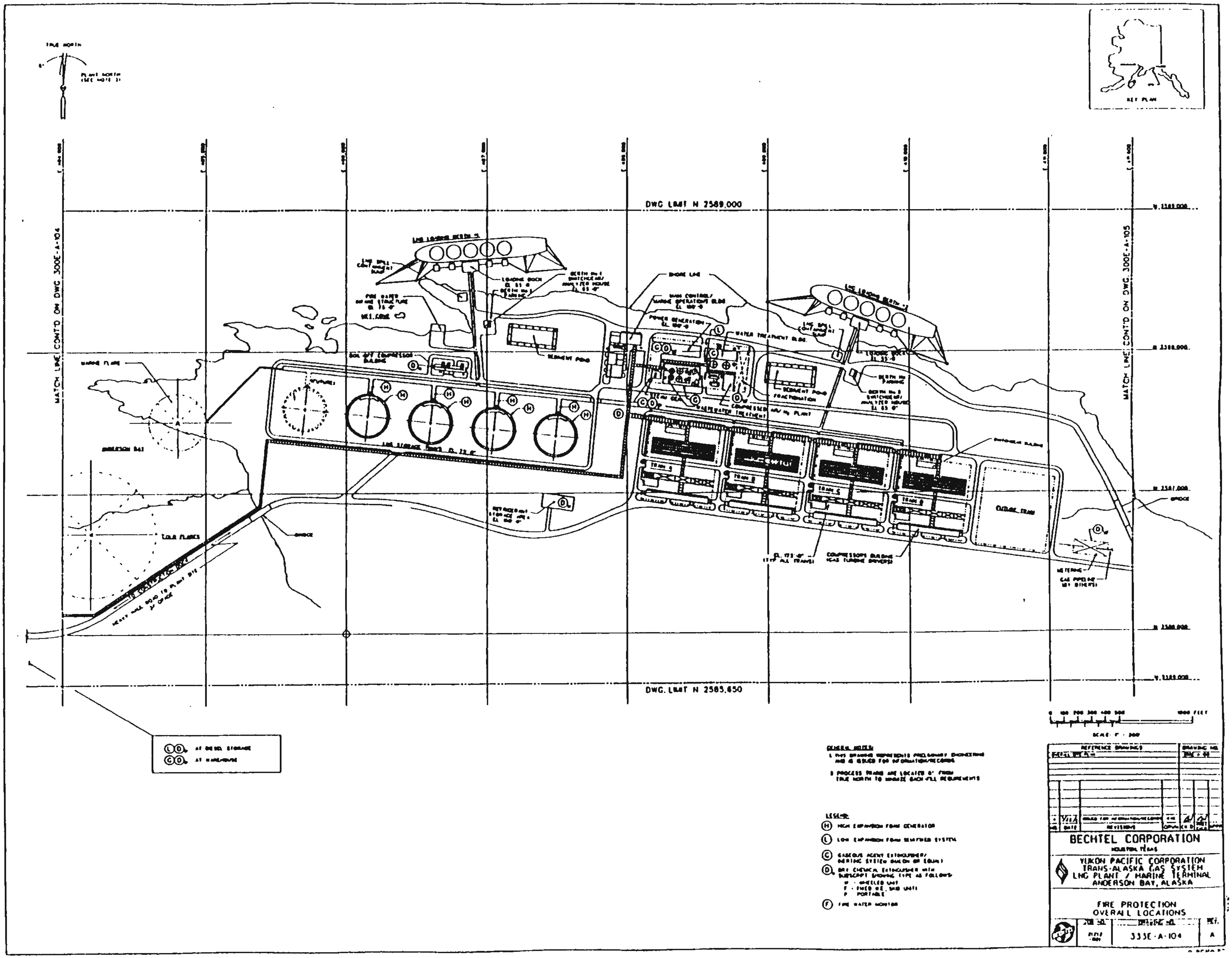
Portable hand dry chemical extinguishers of 20 or 30 lb capacity are to be distributed throughout the process and storage areas, on both docks and in all other locations where flammable gases or liquids are stored or processed. Wheeled dry chemical units of 150 or 350 lb capacity are to be located beneath the east-west pipe racks in each liquefaction train (five per train), in the fractionation area (two) and in all buildings that house gas turbines and/or flammable gas compressors (one wheeled unit per two turbines or turbine/compressor sets).

Hand portable fire extinguishers containing an approved gaseous extinguishing/inerting agent are to be installed in all buildings or rooms that house electrical or electronic equipment.

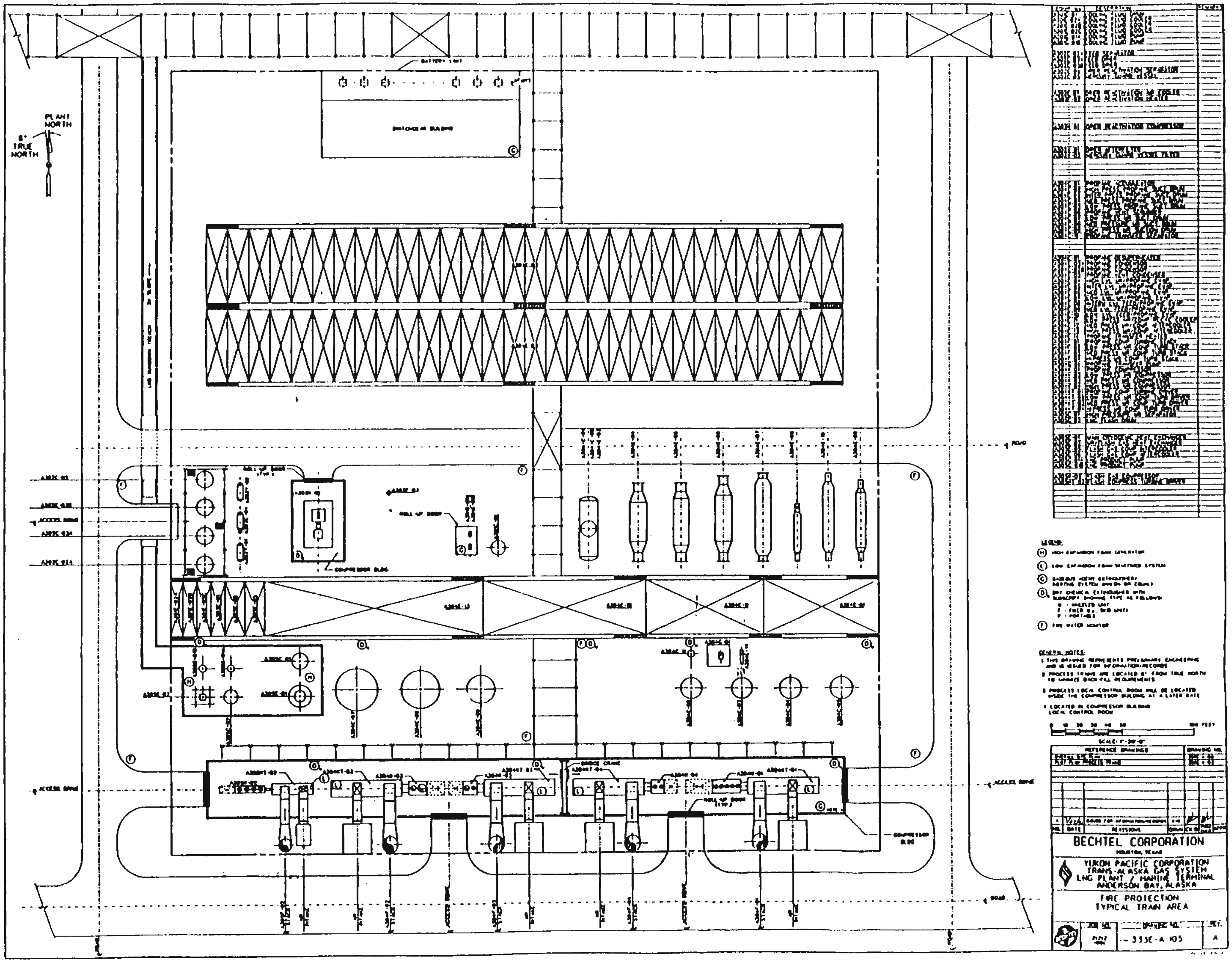
Mobile and portable fire fighting equipment is to include the following:

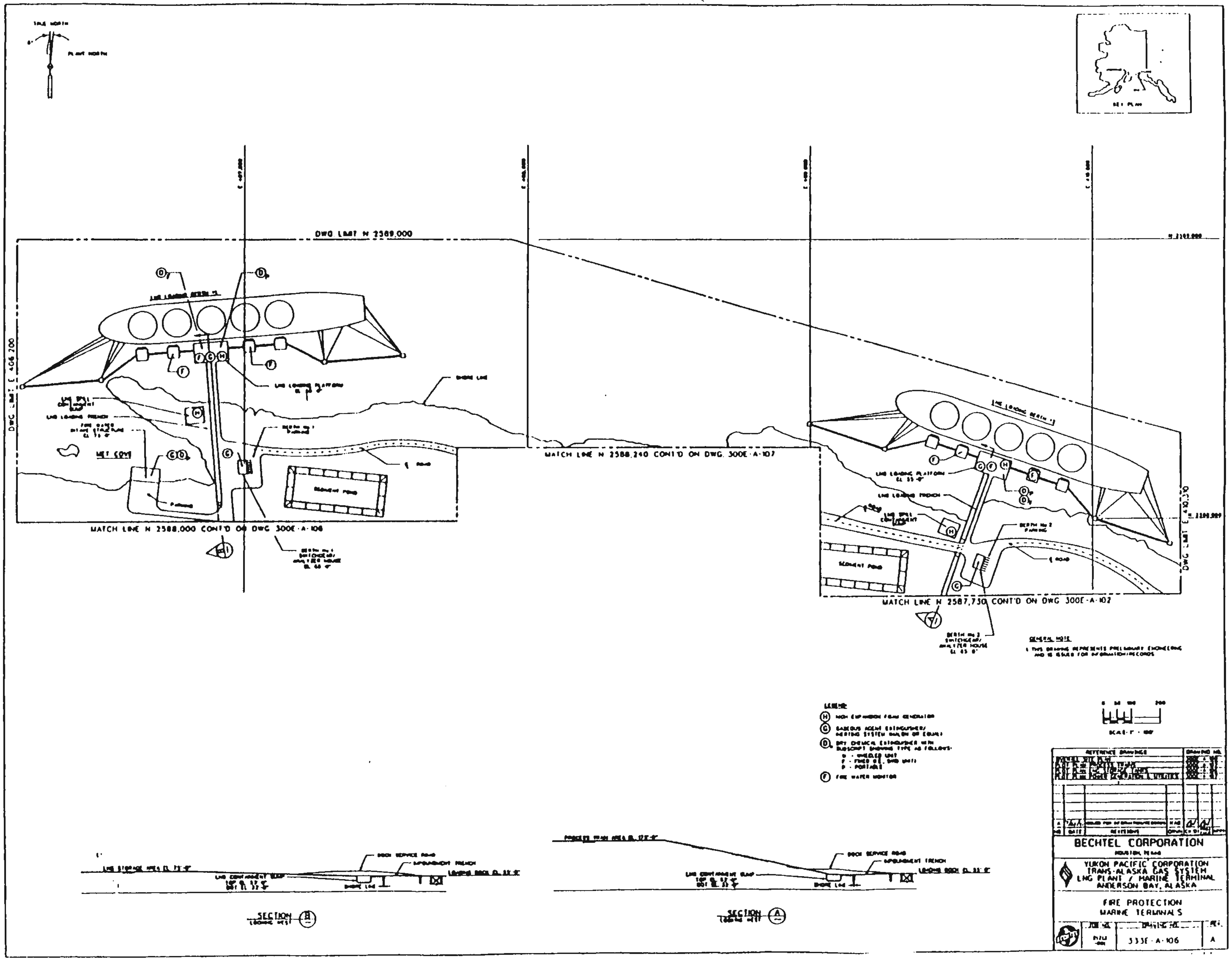
Two fire trucks (water only)
One fire truck (high-expansion foam)
One fire truck (water and low-expansion foam)
Six portable high-expansion foam generators
One 3000 lb, skid-mounted, dry powder unit on wheels with hose reels and one monitor

These equipment units are to be located at the Fire Station. Portable and mobile foam producing equipment and the water fire trucks are to be capable of being connected to hydrants on the firewater distribution system.



