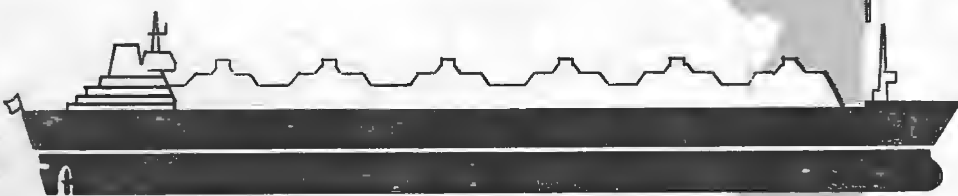
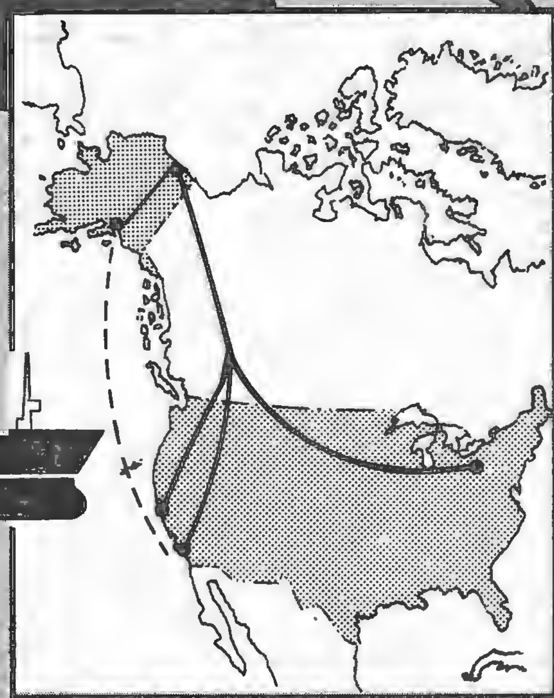
ALASKA NATURAL GAS TRANSPORTATION SYSTEMS

Final Environmental Impact Statement





FEDERAL POWER COMMISSION STAFF

VOL. II

EL PASO ALASKA SYSTEM

April 1976

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FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE ALASKAN ARCTIC NATURAL GAS TRANSPORTATION SYSTEMS

VOLUME II

EL PASO ALASKA COMPANY
Docket No. CP 75-96

APRIL 1976

FOREWORD

The Federal Power Commission, pursuant to the Natural Gas Act, is authorized to issue certificates of public convenience and necessity for the construction and operation of natural gas facilities subject to its jurisdiction, on the conditions that:

> /a/ certificate shall be issued to any qualified applicant therefor, authorizing the whole or any part of the operation, sale, service, construction, extension, or acquisition covered by the application, if it is found that the applicant is able and willing properly to do the acts and to perform the service proposed and to conform to the provisions of the Act and the requirements, rules, and regulations of the Commission thereunder, and that the proposed service, sale, operation, construction, extension, or acquisition, to the extent authorized by the certificate, is or will be required by the present or future public convenience and necessity; otherwise such application shall be denied.

15 U.S.C. 717

The Commission shall have the power to attach to the issuance of the certificate and to the exercise of the rights granted thereunder such reasonable terms and conditions as the public convenience and necessity may require.

Section 1.6 of the Commission's Rules of Practice and Procedure allows any person alleging applicant's non-compliance with such conditions to file a complaint noting the basis for such objection for the Commission's consideration. 18 C.F.R. §1.6 (1972).

Section 2.82 (c) of the Commission's General Rules allows any person to file a petition to intervene on the basis of the staff draft environmental impact statement.

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* Note: The Sections in this TABLE OF CONTENTS which are typed in script have been adopted from the FPC's DEIS with appropriate changes as noted in the Comments and Responses (Volume IV). The Sections which are typed in regular block print are included in this volume of the FEIS.

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C. ENVIRONMENTAL IMPACT OF THE PROPOSED PROJECT

1. Climate

The construction of the pipeline should have no effect on the climatology of the region. Ice fog, a peculiar phenomenon of the arctic climate, is formed from tiny, frozen water droplets. Ice fogging occurs frequently in the vicinity of Barten Island and may occur at other locations along the proposed pipeline. Ice fogs are quite common in the Fairbanks area because of large volumes of vapor emissions from vehicles, heating systems and industries. Particulates from the same sources provide condensation nuclei. Without winds to dissipate it, ice fog often is confined to narrow patches along highways, construction areas and surrounding industrial plants.