DWG LIMIT N 2589,000
DWG. LIMIT N 2585,650
MATCH LINE CONT'D ON DWG. 300E-A-104
MATCH LINE CONT'D ON DWG. 300E-A-105
SEDIMENT POND
WATER TREATMENT BLDG.
FUTURE TRAIN
GENERAL NOTES:
LEGEND:
HIGH EXPANSION FOAM GENERATOR
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
FIRE PROTECTION
OVERALL LOCATIONS
333E-A-104
A


PLANT NORTH
8° TRUE NORTH
SWITCHGEAR BUILDING
COMPRESSOR BLDG.
ROLL-UP DOOR
ACCESS DRIVE
ROAD
BRIDGE CRANE
LEGEND:
(H) HIGH EXPANSION FOAM GENERATOR
(L) LOW EXPANSION FOAM DELUGE SYSTEM
(G) GASEOUS AGENT EXTINGUISHER/ BOTTLE SYSTEM (HALON OR EQUAL)
(D) DRY CHEMICAL EXTINGUISHER WITH SUBSCRIPT SHOWING TYPE AS FOLLOWS:
S - SKID UNIT
F - FIXED
P - PORTABLE
(F) FIRE WATER MONITOR
GENERAL NOTES:
1. THIS DRAWING REPRESENTS PRELIMINARY ENGINEERING AND IS ISSUED FOR INFORMATION/RECORDS
2. PROCESS TRAINS ARE LOCATED 8° FROM TRUE NORTH TO MINIMIZE BACK FILL REQUIREMENTS
3. PROCESS LOCAL CONTROL ROOM WILL BE LOCATED INSIDE THE COMPRESSOR BUILDING AT A LATER DATE
4. LOCATED IN COMPRESSOR BUILDING LOCAL CONTROL ROOM
0 10 20 30 40 50 100 FEET
REFERENCE DRAWINGS
DRAWING NO.
NO. DATE REVISIONS
BECHTEL CORPORATION
HOUSTON, TEXAS
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
FIRE PROTECTION
TYPICAL TRAIN AREA
JOB NO.
DRAWING NO.
REV.
333E-A 105
A



DWG LIMIT N 2589,000
MATCH LINE N 2588,240 CONT'D ON DWG. 300E-A-107
MATCH LINE N 2588,000 CONT'D ON DWG. 300E-A-106
MATCH LINE N 2587,730 CONT'D ON DWG. 300E-A-102
DWG LIMIT E 406,700
WET COVE
SEDIMENT POND
SECTION B
SECTION A
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
FIRE PROTECTION
MARINE TERMINALS
333E-A-106
A

Firewater System

Firewater supply and distribution systems are to be provided for extinguishing Class A fires; cooling tanks, structures and equipment exposed to excessive heat radiation from fires; producing low- and high-expansion foam; and dispersing flammable vapors. The design of the firewater supply and distribution system is to provide for simultaneous supply of all fixed fire protection systems, including monitor nozzles, at their design flow and pressure involved in the maximum single incident expected in the plant, plus an allowance of 1000 gpm for hand hose streams for a period of not less than two hours. Jockey pumps are to maintain 150 psig system pressure.

Firewater is to be supplied from two independent pumping sources. (See the following figure for a schematic representation.) A 570,000 gallon Fire/Utility Water Tank is to be provided to supply fresh (desalinated) water through the fresh firewater pumping station primarily for pressurizing the firewater system and for initial fire fighting capability. A seawater pumping station is to be designed to supply the entire plant distribution loop with seawater if demand exceeds the capacity of the fresh water system. Seawater is to be pumped from the Firewater Intake Structure into the distribution loop by two electric motor-driven submerged seawater fire pumps (11,500 gpm each) with two additional diesel engine-driven spare pumps.

Initial firewater requirements are to be supplied by the motor- and diesel-driven fresh firewater pumps (4000 gpm each). When the firewater demand exceeds the pumping capacity or when the water supply in the Fire/Utility Water Tank reaches the low alarm level, the seawater pumping station is to be automatically activated. The electric fresh firewater pump is to start upon receipt of a low pressure firewater loop signal. The diesel-driven pump is to be activated if the primary electric pump is unable to maintain system pressure. The seawater pumping station is to be placed onstream automatically and is to be designed to maintain system pressure at maximum anticipated demand.

The firewater distribution network is to be a wet underground main with hydrants and monitors strategically located throughout the facility. Sectional isolating valves of the post-indicating type are to be incorporated in the firewater mains to ensure system integrity and to permit isolating the system in the event of a break or for making repairs or modifications. Design details and location of strategic components remain pending.

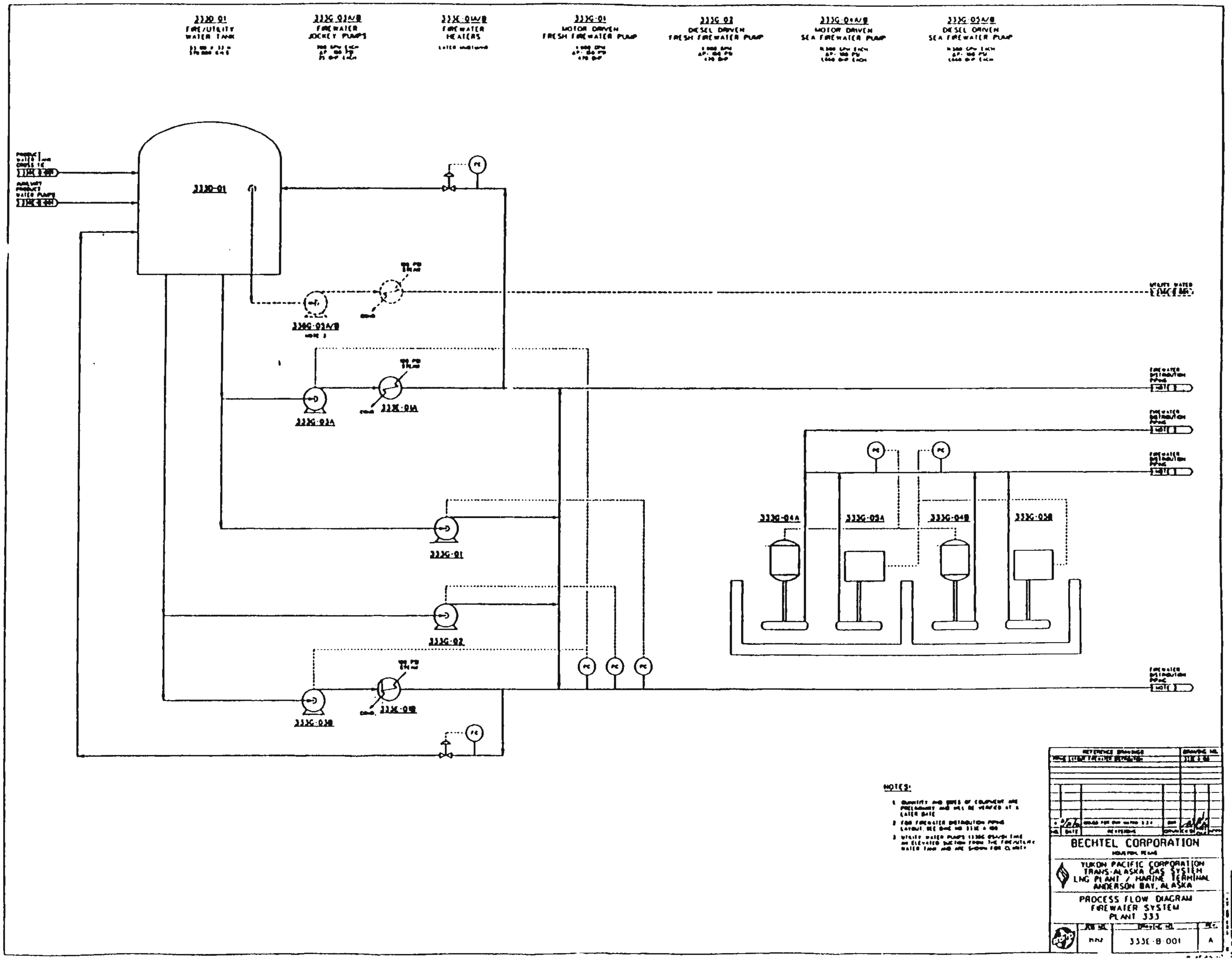
Automatically operated fixed water spray systems are to be installed for the protection of selected tanks, pumps, vessels, columns, heat exchangers and piping. It was indicated that all process vessels that are to contain significant amounts of liquefied gas are to be water sprayed. All fin-fan coolers/condensers that contain flammable fluids or are located above pipe racks carrying flammable fluids are to be water sprayed. Lubrication oil skids located below compressors are to have a combination water spray/low-expansion foam system. All pumps that handle combustible liquids that are above their flash points also are to be protected by fixed water spray systems.

Fixed location, adjustable monitors are to be used to protect tall vessels such as fractionation and liquefaction columns and to provide additional water cooling capability in process areas. Monitors are to have a design flow of 500 gpm and a maximum range of 100 feet.

The firewater loop in the LNG storage tank area is to supply water for fixed water spray systems on the storage tanks, for monitors and hydrants and for producing high-expansion foam. Each LNG storage tank is to be protected by a fixed water spray system on exposed portions of the tank. (The concrete walls would shield much of each storage tank from heat radiation emitted by fires in adjacent tanks.) In order to conserve water and reduce demands on the impoundment area sump pumps, the spray system on each tank is to be sectionalized. Only those sections that are needed in a given situation are to be activated. The piping, valves, etc., from the roof of each tank down to the grade level drainage trench also are to be water sprayed.

The refrigerant storage area is to be equipped with an automatically operated water spray system designed to absorb heat developed by fires and to suppress flames in order to protect piping, refrigerant storage tanks and surrounding equipment.

Fire fighting provisions at each of the two docks are directed to protection of the dock facilities. The firewater systems are to include a firewater distribution system (normally dry), three hydrants (with hose racks) at strategic locations at the loading platforms, two firewater monitors at the inner breasting dolphins, one firewater monitor at the intersection of the loading platform and trestle and two elevated, pre-aimed, remote on-off firewater monitors to protect the loading arms. Additionally, a fixed water spray system is to be provided on the gangway, LNG Drain Drum, LNG piping and critical valves. A fixed water spray system also is to be provided on the outside of the Dock Operations Building.



333D-01
FIRE/UTILITY WATER TANK
333G-02A/B
FIREWATER JOCKEY PUMPS
333E-01A/B
FIREWATER HEATERS
333G-01
MOTOR DRIVEN FRESH FIREWATER PUMP
333G-02
DIESEL DRIVEN FRESH FIREWATER PUMP
333G-04A/B
MOTOR DRIVEN SEA FIREWATER PUMP
333G-05A/B
DIESEL DRIVEN SEA FIREWATER PUMP
333D-01
333G-03A
333E-01A
333G-01
333G-02
333G-03B
333E-01B
333G-04A
333G-05A
333G-04B
333G-05B
NOTES:
BECHTEL CORPORATION
YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA
PROCESS FLOW DIAGRAM
FIREWATER SYSTEM
PLANT 333
333E-B-001
A

Spill Containment

At the present stage of design, spill containment systems for the proposed facility are tentative, final configurations are to be developed as design progresses. The impoundment systems are to be designed to comply with Federal Regulation 49 CFR Part 193 which requires that each LNG container and each LNG transfer system have an impoundment capable of containing the quantity of LNG that could be released by a credible accident. YPLP indicates that containers in the proposed facility requiring such impoundment include: liquefaction system main cryogenic heat exchangers, LNG flash drums, LNG storage tanks and loading arm drain tanks on each loading dock. Similarly, YPLP indicates that LNG transfer systems necessitating impoundment include: lines from the liquefaction trains to the LNG storage tanks, LNG loading lines from the storage tanks to the docks and LNG ship loading arms. Each of the containers and transfer systems are to have an impoundment, although each is not required to have an exclusive system; a properly designed system may serve a combination of containers and/or transfer systems. The volume of each impounding system is to be sufficiently large to contain the volume of LNG that could be released in 10 minutes from the single pipe rupture that would produce the highest release rate, plus the volume of LNG that could drain from the pipe (and associated containers) following an emergency shutdown. Detail configurations are not available at this time.

For the proposed conventional metal double wall storage tank configuration (Type T-2), containment of LNG in the event of liquid spillage from the inner tank is to be provided by a Class 2 impoundment system, using an external high concrete wall dike capable of withstanding the hydrostatic head of the impounded LNG, the rapid thermal shock, the hydrodynamic action, etc., resulting from a tank failure as required by subpart 193.2155 of 49 CFR-193. The prestressed concrete containment dike is approximately 92′-3" high above grade, 314′ outside diameter with a 2′-thick wall to be separated from the storage tank outer shell by a 15′ annulus. The top of the wall is to be set at the same elevation as the top of the inner tank. While the containment dike enclosure is to be equivalent to 137 percent of storage tank contents, subpart 193.2181 requires a minimum capacity of 150 percent for Class 2 LNG storage tank impoundment. Quiescent full tank contents would fill the containment to a level of 67′.

The spill containment system consists of the rock subgrade and the prestressed wall, which is to be keyed into the rock to provide a connection between the elements. The wall is to be prestressed both vertically and horizontally to resist liquid pressure from the full contents of LNG from the inner tank and the coincident thermal gradients through the wall. The prestress levels are to be selected to maintain minimum compression zone in the wall under this condition. The wall foundation is to be an enlarged extension of the wall and keyed into the bedrock. It is the intention that the weight of the wall be sufficiently large to resist the seismic and wind uplift forces acting on the foundation; consequently, rock anchors would not be required.

Because of the high snowfall in the area it is proposed that the annular space be covered with a roof to eliminate the accumulation of snow and ice between the tank and the wall. A gravity drainage system to sump pumps in the annular space is also to be provided. Ventilation fans would be needed to assure a flammable vapor mixture does not collect in the annular space.

Each of the other proposed LNG storage tank configurations (Type T-4 and Type T-6) are to be constructed with an integral concrete outer wall which

YPLP indicates is to serve as a Class 1 impoundment system capable of holding 110 percent of the tank contents. The use of an outer wall of a double-wall tank as a dike is permitted by DOT regulations in Sections 193.2153(a), 193.2161(b) and 193.2155(c), provided that the concrete wall is designed to withstand the equivalent impact loading of collision by, or explosion of, the heaviest aircraft which can take off at the Valdez airport. This type of equivalent impact analysis has not been conducted for either of the two double- or increased-integrity tank designs proposed by YPLP and as such do not presently meet the DOT regulations. We recommend that YPLP submit to DOT for approval and to the FERC the equivalent impact load analysis required by DOT regulations. If written approval of the impact analysis cannot be obtained, YPLP shall construct a separate and independent impounding system for such storage tanks consistent with existing standards and codes.

Potential spills or leakage from rundown piping extending from each of the four liquefaction trains to the LNG storage tanks and from the storage tanks to each dock is to be accommodated by sloped impoundment trenches which vary in width from 10′ to 40′, depending on number and size of pipes in the pipe racks. Concrete walls of these LNG impounding trenches would vary from 4.5 to 9 feet high. The trenches are to be subdivided to limit liquid exposure areas.