Intense radiational cooling during the winter months causes a strong temperature inversion to occur up through 4,000 to 5,000 feet above the terrain. Temperature inversions in conjunction with large quantities of particulate matter and moisture can increase the severity of local ice fog conditions. The proposed 30,000-horsepower compressor stations would each produce 7,200 gallons of 600° F water vapor per hour. This source of moisture would be adequate for the formation of ice fogs in the immediate vicinity of each compressor station given the additional criteria previously described.

The impact of the ice fog would generally be micrometeorological, that is, site dependent. Ice fogs would be confined to the immediate vicinity of each compressor station site.

2. Topography

a) Pipeline

Topographic impacts of the proposed pipeline would be primarily confined to the vicinity of the pipeline. River crossings, borrow areas, ditch mounds, grading, filling, bedrock cuts, tunnels and structures would alter the local topography. The degree and duration of topographic changes would vary with the construction activity and the area in which such activity takes place. For example, the pits created by borrow operations in active floodplains, on level land and sidehills would remain, unless concerted efforts to fill, grade, cover with soil, and revegetate were made. In addition, replacement of the borrow material by less permeable material would affect groundwater movement. Bedrock quarries would leave a visible scar and may remove prominent topographical features. Both borrow pits and quarries could leave closed basins in which water would gather and stand. In permafrost areas this new water-filled basin could cause degradation of local permafrost.

A backfill mound would cover the proposed pipeline along the entire route. The visibility of the mound depends upon the variability of the surrounding land surface. The overall visual impact of the backfill mound on the existing topography is considered to be slight and incremental because of the road, oil pipeline and other man-made intrusions which would already exist along this route. The primary topographic problem caused by the backfill mound is the alteration of the microrelief of the land surface. This alteration of the microrelief can have a significant effect on the localized drainage, encouraging waterflow alongside the mound until a reversal of slope is reached. Additionally, the lack of surface roughness due to less-developed vegetation or smoothing by construction operations would induce waterflow alongside the backfill mound even though drainage crossover breaks are provided. Erosion resulting from this drainage disruption could have a greater effect on local topography than the mound itself.

Permafrost alterations initiated by the proposed pipeline could cause the development of surface features such as pingo mounds, thaw lakes, and thermokarst pits, which ultimately alter the local topography.

b) Gravina LNG Site

Impact upon the onshore topography of the site would probably be limited to areas where grading is required. The existing land surface at the proposed location of the liquefaction train ranges from 100 to about 225 feet in elevation. In order to grade this to a level surface, cuts of up to 75 feet could be expected while the downhill (eastern) portion would have to be raised about 50 feet. The final grade under the LNG tanks would be 148 feet whereas this area presently ranges from 100 to 200 feet in elevation. Cuts of about 10 feet would be necessary for the impounding area and sump and the southern border of the tank and sump area would be formed by the dike which would be at least 10 feet high. The applicant has estimated that 8 million cubic yards of material would be involved in cut and fill operations at the site.

The applicant has not finalized plans for the offsite residential area. However, a preliminary location map shows that the access raod to the 40-acre residential area would parallel existing topographic contours resulting in a minimal amount of grading over its length of approximately 1 mile. (See Figure 1.3-1 in Volume III, El Paso Alaska application in Docket No. CP75-96.) If it is assumed that the entire residential area is leveled to an elevation of 200 feet, the amount of earth to be moved would be about 2.3 million cubic yards. This would be a worst case situation and is not likely as the applicant intends to utilize existing contours as much as possible.

The areas topography could be further altered at borrow pits. If borrow activity is required, the applicant has proposed to develop aggregate sources at the mouth of Simpson Creek or the Rude River.

There is an increased potential for erosion whenever vegetative cover is removed from the soil and/or earth moving activities are required. Removal of the organic surface layer would promote surface runoff and erosion of the underlying silt. Compaction of the construction area would increase these problems.

Adjacent to Harris Creek, the potential for erosion of the site graded area would exist. Increased sediment load and partial blockage of the creek channel could result from the construction activity at the site and borrow areas could supply additional sediment to the creek.

Construction and operation of the marine facilities could alter existing offshore sediment distribution patterns.