Each LNG storage tank would have an approximately 30-foot wide by 100-foot long by 9-foot high impoundment trench for the 24-inch LNG fill and withdrawl lines. Each impoundment would provide containment of spills associated with the horizontal lines from the common pipe rack to the base of the LNG storage tank. Since all LNG transfer lines would enter or exit through the tank roof, the 24-inch fill and withdrawl lines would have a vertical segment from the base of the tank up to the roof--a distance of 96 feet for type T-2, 112 feet for T-4, and 91 feet for T-6.

Part 193.2161 of the DOT regulations prohibits any penetrations of a dike in order to accomodate piping. As a result, the vertical piping segments would be external to the outer tank wall of the type T-4 and T-6 tanks, and external to the impoundment as presently configured. The final design of the spill containment systems will also need to provide for impoundment of the vertical segments of the fill and withdrawl lines.

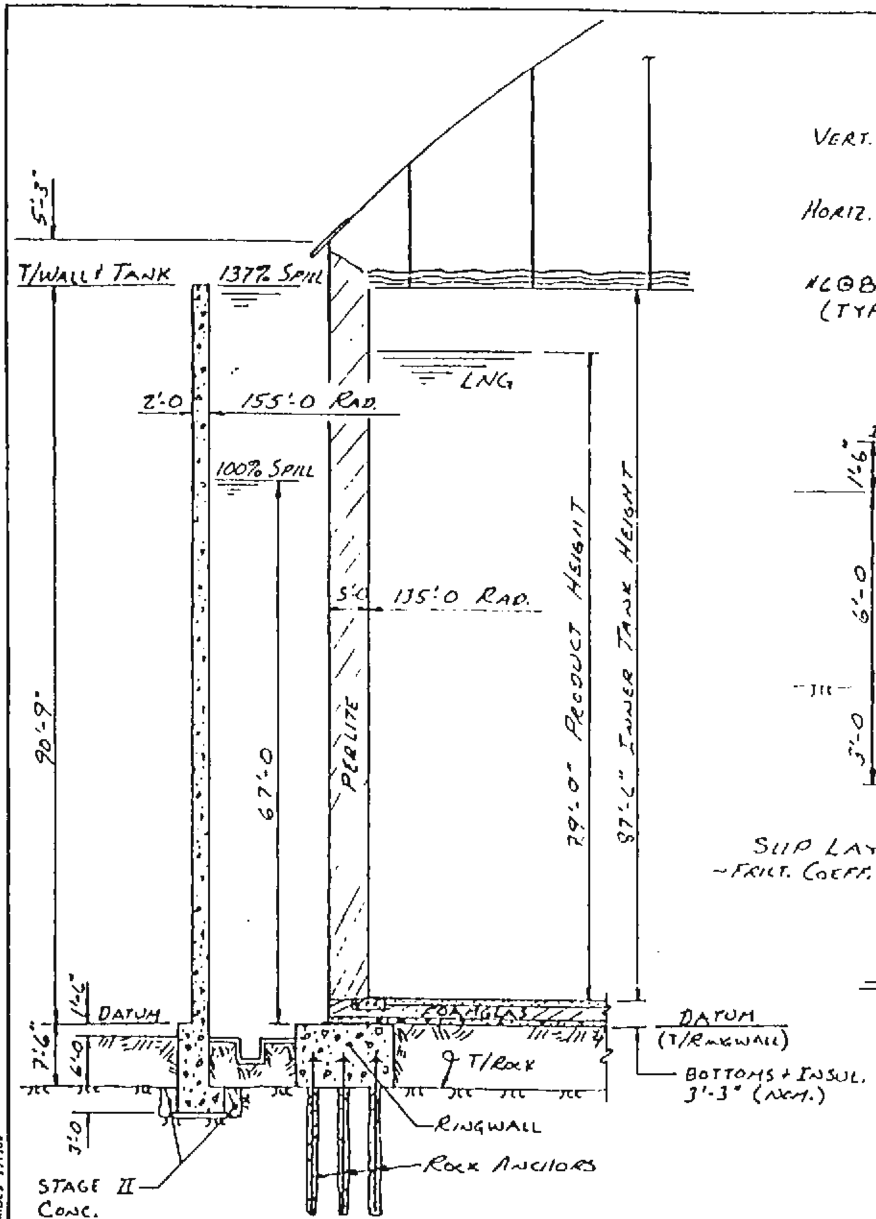
Each liquefaction train is to have a curbed impounding area for containing LNG released from within the train or from the rundown piping. Each impoundment is to provide local containment with drainage to the west side of each liquefaction train and then north via a rundown trench to the main LNG pipe rack impoundment. The local containment is to surround and to accommodate leakage from the Main Cryogenic Heat Exchanger, the LNG Flash Drum and from associated LNG transfer pumps, MR/Flash Heat Exchanger and High Pressure MR Separator. The concrete curbed containment surrounding the LNG components is estimated to be 50′ x 100′ x 6" to 9" deep. The LNG rundown trench is estimated to be 10′ x 450′ x 6′ deep with a two percent slope toward the main LNG pipe rack impoundment and is to be subdivided to limit liquid exposure area.

Perhaps the most difficult design task is to develop effective spill containment and diversion for the loading docks and associated trestles. Curbed concrete spill containment is to be provided beneath the LNG loading arms at each dock. Although several arrangements have been proposed to accommodate potential spills and possible diversion to an onshore impoundment, a final configuration has not been presented.

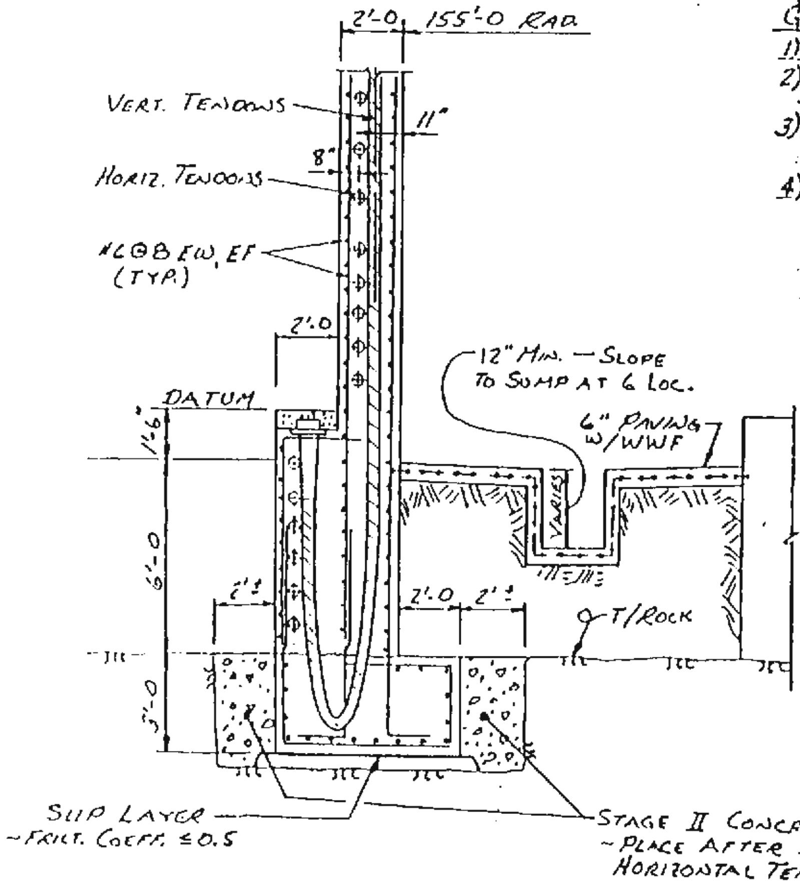
Equally difficult is to design spill impoundment systems that retain the required containment capacity at a site that may experience more than 500 inches of snowfall each year. Various ideas were discussed for snow control (snow removal from dikes, snow roofing, heat traced dike floors, etc.) but the issue remains unresolved. Although it was not discussed at the meeting, in addition to the above concepts, YPLP should be aware of a concentric "pipe-in-pipe" containment design system. The latter concept may in a limited way reduce snow control and removal activities around some specific piping arrangements, but may be of limited value in its use around flanges, elbows and other non-linear piping. Another potential application of this concept is impoundment for the vertical segments of the fill and withdrawl lines for the LNG storage tanks. However, it should be made clear that this design concept would be in addition to already planned containment systems.

The two 26,000 gallon ethane and two 430,500 gallon propane refrigerant storage tanks are to be contained in a remote impounded area approximately 260 feet south of LNG Storage Tank 1. It was indicated that design of the system is to be in accordance with applicable standards recommended by API 2510, Design and Construction of Liquefied Petroleum Gas (LPG) Installations.

YPLP indicates that the facility is to be equipped with state-of-the-art responsive spill and hazard detection systems. The systems are to automatically actuate shutdown of the affected components as required by 49 CFR Part 193. YPLP also indicates that the detection and shutdown time for any sizable spill should be shorter that 10 minutes. However, in keeping with code requirements, the impounding areas are to be sized to contain 10 minute spills.



TYPICAL SECTION
(Scale: 1/16" = 1'-0)



DETAIL AT BOTTOM OF WALL
(Scale: 1/4" = 1'-0)

GENERAL NOTES

1) CONCRETE DESIGN PER ACI 318-89
2) CONCRETE COMPRESSIVE STRENGTH, f'_c = 4000 PSI
3) ALLOWABLE BEARING PRESSURE ON BEDROCK ASSUMED = 10,000 PSF
4) REINFORCING STEEL IN WALL TO BE ASTM A706

EST. QUANTITIES – ONE WALL

ITEM	CONCRETE	REINF. STEEL
WALL	8100 CY	1,150,000 #
FOOTING	700	100,000
STG. II CONC.	500	—
PAVING	300	** 30,000
TOTALS	9600 CY	1,280,000 #

** WWF

Indicates change from previous issue

CBI

Supplier's/Purchaser's No.

310' φ CONTAINMENT WALL FOR 800 MB LNG TANK
YUKON PACIFIC CORP, ALASKA

Customer's No.

By RP Chkd ____ Date 5-21-91

Engineering Supervisor

Contract No. S 14520

Dwg. A-1 Rev. 0

Sheet

Remarks

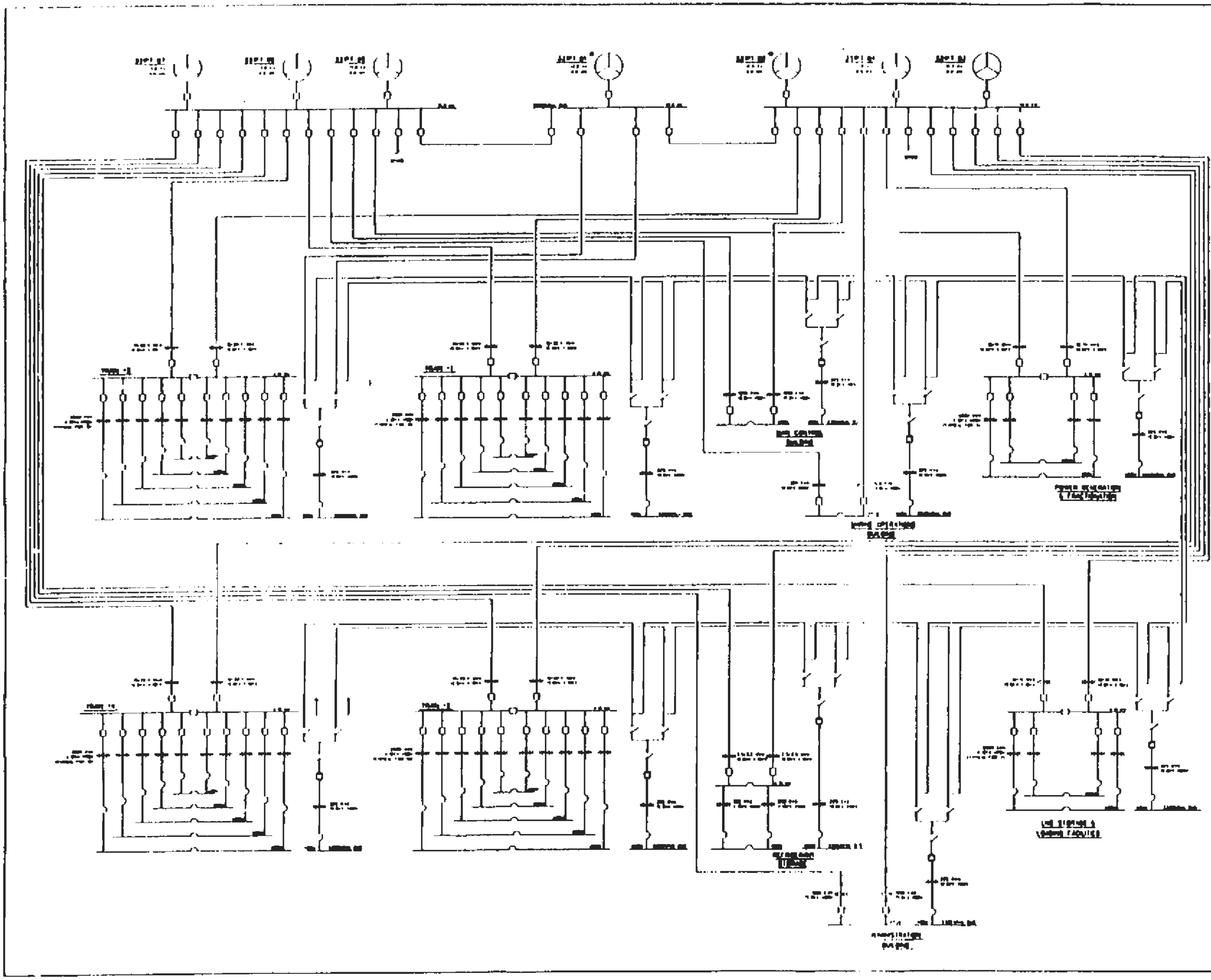
Revisions

By | Chkd | Date | By | Chkd | Date

Electrical Power Generation

The facility is to be designed to provide total electric power requirements onsite. Power generators are to consist of seven 8.8 MW gas turbine-driven Mars GSC 12000 units manufactured by Solar Turbines. Power is to be generated at 13.8 kV, 3 phase, 60 Hz. Two of the turbine-generator units are to provide "black start" capabilities, i.e. the turbines being capable of operation with diesel fuel in the event that natural gas supply is interrupted. The high voltage power is to be reduced to operating voltage by transformers located at major facility entities. Each major entity is to have an essential bus to provide power to more critical controls and components.

All electrical transmission/distribution lines are to be provided underground.



NOTES:

REFERENCE DRAWINGS	DRAWING NO.

NO.	DATE	REVISIONS	DRAWN	CK'D		APPR

BECHTEL CORPORATION

HOUSTON, TEXAS

YUKON PACIFIC CORPORATION
TRANS-ALASKA GAS SYSTEM
LNG PLANT / MARINE TERMINAL
ANDERSON BAY, ALASKA

ELECTRICAL
SINGLE LINE DIAGRAM
OVERALL

JOB NO.	DRAWING NO.	REV.
21212	300-D-P-101	A

Emergency Access Road

As a result of the remote location of the proposed site and lack of an all-weather vehicular access road, the primary access/egress to the plant for operating personnel, contractors, materials and supplies would be waterborne transportation using the cargo/personnel ferry dock located west of the main terminal facilities in Anderson Bay. If an emergency situation necessitated the evacuation of plant personnel, either tugboats present at the terminal or worker transport boats would be used. Similarly, waterborne transportation would be required to receive any medical or emergency personnel and equipment at the site. Yukon Pacific also plans to make arrangements with Alyeska and the U.S. Coast Guard to mobilize their boats in an emergency situation.

During summer months, an overland emergency egress route would be available at the east end of the site using the TAGS pipeline right-of-way. Yukon plans to maintain this right-of-way as an unimproved private trail, removing brush to facilitate pipeline surveillance. While this route would allow evacuating personnel to reach the Alyeska Terminal, about 3.3 miles away, it is not envisioned to provide access for emergency personnel and equipment to the terminal.

The need for access to an LNG facility is addressed in the DOT regulations, under Subpart B - Siting Requirements. Specifically, Part 193.2055 requires in part:

> ...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. (emphasis added)

Plant access is also addressed in NFPA 59A. Under 2-2.1, some factors to be considered in selection of plant site locations include:

> (b) Accessibility to plant; at least one **all-weather vehicular road** shall be provided. (emphasis added)

The principle reliance on waterborne transportation for emergency evacuation of personnel and for access of medical and emergency personnel and equipment raises several concerns. During severe weather conditions, boats may be unable to reach the terminal to evacuate personnel or to supply emergency personnel and equipment. The cargo/personnel ferry dock, at an elevation of 25 feet, would be well below the 75-foot design tsunami and slide-induced wave runnup. Further, an easterly wind could place the cargo/personnel ferry dock -- the only year-round access point -- within the range of flammable vapors under some LNG spill scenarios. These concerns raise questions on compliance with the **all-weather vehicular road** requirement in NFPA 59A, as well as the ability of waterborne access to meet the **ease of access** requirement in Part 193.2055.

The conversion of the TAGS pipeline right-of-way into an all-season emergency access road could alleviate these concerns as well as providing several benefits:

- the road would provide a second principal access point at the opposite end of the site from the cargo/personnel ferry dock;

- the overland road would provide a second mode of emergency access to supplement or substitute for waterborne transportation;

- medical and other emergency equipment could access the site more quickly by an overland route and would be unaffected by severe marine weather;

- an overland road would provide direct access for contractors, maintenance specialists and their equipment to perform non-routine repairs at the facility. In some cases, early repair or replacement of critical components can prevent a simple problem from developing into more serious consequences;

- an overland access road connecting with the Alyeska Terminal would enable both facilities to "pool" their mobile fire fighting equipment and provide mutual aid in the event of a hydrocarbon fire or other serious incident at either facility; and

However, the staff recognizes several obstacles in converting an unimproved trail -- primarily designed to permit the passage of pipeline construction equipment on the right-of-way -- into an all-season access road:

- additional clearing, cut and fill, and bridge construction would be required.

- the high potential for rock slides and avalanches would present continuing maintenance difficulties.

- snow removal for the 3.3-mile road.

Regardless of the above obstacles, the staff believes that the safety and operational benefits of the all-weather access road clearly offset the problems. Further, the all-weather access road would comply with NFPA 59A and Part 193.2055.

While the Alyeska Terminal would be outside the hazard range of any credible accidents at the LNG facility, communication between the two facilities is essential to ensure that a serious incident at one facility or the associated shipping does not propagate to the other facility. It therefore appears prudent to establish a direct telephonic linkage between the two facilities solely devoted to emergency usage. Further, the respective emergency plans at each facility should identify potential incidents which could affect the adjacent facility and a procedure for notification and response.

Conclusions and Recommendations

Study and evaluation of information submitted by Yukon Pacific Company L.P. (YPLP) has been completed by the authors for the facility in its preliminary design and preconstruction state. Particular emphasis has been placed on cryogenic processes, relevant safety systems and associated utilities. Clarification of specific material was provided by YPLP at the recent technical conference and site inspection conducted by Federal Energy Regulatory Commission (FERC) staff and cryogenics consultants on May 26, 1992.

Through careful consideration of existing cryogenic design, consistent with and acknowledging the present state-of-the-art, it must be recognized that additional detailed engineering analysis will be required to complete the intended review process. Although considerable care has been taken and extensive effort has been made by YPLP and its contractors in designing a facility embodying safeguards (including hazard control and safety systems) to either prevent the occurrence of accidents or to reduce the impact of credible accidents, the detail design remains in a preliminary stage.

Notwithstanding the fact that the material submitted by YPLP to the FERC is extensive, considering the initial phase of design, supplemental information is required before a more definitive assessment can be made on the adequacy of design and on the adherence of the design to various applicable standards, codes and engineering practices. Areas of particular interest and concern where supplemental information is required include: 1) final selection of LNG storage tank contractor in order to establish design details, 2) confirmation of final design for dock facilities, particularly the details that will define spill containment, hazard detection and hazard control systems, 3) impoundment for the vertical segments of the storage tanks fill and withdrawl lines, 4) specific manufacturer, number and locations of hazard detection devices throughout the facility (only general locations without specific numbers have been presented in many instances), 5) specific hazard control systems, including chemical quantity, unit locations, dispersion flow rates and foam confinement techniques, 6) specific interrelationship between the hazard detection system and the hazard control system that is to provide automatic emergency shutdown and actuation of hazard control devices, 7) design details and hazard control systems for the refrigerant storage vessels, 8) detailed procedures to define snow control and/or removal techniques for the heavy snowfall at the plant site to prevent adverse influence on operations and safety systems (especially spill impoundment systems), 9) analysis of safety considerations relating to the large quantity of refrigerants (MR fluids, propane and ethane) contained in the process areas and the desirability of containment systems to accommodate potential refrigerant spillage and 10) the need for a permanent access road for emergency access/egress purposes. Supplemental submissions made by YPLP will be reviewed as appropriate.

In addition to the above requirement for supplemental technical information, the following specific recommendations are made:

1) It is recommended that an additional technical conference (or conferences) be held as engineering design develops so that present areas of uncertainty may be more fully explored. These conferences should be held <u>prior</u> to initiating construction at the site. At least one technical conference should be held <u>prior</u> to initiation of construction after designs are finalized and major vendors (including LNG and other major storage tanks) have been selected and complete design details have been made available to FERC staff. The applicant shall also provide design details to the Office of Pipeline Safety of the Department of Transportation and the United States Coast Guard Captain of the Port of Valdez so that they may have the opportunity to participate in the technical conferences to assure compliance with their applicable regulations.

2) It is recommended that construction not be initiated without a written notice to proceed from the Director of the Office of

Pipeline and Producer Regulation. Any major alterations to facility design should be filed with the Secretary of the FERC for review and written approval by the Director of the Office of Pipeline and Producer Regulation prior to initiation.

3) It is recommended that onsite inspections be conducted as significant milestones develop during the construction phase and <u>prior</u> to commencement of initial facility operation.

4) It is recommended that following commencement of operation, the facility be subject to regular FERC staff technical reviews and site inspections on at least a biennial basis or more frequently as circumstances indicate. <u>Prior</u> to each FERC staff technical review and site inspection, the Company should respond to a specific data request including information relating to possible design and operating conditions that may have been imposed by other agencies or organizations, provision of up-to-date detailed piping and instrumentation diagrams reflecting facility modifications and provision of other pertinent information not included in the semi-annual reports described below.

5) It is recommended that YPLP submit semi-annual reports to the FERC after initiating construction and continuing through the operational period. During the construction phase the semi-annual reports should provide construction status of major components including significant design and schedule modifications required (and/or anticipated). The reports also should address changes in facility design including anticipated future plans. During the operational phase the semi-annual reports should provide changes in facility design and operating conditions, abnormal operating experiences, activities (liquefaction and LNG shipping schedules), plant modifications including those proposed during the forthcoming 12-month period. Abnormalities shall include but not be limited to storage tank vibrations and/or vibrations in associated cryogenic plumbing, storage tank settlement, significant equipment and instrumentation malfunctions or failures, nonscheduled maintenance or repair (and reasons therefor), relative movement of the inner vessel, vapor or liquid releases, fires involving natural gas, refrigerants and/or from other sources, negative pressure (vacuum) within the LNG storage tanks and higher than predicted boiloff rates. The reports should be submitted within 45 days after each period ending December 31 and June 30.

   Included in the above items should be a section entitled "Significant plant modifications proposed for the next 12 months (dates)". The section should be included in the semi-annual operational reports to provide Commission staff with early notice of anticipated future construction and maintenance projects at the LNG terminal.

6) It is recommended that a permanent access road be built to allow emergency equipment and personnel access/egress between the plant and the City of Valdez.

7) Regarding proposed use of double- or increased-integrity LNG storage tanks, if further consideration is contemplated, it is recommended that YPLP immediately submit to the DOT for approval, and to the FERC, the equivalent impact load analysis required by Section 193.2161(b) and 193.2155(c) of the DOT regulations. If written approval of the impact analysis cannot be obtained, YPLP shall construct separate and independent impounding systems for such storage tanks consistent with existing standards and codes.

8) Yukon Pacific shall establish direct telephonic linkage with the Alyeska Terminal and the U.S. Coast Guard Vessel Traffic Center in Valdez and ensure that procedures for notification and response to potential incidents are included in the emergency plans for each facility.

APPENDIX A

Attendance List
Site Inspection and Technical Review

May 26, 1992

ATTENDANCE LIST
Site Inspection and Technical Review

Yukon Pacific Company L.P.
Valdez, Alaska

Docket No. CP88-105-001

May 26, 1992

NAME	COMPANY	TITLE	PHONE
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Calvin Ayres	APCI	Lead Process Engr.	215/481-6459
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Harry Noah	YPC	Manager, Env. & Permitting	907/265-3100
William Martinsen	Quest Consultants	Principal Engr.	405/329-7475

APPENDIX C

BIOLOGICAL ASSESSMENT
AND
CONCURRENCE LETTER

FEDERAL ENERGY REGULATORY COMMISSION

WASHINGTON, D. C. 20426

OFFICE OF PIPELINE AND PRODUCER REGULATION

IN REPLY REFER TO:
OPPR/DEMEA/ECB
Yukon Pacific Company L.P.
Docket No. CP88-105-000

MAR 04 1993

Steven Pennoyer
Director, Alaska Region
National Marine Fisheries Service
P.O. Box 21668
Juneau, AL 99802-1668

Jeanne L. Hanson
Western Alaska Office
National Marine Fisheries Service
222 W. 7th Avenue, #43
Anchorage, AL 99513-7577

Dear Mr. Pennoyer and Ms. Hanson:

In accordance with Section 7 of the Endangered Species Act, as amended, I am providing you in this letter with a Biological Assessment (BA), prepared by the environmental staff of the Federal Energy Regulatory Commission, on the Liquefied Natural Gas (LNG) facilities proposed for construction by the Yukon Pacific Company L.P. (Yukon Pacific) in the above-referenced docket. This BA addresses the four federally listed species that were identified in your letter to me dated February 11, 1993, as well as the endangered northern right whale. As you are aware, Yukon Pacific's LNG facilities are associated with the proposed Trans-Alaska Gas System (TAGS) Project, a project whose effect on federally listed species was addressed in a letter dated May 19, 1987 from Mr. Jules V. Tileston (BLM, Anchorage) to Mr. Robert W. McVey (NMFS, Juneau).

BIOLOGICAL ASSESSMENT

The following listed species are considered in this BA:

Common Name	Scientific name	Status
Northern right whale	*Eubalaena glacilis*	Endangered
Humpback whale	*Megaptera novaengliae*	Endangered
Fin whale	*Balaenoptera physalus*	Endangered
Gray whale	*Eschrichtius robustus*	Endangered
Steller sea lion	*Eumetopias jubatus*	Threatened

Project Description

The LNG plant and marine terminal for the proposed TAGS project would be located at Anderson Bay along the southern shoreline of Port Valdez (see figure 1). The marine facility would consist of two LNG tanker berths and a cargo/personnel ferry dock. The tanker berths would be oriented approximately parallel to the shoreline in 50 feet (MLLW) of water.

Construction of the development site would involve considerable blasting (twice per day), overburden removal, and fill. Approximately 9.7 million cubic yards of bulk overburden and rock would require excavation, of which approximately 61 percent (5.9 million cubic yards) would be used for structural fill onsite with the remaining material (3.7 million cubic yards) requiring disposal. The structural fill would cover over approximately 18 to 21 acres of Anderson Bay's intertidal zone in development of the construction dock and off-loading area. An additional 13 acres of subtidal habitat also would be destroyed from disposal of waste overburden and rock at a proposed site at the east end of Anderson Bay. An alternative disposal site located in deeper waters offshore of Anderson Bay is also being evaluated, and would involve only clean blast rock unless this material cannot be separated from the overburden.