3. Geologically Related Impacts

The impact of the construction and the operation of the proposed pipeline upon the geology of the area, and conversely, the geologic environment on the pipeline are addressed in the following subsections.

a) Resources

The construction and operation of the proposed pipeline would have only marginal secondary impacts on mineral resources other than oil, gas and aggregate (sand, gravel, and quarry run rock).

The impact on petroleum resources would be significant above and beyond that of the Alyeska Pipeline Service Company. With the availability of a natural gas transmission system, marginally economic oil fields with significant associated gas and non-associated gas fields would be more likely to be developed.

Potential petroleum provinces crossed or near the proposed pipeline route include the Copper River Basin, Yukon Flats, and the northeastern end of the Yukon-Koyukuk Province. The presence of the LNG terminal at the southern end of the pipeline could provide a collection and export facility for natural gas from the offshore area in the Gulf of Alaska and the onshore area east of Prince William Sound.

Experience in large oil fields elsewhere in the world indicates that the development of the Prudhoe Bay Field as a result of construction of the oil and gas pipelines would lead to extensions of the field and possibly to the discovery of additional fields nearby. Thus, the expansion of the oil and gas producing operations of the Arctic Slope petroleum province is to be expected, except as restricted by governmental regulation, classification or other policy. Therefore, operation of the pipeline system could lead to discovery, extraction, transportation and use of additional quantities of oil and gas in excess of the presently proved reserves in the region traversed by the pipeline.

The impact of the proposed pipeline on the aggregate resource, already strained by the Alyeska Pipeline Service Company construction, would be significant. Gravel would be in short supply at the time of the proposed pipeline construction. The requirement for 6.5 million cubic yards of gravel would in some areas compel the builders to utilize active riverbeds. This would have a severe impact on the local stream hydrology and the water quality below the extraction site. The use of bedrock quarries for crushed rock may provide enough economic incentive to develop them for extra-pipeline use as well.

The impact of the proposed pipeline on coal, heavy metals and geothermal resources would be secondary, through the increase in access in areas along the pipeline route, especially in those portions of the route where it deviates from the Alyeska right-of-way.

b) Permafrost

Any construction in a permafrost zone, whether continuous or discontinuous will have some impact on the permafrost. The objective is to reduce this impact, especially in continuous zones having a great depth of permafrost. The delicate heat balance of the permafrost can be altered by climatic change, change in the insulating qualities of the surficial material, and by the effect of water, standing or flowing over it. The effect of the climatic change is to increase or decrease the mean annual temperature or the amplitude of the temperature curve. Compaction or removal of the surface material would reduce the insulation between the existing permafrost and the incident heat in the summer. The addition of water bodies in an area would raise the effective average temperature at the ground surface, and the removal of such water would lower the average ground surface temperature.

There are natural disturbances of the permafrost regime, such as climatic change, lake drainage, stream channel migration, fire and solifluction. A natural disturbance of the permafrost along the pipeline, especially prior to commencement of gas flow could cause loss of pipeline support or floating of the pipeline.

Human activities include the disruption of the vegetative mat by vehicular traffic, placement of structures, and excavation. The thickness and general insulating qualities of the organic layer and the ice content of the uppermost permafrost layers are probably most critical in determining specific impacts. All disturbances in permafrost areas would have long-term effects on the permafrost regime. This is in part due to the slow nature of the reaction as the temperature change slowly penetrates down into the permafrost, until the level of zero seasonal change in temperature is reached. The removal or destruction in situ of the present ground surface materials would have short-term impacts during the construction work, especially if the exposed soil is ice-rich. Degradation of the permafrost then results on one or both of the following mechanisms: thermal erosion or thermal melting. Exposure of the ice-rich soil to solar radiation results in thermal melting. If the ice-rich soil is brought into contact with running water, thermal erosion will take place, as the water not only melts the interstitial ice, but also carries away the soil particles. If a high-ice content area is involved, subsidence of the soil surface, gullying and establishment of new drainage patterns may occur. The problem from the engineer's viewpoint is that once initiated, permafrost degradation is difficult to halt until a new heat balance is achieved. Disturbed areas in permafrost regions are slow to revegetate naturally because of the shortness and coolness of the summer.

The temperature of the permafrost in an area is indicative of its ability to stave off degradation. In the lowland area north of the Brooks Range, the temperature of permafrost at depths just below the zone of seasonal variation generally ranges from about 12^{o} to $23^{o}F$. In lowland areas south of the Brooks Range, the permafrost temperature generally is warmer than about $23^{o}F$. Within the mountainous areas (e.g., Brooks Range, Yukon-Tanana Upland, Chugach and Alaska Ranges), the temperature of the permafrost is extremely variable.