When fully operational, the terminal would load approximately 275 LNG tanker ships per year. The tankers would enter Prince William Sound (PWS) in ballast, load with LNG at the terminal, and exit PWS to deliver LNG to Asian markets. Tankers would use existing ship lanes through PWS and the Valdez Arm; however, an additional 1-mile turning radius would be required for berthing tankers at the terminal.

Summary of Species Biology and Status in the Area

Northern Right Whale

This is probably the most endangered whale in the North Pacific. Recent estimates place the North Pacific population at between 100-200 individuals (Braham and Rice 1984). Northern right whales have not been observed in the PWS area in recent times. However, PWS lays adjacent to the Gulf of Alaska where, historically, major concentrations occurred (Scarff 1986). Consequently, the possibility of encountering a right whale in the PWS area does exist given their traditional use of the area. However, this possibility is very slight given the small size of the existing population and the lack of evidence for recovery in the North Pacific (Scarff 1986).

Gray Whale

This whale passes through the PWS area twice each year on its annual migration to and from winter breeding grounds in Mexico and summer feeding grounds in the Bering and Chukchi seas (Braham 1984). Timing of passage is usually in the spring (March-May) and fall (November-January). Gray whales closely follow the coast around the Gulf of Alaska, frequently passing through both Hinchinbrook Entrance and Montague Strait (Hall 1979). Although gray whales occur in PWS, they have seldom been reported in the Valdez Arm and are considered a rare visitor at that locality.

Humpback Whale

This whale occurs primarily in two distinct areas of PWS during two separate periods (Hall 1979). During May to late June they are most frequently reported feeding in the area between Perry, Naked, and Eleanor islands, which is characterized by high primary and secondary productivity during the spring of the year. By early July, most move to near Icy and Whale Bays near Chenega Island (Hall 1979). Individuals are observed throughout PWS and occasionally are seen in the Valdez Arm where they are considered a rare visitor.

Fin Whale

Fin whales occur in the Gulf of Alaska from May to November (Berzin and Rovnin 1966) where they have generally been found feeding in deeper waters along submarine canyons and the shelf break (Consiglieri and Braham 1982; Leatherwood et al. 1983; Brueggeman et al. 1987, 1988). Hall (1979) observed fin whales in PWS from April to June, but believed these animals were primarily transients. A few animals have been known to wander into Valdez Arm, but are considered a rare visitor there.

Steller Sea Lion

This sea lion is found in PWS throughout the year. A major breeding rookery occurs at Seal Rocks at the southern end of the sound and several haulout sites occur throughout PWS. Neither the rookery or any of the major haulout sites occur near Valdez Arm (T. Loughlin, NMFS, pers. comm.). The closest haulout site to Valdez Arm is Glacier Island (west of the mouth of the Arm) which is used only in the winter (D. Calkins, ADFG, pers. comm.). Steller sea lion use of Valdez Arm is only occasional and sporadic (D. Calkins, ADFG, pers. comm.) and there are no haulout sites here. A spring influx into the Arm may occur if spawning herring are present, but herring use of Valdez Arm is also occasional and sporadic (unpublished data, ADFG). Consequently, Steller sea lions are considered occasional visitors to Valdez Arm. All major haulouts occur 10-40 nm west of the shipping lanes. However, the Seal Rocks rookery lies at the mouth of Hinchinbrook Entrance with shipping lanes occurring on both the east and west side of the rocks, and is considered an off-lying danger to traffic.

No critical habitat has been identified for any of the above listed species in the project area or the total PWS area. However, the National Marine Fisheries Service (NMFS) has future plans for designating specific Steller sea lion rookeries and haulouts in PWS as critical habitat. These areas, recommended by the Steller Sea Lion Recovery Team, include the Seal Rocks rookery, and the Needle, Wooded Island, Perry Island, Point Elrington, and Point Eleanor haulout sites (see figure 1).

In summary, gray, humpback, and fin whales can be found seasonally in PWS and may occasionally enter Valdez Arm, with humpback whales the most likely to enter. There are no historic records for northern right whales for PWS. Steller sea lions are found in PWS year-round and may occur in Valdez Arm in numbers if spawning herring are present. But for the most part, major use areas of all five species are located in PWS far from Valdez Arm.

Potential Impacts

Impacts from construction of the marine terminal would consist mainly of noise while building piers and berths for tankers and cargo ships, and from blasting during excavation. These impacts are expected to be very minor on listed marine mammals as they seldom occur in the area.

Impacts from turbidity, which could affect production of food sources, would be slight as little or no dredging operations are anticipated. However, 18 to 21 acres of intertidal habitat (an important food-producing area) and 13 acres of subtidal habitat would be lost due to filling and overburden and rock disposal. The loss of this intertidal habitat would not adversely affect the four whale species or Steller sea lion because Anderson Bay does not appear to be a primary feeding area for these species.

Potential impacts of accidental fuel or oil spills from the terminal site are preventable to a large degree, as fuels and oils would be stored in approved facilities with appropriate spill containment and other safeguards. LNG would not constitute a major hazard to whales or sea lions due to its tendency to vaporize at normal environmental temperatures. Even a worst-case scenario for a fuel or LNG spill within Valdez Arm would not be detrimental to the whales or sea lion, as they seldom occur in that portion of the project area.

Cumulative effects of the project are expected to be inconsequential to threatened and endangered marine mammals. There are no adverse effects from the existing Alyeska Marine Terminal on the four species of whales and the Steller sea lion, and none are expected from the TAGS LNG terminal based on existing information on utilization of Valdez Arm by these species.

Any affect on whales and sea lions from the addition of 275 LNG tankers per year would occur primarily outside of Valdez Arm. Approximately 900 crude oil tankers presently are loaded each year at the adjacent Alyeska Marine Terminal. For whales, these impacts would primarily be noise disturbance from shipping traffic or collisions with tankers. Whales have been observed exhibiting avoidance behavior when subjected to noise from ships and boats. Collisions are known to occur between ships and whales. For sea lions, the greatest danger would be the increased potential of a tanker running aground at the Seal Rocks rookery, which lies between the existing traffic lanes at Hinchinbrook Entrance. While crude oil would not be involved, a LNG fire or general disturbance associated with the incident could impact breeding sea lions, and a LNG tanker grounding at Seal Rocks could be especially harmful to the Steller sea lion if it occurred during the pupping season (May 15 to July 15).

As the shipping traffic that would be associated with the LNG terminal is expected to utilize existing shipping lanes, impact is expected to be minimal. To date, no known major impact on the whale or sea lion populations from normal shipping activities along these lanes has been documented. However, the "Exxon Valdez" oil spill has shown that tankers can stray from shipping lanes with disastrous consequences. Unlike the "Exxon Valdez", the LNG tankers would use double hull construction to protect the cargo tanks in the event of a collision or grounding.

Conclusion

No direct impacts on the populations of northern right, gray, humpback, or fin whales, or Steller sea lions are anticipated as a result of this project. Valdez Arm is not documented as being important habitat or often used by any of these species. The potential increase in shipping will have little or no effect on marine mammals as existing, high use shipping travel lanes will be utilized for transport of LNG to market. There is no documented evidence that normal shipping activities have had any major adverse effects on whales or sea lions in PWS.

No cumulative impacts are anticipated from the construction of the LNG terminal or associated shipping.

Based on available information, the FERC environmental staff concludes that the proposed Yukon Pacific LNG terminal and related activities would not affect federally listed whale and sea lion populations. Therefore, Formal Consultation between our agencies will not be necessary. I would appreciate if, pursuant to 50 C.F.R. § 402.10(j), you would provide me with your comments on and/or concurrence with this BA and its finding of no affect within 30 days of your receipt of this letter.

Thank you for your cooperation in this matter. If you have any questions, please contact Mr. Mark C. Kalpin of my staff at (202) 208-0918.

Sincerely,

Bob Arvedlund

Robert K. Arvedlund, Chief
Environmental Compliance and
Project Analysis Branch

Literature Cited

Berzin, A. A. and A. A. Rovnin. 1966. The distribution and migrations of whales in the northeastern part of the Pacific, Chukchi and Bering seas. Izvestia TINRO 58:179-207.

Braham, H. W. 1984. Distribution and migration of gray whales in Alaska. Pages 249-266 in: M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), The Gray Whale, Eschrichtius robustus. Academic Press, New York.

Braham, H. W. and D. W. Rice. 1984. The right whale, Balaena glacialis. Marine Fisheries Review 46:38-44.

Brueggeman, J. J., G. A. Green, R. A. Grotefendt, and D. G. Chapman. 1987. Aerial surveys of endangered cetaceans and other marine mammals in the northwestern Gulf of Alaska and southeastern Bering Sea. Final Report prepared for the Minerals Management Service and NOAA Office of Oceanography and Marine Assessment. Contract No. 85-ABC-00093.

Brueggeman, J. J., G. A. Green, R. W. Tressler, and D. G. Chapman. 1988. Shipboard surveys of endangered cetaceans in the northwestern Gulf of Alaska. Final Report prepared for the Minerals Management Service and NOAA Office of Oceanography and Marine Assessment. Contract No. 85-ABC-00093.

Consiglieri, L. D. and H. W. Braham. 1982. Seasonal distribution and relative abundance of marine mammals in the Gulf of Alaska. Final Report prepared for NOAA/OCSEAP, Juneau. Research Unit 68. Contract No. R7120806.

Hall, J. 1979. A survey of cetaceans of Prince William Sound and adjacent vicinity - their numbers and seasonal movements. Final Report prepared for NOAA/OCSEAP. Contract No. 01-6-022-1560.

Leatherwood, S., A. E. Bowles, and R. R. Reeves. 1983. Endangered whales of the eastern Bering Sea and Shelikof Strait, Alaska; Results of aerial surveys, April 1982 through April 1983 with notes on other marine mammals seen. Hubbs-Sea World Research Institute Technical Report No. 83-169.

Scarff, J. W. 1986. Historic and present distribution of the right whale (Eubalaena glacialis) in the eastern North Pacific south of 50°N and east of 180°W. Report to the International Whaling Commission (Special Issue 10):43-63.

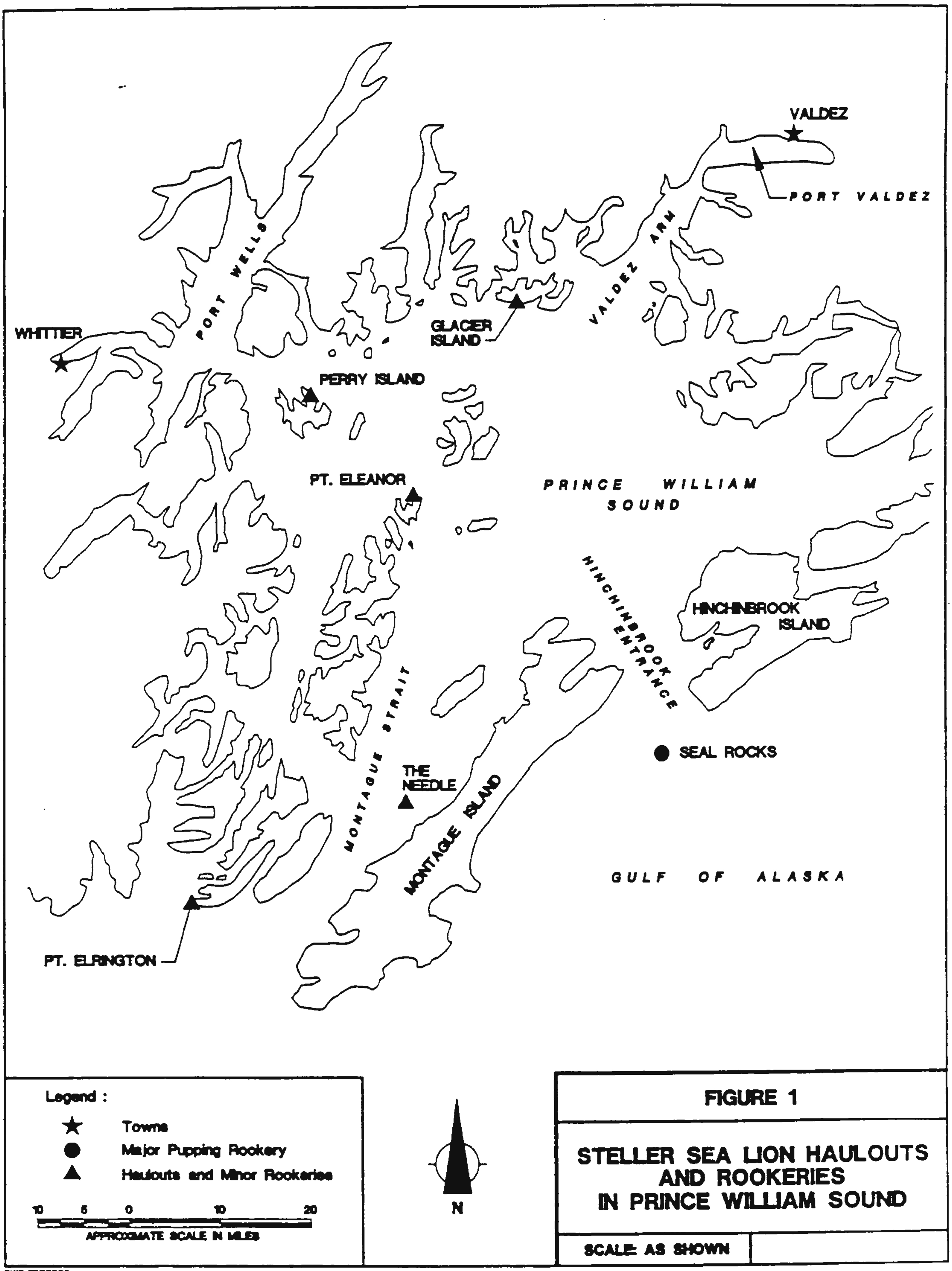

FIGURE 1

STELLER SEA LION HAULOUTS AND ROOKERIES IN PRINCE WILLIAM SOUND

SCALE: AS SHOWN

DWG-FERC222

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
P.O. Box 21668
Juneau, Alaska 99802-1668

March 17, 1993

RECEIVED BY

MAR 29 1993

Robert Arvedlund, Chief
Environmental Compliance &
Project Analysis Branch
Federal Energy and
Regulatory Commission
825 North Capitol Street
Washington, D.C. 20426

RE: OPPR/DEMEA/ECB
Yukon Pacific Corp.
Docket No. CP88-105-000

Attn: Mr. Mark C. Kalpin

Dear Mr. Arvedlund:

This is in response to your recent submission under Section 7 of the Endangered Species Act of 1973, as amended, of a Biological Assessment to determine the effects of the Liquefied Natural Gas (LNG) facilities proposed for construction by the Yukon Pacific Company (YPC), on endangered and threatened species.

We concur that there is presently no identified critical habitat for any of the four species of the whales concerned. In addition, although we have future plans for designating specific Steller sea lion rookeries and haulouts in Prince William Sound as critical habitat, none of these areas are within Valdez Arm.

Therefore, we agree with your conclusion that construction of the LNG terminal would not have direct impacts on the populations of northern right (Eubalaena glacilis), humpback (Megaptera novaeangliae), fin (Balaenoptera physalus), gray (Eschrichtius robustus) whales, or Steller sea lions (Eumetopias jubatus). Since we agree that the LNG terminal is not likely to have direct adverse impacts on the species identified, a formal consultation is not required for this project. We wish to point out, however, that this opinion only considers the direct effect of the construction of the LNG terminal and does not consider any potential cumulative impacts as discussed on page 5. Should it be determined that cumulative impacts are occurring, additional consultation may be required to assess the effects of these impacts.

Accordingly, this concludes Section 7 consultation between the Federal Energy Regulatory Commission and National Marine Fisheries Service. Should project plans change or new information become available that changes the basis of this decision, then consultation should be reinititated. Should you require any other additional information please contact Ms. Jeanne L. Hanson of my staff at (907) 271-5006.

Sincerely,

Steven Pennoyer
Director, Alaska Region

cc: Yukon Pacific - Anchorage
Alaska State Office, Bureau of Land Management, Branch of Pipeline Monitoring - Anchorage
USFWS, EPA, DGC, ADFG, ADEC, Corps - Anchorage

APPENDIX D

LIST OF PREPARERS

APPENDIX D

LIST OF PREPARERS

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APPENDIX E

REFERENCES AND CONTACTS

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REFERENCES AND CONTACTS

Abbot, S.M. (ed). 1992. Mountain Goat, Federal Aid in Wildlife Restoration Survey-Inventory Management Report - 1 July 1991 -30 June 1992. Unpublished report Alaska Department of Fish and Game, Juneau, Alaska.

Alaska Department of Fish and Game. 1973. Alaska's Wildlife and Habitat, Division of Game, Juneau. pp 144.

Alaska Department of Fish and Game, Division of Subsistence. 1988. Valdez: An Overview. Juneau, Alaska. March.

Alaska Department of Fish and Game. 1992. Letter dated July 22, from P. Brna (Joint Pipeline Office) to H. Noah, included in Appendix A In: Anderson Bay Salmon Enumeration Project. Alaska Department of Fish and Game, Habitat Division, F.M. Thompson. 1993. pp. 20.

Alaska Department of Labor, 1992. Data faxed on January 27, from B. Elliott (Labor Economist, Alaska Department of Labor, Research and Analysis, Juneau, Alaska) to P. Reynolds (Ebasco).

Alaska Department of Natural Resources. Undated. State Comprehensive Outdoor Recreation Plan.

Alaska Department of Natural Resources, Alaska Department of Fish and Game. 1988. Prince William Sound Area Plan for State Lands. Anchorage, Alaska.

Alyeska Pipeline Service Company. Undated. Marine Terminal. Anchorage, Alaska.

Anacker, S. 1993. Telephone communication on March 10, between P. Reynolds (Ebasco) and S. Anacker (Director, Valdez Convention and Business Bureau, Valdez, Alaska).

Armstrong, R.H. 1990. Guide to the Birds of Alaska. Alaska Northwest Books, Anchorage, Seattle.

Baker, C.S., L.M. Herman, B.G. Bays, and G.B. Bauer. 1983. The Impact of Vessel Traffic on the Behavior of Humpback Whales in Southeast Alaska: 1982 Season. Report from Kewalo Basin Marine Mammal Laboratory, Honolulu, Hawaii, for National Marine Mammal Laboratory, Seattle, Washington. pp 30.

Barber, E. 1993. Telephone communication on April 1, between L. Brown (Ebasco) and E. Barber (State Pipeline Coordinator's Office, Alaska Department of Natural Resources).

Barton, J. 1993. Telephone communication on April 28, between D. Lake (Ebasco) and J. Barton (U.S. Environmental Protection Agency, Region 10, Seattle, Washington).

Bauer, J. 1992. Telephone communication on July 7, between K. Godtfredsen (Ebasco) and J. Bauer (Alaska Department of Environmental Conservation, Oil Spill Office).

Behrends, B. 1992. Telephone communication on July 7, between M. Greenig (Ebasco) and B. Behrends (Recreation and Lands Planner, Cordova Ranger District, Chugach National Forest, Cordova, Alaska).

Benson, C. 1993. Telephone communication on March 3, between P. Reynolds (Ebasco) and C. Benson (Property Assessor, State of Alaska, Anchorage, Alaska).

Berzin, A.A. and A. A. Rovnin. 1966. The Distribution and Migrations of Whales in the Northeastern part of the Pacific, Chukchi and Bering seas. Izvestia TINRO 58:179-207.

Bingham, D. 1992. Telephone communication on July 7, between M. Greenig (Ebasco) and D. Bingham (Superintendent, Matsu(?)/Valdez/ Copper River Area, Alaska State Parks, Palmer, Alaska).

Bohne, B.A., J.A. Thomas, E.R. Yohe, and S.H. Stone. 1985. Examination of Potential Hearing Damage in Weddell Seals (*Leptonychotes weddelli*) in McMurdo Sound, Antarctica. Antarctica Journal 20:174-176.

Braden, T. 1993. Telephone communication on February 18, between L. Brown (Ebasco) and T. Braden (Alaska Department of Natural Resources).

Braham, H. W. 1984. Distribution and Migration of Gray Whales in Alaska. In: The Gray Whale, *Eschrichtius robustus*. M. L. Jones, S. L. Swartz, and S. Leatherwood (eds.), Academic Press, New York. pp. 249-266.

Braham, H. W. and D. W. Rice. 1984. The Right Whale, *Balaena glacialis*. Marine Fisheries Review 46:38-44.

Brna, P. 1992a. Telephone communication on February 21, between K. Engel (Ebasco) and P. Brna (Joint Pipeline Office, Alaska Department of Fish and Game).

Brna, P. 1992b. Telephone communication on July 23, between K. Godtfredsen (Ebasco) and P. Brna (Joint Pipeline Office, Alaska Department of Fish and Game).

Brna, P. and G. Stackhouse. 1993. Telephone communication in February, between K. Kuzis (Ebasco) and P. Brna (Joint Pipeline Office, Alaska Department of Fish and Game) and G. Stackhouse (Biologist, U.S. Fish and Wildlife Service, Valdez, Alaska).

Broome, S.W. 1990. Creation and Restoration of Tidal Wetlands of the Southeastern United States: In: Wetland Construction and Restoration, J. Kusler and M. Kentula (eds). Island Press, Washington, D.C. pp. 37-63.

Brownell, R.L., Jr., P.B. Best, and J.H. Prescott (eds). 1986. Report of the Workshop on the Status of Right Whales. Report to the International Whaling Commission, Special Issue 10:1-33.

Brueggeman, J.J., G.A. Green, R.A. Grotefendt, and D.G. Chapman. 1987. Aerial Surveys of Endangered Cetaceans and Other Marine Mammals in the Northwestern Gulf of Alaska and Southeastern Bering Sea. Final Report prepared for the Minerals Management Service and NOAA Office of Oceanography and Marine Assessment. Contract No. 85-ABC-00093.

Brueggeman, J.J., G.A. Green, R.W. Tressler, and D.G. Chapman. 1988. Shipboard Surveys of Endangered Cetaceans in the northwestern Gulf of Alaska. Final Report prepared for the Minerals Management Service and NOAA Office of Oceanography and Marine Assessment. Contract No. 85-ABC-00093.

Bureau of Land Management (BLM) and U.S. Army Corps of Engineers (COE). 1988. Final Environmental Impact Statement for the Proposed Trans-Alaska Gas System. Prepared by BLM and COE.

Calkins, D.G. 1978. Feeding Behavior and Major Prey Items of the Sea Otter, *Enhydra lutris*, in Montague Strait, Prince William Sound, Alaska. Fisheries Bulletin 76:125-131.

Calkins, D.G. 1986. Marine Mammals. In: The Gulf of Alaska, Physical Environment and Biological Resources. D.W. Hood and S. T. Zimmerman (eds.). Minerals Management Service Publication OCS-MMS 86-0095. Washington, D.C., U.S. Government Printing Office. pp. 527-558.

Calkins, D.G. and K.W. Pitcher. 1983. Population Assessment, Ecology, and Trophic Relationships of Steller Sea Lions in the Gulf of Alaska. In: Environmental Assessment of the Alaskan Continental Shelf. U.S. Department of Commerce and U.S. Department of Interior, Final Reports of the Principal Investigators, Volume 19. pp. 447-546.

Chester R. and M.J. Huges. 1967. A Chemical Technique for Separation of Ferromanganese Minerals, Carbonate Minerals, and Adsorbed Trace Metals from Pelagic Sediments. Chemical Geology. pp. 2, 249.

City of Valdez. 1986. Valdez Coastal Management Program. City of Valdez, Community Development Department. Valdez, Alaska.

City of Valdez. 1992. Letter dated March 2, from W. Wilcox (City Engineer, City of Valdez, Alaska) to P. Reynolds (Ebasco).

Clark, M. 1993. Telephone communication on February 25, between P. Reynolds (Ebasco) and M. Clark (Accountant Valdez City Schools, Valdez, Alaska).

Colonell J.M., H.J. Niebauer, and D. L. Nebert. 1988. Processes of Ballast Water Dispersal. In: Environmental Studies in Port Valdez, Alaska, D.G. Shaw and M.J. Hameedi (eds). Lecture Notes on Coastal and Estuarine Studies, Vol. 24, Springer-Verlag Berlin Heidelberg. pp. 39-67.

Comerci, L. 1993. Telephone communication on April 28, between D. Lake (Ebasco) and L. Comerci (U.S. Environmental Protection Agency, Region 10, Anchorage, Alaska).

Consiglieri, L.D. and H.W. Braham. 1982. Seasonal Distribution and Relative Abundance of Marine Mammals in the Gulf of Alaska. Final Report prepared for NOAA/OCSEAP, Juneau. Research Unit 68. Contract No. R7120806.

Cooney R.T. and K.O. Coyle. 1988. Water Column Productivity. In: Environmental Studies in Port Valdez, Alaska, D.G. Shaw and M.J. Hameedi (eds). Lecture Notes on Coastal and Estuarine Studies, Vol. 24, Springer-Verlag Berlin Heidelberg. pp. 93-115.

Coulter, H.W. and R.R. Migliaccio. 1966. Effects of the March 27, 1964 Earthquake at Valdez, Alaska. U.S. Geological Survey Professional Paper 542-C.

Cowardin, L.W., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service, Washington, DC. FWS/OBS-79/31.

Craig, G. 1986. Peregrine Falcon. In: Audubon Wildlife Report 1986, R.L. Di Silvestro (ed), National Audubon Society, New York, New York. pp. 806-824.

Crystal, J. 1992. Telephone communication on July 9, between P. Reynolds (Ebasco) and J. Crystal (Administrative Assistant to Chief of Police, Police Department, Valdez City Hall, Valdez Alaska).

Dames and Moore. 1990a. Trans-Alaska Gas Systems, Wetland Functional Assessment Ad Rating: Anchorage, Alaska, 35 p., Preliminary Draft.

Dames and Moore. 1990b. Anderson Bay Marine Engineering and Environmental Reconnaissance Survey Report. Submitted to Yukon Pacific Corporation, December 31, 1990.

Dames and Moore. 1991. In: Environmental Baseline Data, Proposed LNG Plant/Marine Terminal Site, Port Valdez, Alaska. Yukon Pacific Corporation. Anchorage, Alaska.

Darbyshire & Associates. 1991. Valdez Comprehensive Development Plan. Valdez, Alaska.

de Laguna, F. 1956. Chugach Prehistory: the Archaeology of Prince William Sound Alaska. University of Washington Press, Seattle, Washington.

DeGange, A.R. and G.A. Sanger. 1986. Marine Birds. In: The Gulf of Alaska, Physical Environment and Biological Resources, D.W. Hood and S.T. Zimmerman (eds). Minerals Management Service Publication OCS-MMS 86-0095. Washington, D.C., U.S. Government Printing Office. pp. 479-524.

Dehoney B. and E. Mancini. 1984. Aquatic Biological Impacts of Instream Right-Of-Way Construction and Characteristics of Invertebrate Community Recovery. In: Proceedings of the Third International Symposium on Environmental Concerns in Rights-Of-Way Management, A.F. Crabtree (ed). Mississippi State University. pp. 499-507.

Dengel, D. 1992. Telephone communication on July 17, between M. Greenig (Ebasco) and D. Dengel (Community Development Director, City of Valdez, Valdez, Alaska).

Dengel, D. 1993. Telephone communication on February 25, between P. Reynolds (Ebasco) and D. Dengel (Community Development Director, Valdez City Hall, Valdez, Alaska).

Department of Finance. 1992. Comprehensive Annual Financial Report of the City of Valdez (Fiscal Year 1991), Alaska.

Eliason, K. 1993a. Telephone communication on March 16, between D. Lake (Ebasco) and K. Eliason (Project Engineer, Yukon Pacific).

Eliason, K. 1993b. Telephone communication on April 29, between D. Lake (Ebasco) and K. Eliason (Project Engineer, Yukon Pacific).

Estes, J.A., R.J. Jameson, and A.M. Johnson. 1981. Food Selection and Some Foraging Tactics of Sea Otters. In: Worldwide Furbearer Conference Proceedings, J. Chapman and D. Pursley (eds.), Frostburg, Maryland. pp. 606-642.

Exxon Valdez Oil Spill Trustees. 1992. Appendix A - Summary of Injury. In: Exxon Valdez Oil Spill Restoration - 1993 Draft Work Plan. Exxon Valdez Oil Spill Trustee Council, Anchorage, Alaska.

Feder, H.M. and A.J. Paul. 1977. Biological Cruises of the R/V Acona in Prince William Sound, Alaska, from 1970 to 1973. Sea Grant Report No. 77-14. Report No. R77-4, Alaska Sea Grant Program, University of Alaska, Fairbanks, Alaska. pp. 79.

Feder, H.M. and G.E. Keiser 1980. Intertidal Biology. In: Port Valdez Alaska; Environmental Studies 1976-1979. Colonell, J.M. (ed.) Occasional Publication No. 5, Institute of Marine Science, University of Alaska, Fairbanks, pp. 145-233.

Feder, H.M. and G.E. Matheke. 1980. Subtidal Benthos. In: Port Valdez Alaska; Environmental Studies 1976-1979. Colonell, J.M. (ed.). Occasional Publication No. 5, Institute of Marine Science, University of Alaska, Fairbanks, pp. 237-324.

Feder H.M. and S.T. Jewett. 1987. The Subtidal Benthos. In: The Gulf of Alaska: Physical Environment and Biological Resources, OCS Study, D.W. Hood and S. T. Zimmerman (eds). MMS 86-0095, U.S. Department of Commerce and Industry. pp. 347-396.

Feder, H.M. and S.T. Jewett. 1988. The Subtidal Benthos. In: Environmental Studies in Port Valdez, Alaska. D.G. Shaw and M.J. Hameedi (eds.). Lecture Notes on Coastal and Estuarine Studies No. 24, Springer Verlag. pp. 165-202.

Federal Power Commission. 1976. Alaskan Arctic Natural Gas Transportation Systems, Final Environmental Impact Statement. April 1976. Docket No. CP75-96.

Fesler and Fredston, 1991. In: Environmental Baseline Data, Proposed LNG Plant/Marine Terminal Site, Port Valdez, Alaska. Yukon Pacific Corporation. Anchorage, Alaska.

Forsell, D. J. and P. J. Gould. 1981. Distribution and Abundance of Marine Birds and Mammals Wintering in the Kodiak Area of Alaska. Washington, D. C., U.S. Fish and Wildlife Service, Office of Biological Services, FWS/OBS-81/13.

Fuller, R.G. and J.B. Kirkwood. 1977. Ecological Consequences of Nuclear Testing. In: The Environment of Amchitka Island, Alaska, M.L. Merritt and R.G. Fuller (eds). TID-26712, Energy Research and Development Administration, Springfield, Virginia. pp 627-649.

Gambell, R. 1976. World Whale Stocks. Mammalian Review 6:41-53.

Gilson, T. 1993. Telephone communication on February 26, between P. Reynolds (Ebasco) and T. Gilson (Treasurer, City of Valdez, Valdez, Alaska).

Goering J. J., C.J. Patton, and W.E. Shiels. 1973. Nutrient Cycles. In: Environmental Studies of Port Valdez, D.W. Hood, W. E. Shiels, and E.J. Kelley (eds). Occasional Publication No. 3, Institute of Marine Science, University of Alaska, Fairbanks, Alaska. pp. 225-248.

Gosink T. A. and A.S. Naidu. 1983. Trace Elements. In: Environmental Studies in Port Valdez, Alaska: 1980-1982, Final Report to Alyeska Pipeline Service Company, Institute of Marine Science, University of Alaska, Fairbanks, Alaska. pp. 1-15.

Grant, K. 1993. Telephone communication on March 10, between P. Reynolds (Ebasco) and K. Grant (Alaska Marine Highway System Reservations and Marketing, Anchorage, Alaska).

Griese, 1991. In: Environmental Baseline Data, Proposed LNG Plant/Marine Terminal Site, Port Valdez, Alaska. Yukon Pacific Corporation. Anchorage, Alaska.

Griffin, D. 1992. Telephone communication on July 10, between P. Reynolds (Ebasco) and D. Griffin (City Manager, Valdez, Alaska).

Griffin, D. 1993. Telephone communication on March 11, between P. Reynolds (Ebasco) and D. Griffin (City Manager, Valdez, Alaska).

Gusey, W. F. 1978. The Fish and Wildlife Resources of the Gulf of Alaska. Environmental Affairs, Shell Oil Co., Houston, Texas. pp. 580.

Hackett, S.W. 1980. Avalanche Zoning in Alaska, U.S.A. Journal of Glaciology, v. 26, pp. 377-392.

Haerer, W. 1993. Telephone communication on March 4, between P. Reynolds (Ebasco) and W. Haerer (Property Assessor, Kenai Peninsula Borough, Kenai, Alaska).

Hall, E.S., Jr. 1990. TAGS: An Archaeological Survey of the Proposed TAGS LNG Plant and Marine Terminal at Anderson Bay (Port Valdez). Ms. on file, Federal Energy Regulatory Commission and Alaska Office of History and Archaeology.

Hall, J. 1979. A Survey of Cetaceans of Prince William Sound and Adjacent Vicinity - Their Numbers and Seasonal Movements. Final Report prepared for NOAA/OCSEAP. Contract No. 01-6-022-1560.

Hanson, A.J. and J.I. Hodges. 1985. High rates of Nonbreeding Adult Bald eagles in Southeastern Alaska. Journal of Wildlife Management 49:454-458.

Hanson, J. 1993. Telephone communication on March 16, between D. Lake (Ebasco) and J. Hanson (National Marine Fisheries Service, Alaska Region).

Hassen, H. 1978. The Effect of European and American Contact on the Chugach Eskimo of Prince William Sound, Alaska, 1741-1930. Ph.D. Dissertation, University of Wisconsin, Milwaukee. University Microfilms, Ann Arbor, Michigan.

Hemming, J.E. and D.E. Erikson. 1979. The Birds of Port Valdez. The Library, State Pipeline Coordinator's Office. Anchorage, Alaska. pp. 31.

Herrero, S. 1986. Bear Attacks: Their Causes and Avoidance. Nick Lyons Books, Winchester Press.

Hill, S.H. 1978. A Guide to the Effects of Underwater Shock Waves on Arctic Marine Mammals and Fish. Pacific Marine Sciences Report 78-26, Institute of Ocean Sciences, Patricia Bay, Sidney, BC. pp 50.

Hogan, M.E. and D.B. Irons. 1988. Waterbirds and Marine Mammals. In: Environmental Studies in Port Valdez, Alaska, D.G. Shaw and M.J. Hameedi (eds). Springer-Verlag Berlin Heidelberg. pp. 225-242.

Hood, D.W. 1973. Summary. In: Environmental Studies of Port Valdez. D.W. Hood, W.E. Shiels, and E.J. Kelly (eds). Occasional Publication No. 3, Institute of Marine Science, University of Alaska, Fairbanks. pp. 481-492.

Hubbard, E. 1993. Telephone communication on March 8, between K. Godtfredsen (Ebasco) and E. Hubbard (Alaska Department of Environmental Conservation).

HYDMET, Inc. 1992. Report dated March 4 from HYDMET, Inc. to Yukon Pacific Corporation cited in response to FERC Query #6.

Isleib, M.E. and B. Kessel. 1973. Birds of the North Gulf Coast Prince William Sound Region, Alaska. University of Alaska, Occasional Paper No. 14, Fairbanks, Alaska. pp. 149.

Jacobs, S. 1993. Telephone communication on March 22, between P. Reynolds (Ebasco) and S. Jacobs (Business Office Manager, Valdez Community Hospital, Valdez, Alaska).

Janka, D. 1992. Communication at public meeting May 26, Valdez, Alaska from D. Janka (Executive Director, Prince William Sound Conservation Alliance).

Jenson, D. 1993. Telephone communication in March, between E. Yould (Ebasco) and D. Jenson (Project Manager, Alyeska Pipeline Service Company).

Jewett, S.C. 1990. Preliminary Investigation of the Food and Feeding Habits of Juvenile Pink Salmon in Port Valdez, Alaska, 1989. Annual Report to Alyeska Pipeline Service Company. p. 24.

Jewett, S.C. and T. C. Sark. 1991. Investigation of the Food Habits of Pink Salmon (*Oncorhynchus gorbuscha*) Fry in Port Valdez, Alaska: 1990. Annual Report Submitted To: Alyeska Pipeline Service Co. pp. 42.

Karinen J.F. 1988. Sublethal Effects of Petroleum on Biota. In: Environmental Studies in Port Valdez, Alaska. D.G Shaw and M.J. Hameedi (eds). Lecture Notes on Coastal and Estuarine Studies, Vol. 24, Springer-Verlag Berlin Heidelberg. pp 293-328.

Kawabata, S. 1992. Telephone communication on August 3, between K. Godtfredsen (Ebasco) and S. Kawabata (U.S. Environmental Protection Agency, Region X).

Kirk, M. 1993. Telephone communication on March 5, between P. Reynolds (Ebasco) and M. Kirk (U.S. Bureau of the Census, Washington, DC).

Knight, R.R., B.M. Blanchard, and L.L. Eberhardt. 1988. Mortality Patterns and Population Sinks for Yellowstone Grizzly Bears. Wildlife Society Bulletin 16:121-125.

Lawson, S. 1992. Telephone communication on February 3, between K. Godtfredsen (Ebasco) and S. Lawson (Alaska Department of Environmental Conservation).

Leatherwood, S., A.E. Bowles, and R.R. Reeves. 1983. Endangered Whales of the Eastern Bering Sea and Shelikof Strait, Alaska; Results of Aerial Surveys, April 1982 through April 1983 with Notes on Other Marine Mammals Seen. Hubbs-Sea World Research Institute Technical Report No. 83-169.

Lloyd (T.) Associates, Prepared for Fish and Wildlife Service. 1984. Physical Impacts of Small-Scale Hydroelectric Facilities and Their Effects on Fish and Wildlife.

LNG/LPG Vessel Management Plan and Emergency Plan. 1988.

Lundfelt, C. 1993. Telephone communication on March 22, between P. Reynolds (Ebasco) and C. Lundfelt (Fire Chief, Fire Department, Valdez City Hall, Valdez, Alaska).

Malinky G. and D.G. Shaw. 1979. Modeling the Association of Petroleum Hydrocarbons and Subarctic Sediments. In: Proceedings of the 1979 Oil Conference (Preventions, Behavior, Control, Cleanup), March 1979, Los Angeles, California. pp. 621-623.

Mattson, C.R. 1977. Valdez Pipeline Terminus Salmon Evaluation Studies Pink and Chum Salmon Fry Observations, 1971-74 and May-June 1977. Manuscript Report - File no. 143. U.S. Department of Commerce, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Auke Bay Laboratory, Auke Bay, Alaska. pp. 51.

McAllister, T. 1992. Telephone communication on March 25, between P. Reynolds (Ebasco) and T. McAllister (Port/Airport Coordinator, Valdez, Alaska).

McCollum, S. 1992. Telephone communication on July 9, between P. Reynolds (Ebasco) and S. McCollum (Secretary to Chief, Fire Department, Valdez City Hall, Valdez, Alaska).

McHardy, B. 1993. Telephone communication on March 31, between P. Reynolds (Ebasco) and B. McHardy (Labor Economist, Alaska Department of Labor, Juneau, Alaska).

McKnight, D.E. and C.E. Knoder. 1979. Resource Development Along Coasts and on the Ocean Floor: Potential Conflicts with Marine Bird Conservation. In: Conservation of Marine Birds of Northern North America, J.C. Bartonek and D.N. Nettleship (eds). U.S. Fish and Wildlife Service Wildlife Research Report 11, Washington, D.C. pp. 183-194.

McRoy, C. P. and S. Stoker. 1969. A Survey of the Littoral Region of Port Valdez. In: D. W. Hood (dir.), Baseline Data for Valdez Pipeline Terminal Environmental Data Study. Unpublished report prepared by the Institute of Marine Science and the Institute of Water Resources, University of Alaska, Fairbanks, for Trans Alaska Pipeline System, Anchorage. Report No. R69-17. pp. 191-218.

Merrell, T.R. Jr. 1988. Fisheries Resources. In: Environmental Studies in Port Valdez, Alaska. D.G. Shaw and M.J. Hameedi (eds). Lecture Notes on Coastal and Estuarine Studies No. 24, Springer Verlag. pp. 165-202.

Metcalf and Eddy, 1979. Wastewater Engineering: Treatment, Disposal, Reuse. McGraw-Hill. New York. pp. 920.

Mizroch, S.A., D.W. Rice and J. M. Breiwick. 1984. The Blue Whale, *Balaenoptera musculus*. Marine Fisheries Review 46:15-19.

Mobley, C.M. et al., 1990. The 1990 Exxon Valdez Cultural Resource Program. Exxon Shipping Company and Exxon Company, Anchorage, Alaska.

Morsell, J.W. 1979. The Mammals of Port Valdez. The Library, State Pipeline Coordinator's Office. Anchorage, Alaska. pp. 14.

Morsell, J.W. and G. Perkins. 1979. Biological Studies Report: Salmon Fry Dispersion in Eastern Port Valdez. Report to Alaska Petrochemical Company, pp. 22.

Muench R.D. and D.L. Nebert. 1973. Physical Oceanography. In: Environmental Studies of Port Valdez. D.W. Hood, W.E. Shiels, and E.J. Kelley (eds). Occasional Publication No. 3, Institute of Marine Science, University of Alaska, Fairbanks, Alaska. pp. 103-149.

Muench R.D. and C.M. Schmidt. 1974. Variations in the Hydrographic Structure of Prince William Sound. University of Alaska, Institute of Marine Science. IMS and Sea Grant Report R75-1.

Murty, T.S. 1979. Submarine Slide-generated Water Waves in Kitimat Inlet, British Columbia. Journal of Geophysical Research, v. 84, No. C12, pp. 7777-7779.

Naidu A. S., H.M. Feder, and S.A. Norrell. 1978. The Effect of Prudhoe Bay Crude Oil on a Tidal Flat Ecosystem in Port Valdez, Alaska. In: Proceedings of the 10th Offshore Technical Conference, Houston, Texas. pp. 97-104.

Naidu, A.S. and L.H. Klein. 1988. Sedimentation Processes. In: Environmental Studies in Port Valdez, Alaska, D.G. Shaw and M.J. Hameedi (eds). Lecture Notes on Coastal and Estuarine Studies, Vol. 24, Springer-Verlag Berlin Heidelberg. pp. 69-91.

National Marine Fisheries Seivice. 1993a. Letter dated February 17, from R. Morris (Western Alaska Office Supervisor, Protected Resources Management Division) to R. Arvedlund (Chief, Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

National Marine Fisheries Service. 1993b. Letter dated March 17, from S. Pennayer (Director, Alaska Region) to R. Arvedlund (Chief, Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

Nelson, S.W., J.A. Dumoulin, and M.L. Miller. 1985. Geological Map of the Chugach National Forest, Alaska. U.S. Geological Survey Map MF-1645-B.

Nenahlo, D. 1992. Telephone communication on July 23, between K. Godtfredsen (Ebasco) and D. Nenahlo (Joint Pipeline Office, Alaska Department of Environmental Conservation).

Newmark, N.M. and W.J. Hall. 1982. Earthquake Spectra and Design. Earthquake Research Institute. p. 103.

Nowlin, R.A. 1992. Unit 6 - Prince William Sound and North Gulf of Alaska Coast. In: Mountain Goat, Federal Aid in Wildlife Restoration Survey-Inventory Management Report - 1 July 1989 - 30 June 1991, S.M. Abbot (ed). Unpublished report Alaska Department of Fish and Game, Juneau, Alaska. pp. 46-62.

O'Clair, C.E. and S.T. Zimmerman. 1987. Biogeography and Ecology of the Intertidal and Shallow Subtidal Communities. In: The Gulf of Alaska: Physical Environment and Biological Resources. OCS Study, D.W. Hood and S.T. Zimmerman (eds). MMS 86-0095, U.S. Department of Commerce and Interior. pp. 347-396.

Parks, N.B. and H. Zenger. 1979. Trawl Survey of Demersal Fish and Shellfish Resources in Prince William Sound, Alaska: Spring 1978. U.S. Department of Commerce, National Marine Fisheries Service, Northwest and Alaska Fisheries Center, Processed Report 79-2. pp. 49.

Pitcher, K. W. 1975. Distribution and Abundance of Sea Otters, Stellar Sea Lions, and Harbor Seals in Prince William Sound Alaska. Division of Game, Alaska Department of Fish and Game. pp. 76.

Pitcher, K. W. 1990. Major Decline in Number of Harbor Seals, *Phoca vitulina richardsi*, on Tugidak Island, Gulf of Alaska. Marine Mammal Science 6:121-134.

Plafker, G., R. Kachadoorian, E.B. Eckel, and L.R. Mayo. 1966. Effects of the Earthquake of March 27, 1974 on Various Communities. U.S. Geological Survey Professional Paper 542-G.

Prince William Sound Tourism Coalition. Undated. Alaska's Prince William Sound Vacation Guide. Valdez, Alaska.

Purcell, H. 1993. Telephone communication on March 30, between L. Smythe (Ebasco) and H. Purcell (Manager, Arctic Camps Inc., Anchorage, Alaska).

R&M Consultants, Inc. 1992. 7-Mile Creek Water Supply Study. Final Report.

Reger, R. 1993. Telephone communication on February 18, between B. Graham (Ebasco) and R. Reger (Alaska Department of Geological and Geophysical Surveys).

Richardson, W.J., C.R. Greene, J.P. Hickie, R.A. Davis, and D.H. Thomson. 1989. Effects of Offshore Petroleum Operations on Cold Water Marine Mammals: A literature review. LGL, Limited, report prepared for Health and Environmental Sciences Department, American Petroleum Institute, Washington D.C. pp 385.

Rieger, S., D.B. Schoephorster, and C.E. Furbush. 1979. Exploratory Soil Survey of Alaska. U.S. Department of Agriculture, Soil Conservation Service, pp. 213.

Ritter R.W. 1984. Water Quality Concerns Associated With Pipeline Stream Crossings. In: Proceedings of the Third International Symposium on Environmental Concerns in Rights-Of-Way Management, A.F. Crabtree, ed. Mississippi State University. pp 447-456.

Robb, N. 1993. Telephone communication on March 4, between M. Greenig (Ebasco) and N. Robb (Director of Parks and Recreation, Valdez, Alaska).

Roberson, K. 1986. Range Extension of the Sitka Black-tailed Deer, *Odocoileus hemionus sitkensis*, in Alaska. Canadian Field-Naturalist. 100: 563-565.

Rural Alaska Community Action Program. 1981. Chugach Region: Community Subsistence Profiles. Alaska. pp. 58.

Scarff, J. W. 1986. Historic and Present Distribution of the Right Whale (*Eubalaena glacialis*) in the Eastern North Pacific South of 50°N and East of 180°W. Report to the International Whaling Commission (Special Issue 10):43-63.

Schlitz, L. 1992. Telephone communication on July 27, between P. Reynolds (Ebasco) and L. Schlitz (Public Works Director, Valdez City Hall, Valdez, Alaska).

Sharma, G.D. and D.C. Burbank. 1973. Geological Oceanography. In: Environmental Studies of Port Valdez, D.W. Hood, W.E. Shiels, and E.J. Kelley (eds). University of Alaska, Institute of Marine Sciences, Occasional Publication No. 3. pp. 15-100.

Shaw, D. 1992. Telephone communication on July 31, between K. Godtfredsen (Ebasco) and D. Shaw (University of Alaska, Institute for Marine Science).

Sheehy, T.J. 1975. Reconnaissance Ecosystem-Soil Inventory and Management Report for the Upper Prince William Sound Planning Unit-B. U.S. Forest Service, Chugach National Forest. pp. 95.

Smith, M. 1992. Telephone communication on February 11, between P. Reynolds (Ebasco) and M. Smith (Property Manager, Alaska State Building Authority, Valdez, Alaska).

Smith, R.L., C.P. McRoy, and S. Stoker. 1969. Biological Studies, Baseline Data survey for Valdez Pipeline Terminal. Report R69-17, Institute of Marine Science, University of Alaska, Fairbanks, pp. 167-235.

Solomon Gulch Hatchery Management Plan. 1990. Valdez Fisheries Development Association, Prince William Sound.

Solomon Gulch Hatchery Management Plan. 1991. Valdez Fisheries Development Association, Prince William Sound.

Spatz, L. 1993. Telephone communication on February 25, between P. Reynolds (Ebasco) and L. Spatz (Regional Economist, Bureau of Economic Analyses, Washington, DC).

Stackhouse, G. 1992a. Telephone communication on February 21, between K. Engel (Ebasco) and G. Stackhouse (Biologist, U.S. Fish and Wildlife Service, Valdez, Alaska).

Stackhouse, G. 1992b. Telephone communication on March 27, between L. Brown (Ebasco) and G. Stackhouse (Biologist, U.S. Fish and Wildlife Service, Valdez, Alaska).

Steffen Robertson and Kirsten, Inc. 1991.

Sturdevant, D. 1993. Telephone communication on March 5, between K. Godtfredsen (Ebasco) and D. Sturdevant (Alaska Department of Environmental Conservation).

Swem, T. 1993. Telephone communication on February 22 between G. Green (Ebasco) and T. Swem (U.S. Fish and Wildlife Service, Anchorage, Alaska).

Thom, R.M. 1990. A Review of Eelgrass (*Zostera marina L.*) Transplanting Projects in the Pacific Northwest. <u>In</u>: The Northwest Environmental Journal, 6: 127-137. University of Washington, Seattle, Washington.

Thom, R.M. 1990. A Review of Eelgrass (*Zostera marina L.*) Transplanting Projects in the Pacific Northwest. <u>In</u>: The Northwest Environmental Journal, 6: 127-137. University of Washington, Seattle, Washington.

Thompson, F.M. 1993. Anderson Bay Salmon Enumeration Project. Alaska Department of Fish and Game, Habitat Division. pp 20.

Thompson, F.M. 1992. Telephone communication on February 20, between K. Kuzis (Ebasco) and F.M. Thompson (Alaska Department of Fish and Game).

Tillman, D.A. 1991. The Combustion of Solid Fuels and Wastes. Academic Press, Inc., San Diego, California.

Tongen, J. 1992. Telephone communication on February 20, between P. Reynolds (Ebasco) and H, Tongen (Business Manager, Valdez City Schools, Valdez, Alaska).

Tooley, M. 1993. Telephone communication in March, between E. Yould (Ebasco) and M. Tooley (Chief Design Engineer Southcentral Region, Alaska State Department of Transportation).

U.S. Army Corps of Engineers. 1993. Letter dated February 12, from L. Reeder (Chief, Project Evaluation Section - South Regulatory Branch) to R. Arvedlund (Chief, Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

U.S. Army Corps of Engineers. Unpublished. Wetland Mitigation Successes and Failures, The Corps Experience.

U.S. Bureau of the Census. 1970, 1980, 1990. U.S. Government Printing Office, Washington, D.C.

U.S. Bureau of Census. 1992. 1990 Census of Population and Housing: Summary Tape file 1A, Pacific Division (Volume 1). CD90-1A-9-1. Washington, D.C. U.S. Bureau of Census, Data User Services Division.

U.S. Department of Agriculture, Forest Service. 1974. National Forests Landscape Management, Vol. 2, Chapter 1, The Visual Management System. U.S.D.A. Agricultural Handbook Number 462, Washington, D.C.

U.S. Department of Agriculture, Forest Service. 1984. Land and Resource Management Plan, Chugach National Forest. Anchorage, Alaska.

U.S. Department of Energy, Office of Fossil Energy. 1989. DOE/FE Opinion and Order No. 350; Order Granting Authorization to Export Liquefied Natural Gas from Alaska, November 16, 1989. ERA Docket No. 87-68-LNG.

U.S. Department of the Interior, Fish and Wildlife Service. 1993. Letter dated April 19, from M. Nation (Acting Field Supervisor) to R. Arvedlund (Chief, Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

U.S. Department of the Interior, Geological Survey. 1986. Water Resources Data for Alaska (1986). U.S. Geological Survey Water Data Report, AK-86-1.

U.S. Environmental Protection Agency. 1993a. Letter dated February 17, from C.D. Robinson, Jr. (Chief, Field Operations Section, Alaska) to R. Arvedlund (Chief, Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

U.S. Environmental Protection Agency. 1993b. Letter dated April 16, from C.D. Robinson, Jr. (Chief, Field Operations Section, Alaska) to C. Zerby (Environmental Compliance and Project Analysis Branch, Federal Energy Regulatory Commission).

Valdez Convention and Visitors Bureau. Undated. Valdez, Alaska Facilities and Services, 1991-92. Valdez, Alaska.

Valdez Fishing Facts. Undated. Author Unknown.

Valdez Police Department. 1992. Unpublished data received by P. Reynolds (Ebasco) from S. McCollum (Secretary to Chief, Fire Department, Valdez City Hall, Valdez, Alaska).

Water Resources Data for Alaska. 1979. U.S. Geological Survey Water Data Report, AK-79-1.

Workman, W.B. 1970. Report on an Archaeological Survey of the Southern Part of the Route of the Proposed Trans-Alaska Pipeline System: Valdez to Hagan's Hill. Ms. on file, University of Alaska Museum, Fairbanks, Alaska.

Workman, W.B. 1978. Continuity and Change in the Prehistoric Record from Southern Alaska. Paper presented at the Taniguchi Foundation Symposium on Alaska Native Cultures, Osaka.

Wright, D.G. 1982. A Discussion Paper on the Effects of Explosives on Fish and Marine Mammals in the Waters of the Northwest Territories. Canada Technical Report of Fishery and Aquatic Sciences 1052. pp 16.

Wright, D.G. 1985. A History and Scientific Rationale of the Development of Guidelines to Cover the Use of Explosives in the Marine Environment in Canada and Other Nations. In: Proceedings of Workshop on Effects of Explosives Use in the Marine Environment. pp 2-15. Canada Oil and Gas Lands Administration, Environmental Protection Branch, Technical Report 5. Ottawa. pp 398.

Wright, R.A. and W.H. Allton. 1971. Sea Otter Studies in the Vicinity of Amchitka Island. BioScience 21:673-677.

Yelverton, J.T., D.R. Richmond, E.R. Fletcher, and R.K. Jones. 1973. Safe Distances from Underwater Explosions for Mammals and Birds. Report DNA 3114T from Lovelace Foundation for Medical Education and Research for Defense Nuclear Agency, Washington, D.C. pp 67.

Yukon Pacific Corporation. 1991. Environmental Baseline Data, Proposed LNG Plant/Marine Terminal Site, Port Valdez, Alaska. Anchorage, Alaska. February 6, 1991.

Yukon Pacific Corporation. 1992. FERC Query #20 and #51 - Supplemental Data.

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