The applicant proposes to introduce natural gas into the pipeline at a temperature below 32^{o} F and above the dew point of the gas. Compression and refrigeration of the gas would take place at regular intervals along the entire length of the pipeline. The purpose of refrigerating the gas is to prevent large-scale and long-term degradation of the permafrost regime along the pipeline. Because the gas would be refrigerated, it is estimated that a frost bulb of unknown size would develop around the pipe. The size of the frost bulb would depend on the specific temperature of the gas, the permeability and porosity of the surrounding soil, and the water content of the soil. Although studies have been done on the effect of chilled pipeline in the soil, they have been of too short duration to predict the long-term heat balance between surface temperature, the frost bulb, and adjacent soil.

It has been surmised that the operation of the chilled pipeline would eventually result in the creation of more permafrost. The direct impact of increasing the permafrost is minor. The effect of the frost bulb and an increase in the permafrost in formerly unfrozen zones under streams and across subsurface drainage zones would have significant secondary impacts.

The major impact of the pipeline on permafrost would occur in the time period from the initial disturbance until the initiation of chilled operation. Portions of the pipeline could be buried in excess of 2 years before the introduction of the chilled gas. Work by the Russians on underground pipelines in permafrost regions indicates that unchilled pipe would be lifted out of the ground during the winter because of frost heaving and other natural forces acting on the pipe. Thus, the first sections of the pipeline could be forced out of the ground during the waiting period.

The unchilled, newly laid pipeline would also be liable to thermal melting and/or thermal erosion during the intervening thaw periods. The magnitude of the problem is unknown, but the pipe-filled ditch could become a water-filled trench, reducing the strength of the materials in the ditch which support the pipe. On sloping terrain, the pipe-filled trench could divert and capture local drainage, causing erosion and removal of the pipe supporting materials, in part by being a channel of reduced resistance to water-flow.

Thus, there are two impacts of the proposed pipeline which must be mitigated to the greatest extent possible -- the initial effect of the construction effort and the subsequent waiting period discussed in later sections.

c) Frost Heave

Frost heave is caused by the difference in volume between frozen and unfrozen water. Frost heave, or the expansion of the soil profile through ice formation, is possible where three conditions exist: freezing temperatures, a source of water, and frost-susceptible soils (soils of fine-grained materials). Although the proposed pipeline system is to be buried below the active layer in perenially frozen soils, it would be susceptible to frost heave. The frost heave problem would primarily result from the migration of pore water (groundwater) toward the expanding freezing front of the frost bulb. The pipeline system would provide the freezing temperature; while the backfilled ditch may provide susceptible soil conditions. Frost heave of the unchilled buried pipe prior to operation is also a problem.

The impact of frost heave upon the pipeline would depend on the severity of the heaving. Uplift of the pipe gradually through an area, especially in a floodplain or riverbed could result in its uncovering and exposure to erosion. Differential uplift on the pipeline would place increased stress on the pipe. In either case the primary environmental impacts would be in the construction effort required to repair or replace the pipe. If the pipe had been stressed to the point of failure after the initiation of gas transmission an additional safety hazard would be added to the repair work. The entrapment of gas under river ice or seasonal frost cannot be entirely dismissed as unlikely. The effect of the repair effort would be similar to that of the original construction impact on vegetation, soils, permafrost, and erosion.

d) Erosion and Mass Wasting

Erosion and mass movement are geological processes which operate using the force of gravity, the former with water or wind as the principal medium and the latter with the entire body of soil and rock debris (water-saturated) as the medium. Consequently, the severity of these processes increases as the slope of the land surface increases. The proposed pipeline route passes through some of the most rugged topography in Alaska, traversing many steep slopes along the route in the Brooks Range, the Alaska Mountain Range, and the Chugach Mountains as well as in some foothills and plateau regions. Whether the pipeline route crosses the land surface parallel to the slope, oblique to the slope, or perpendicular to the slope, the construction effort would upset the equilibrium of the soil mass. Even in rolling terrain, ice-rich soils would be very susceptible to erosion and mass movement since slope stability in permafrost is very sensitive to the amount of water in the soil. Surfaces of as little as 3 percent slope have had significant downhill movement of soil material in permafrost areas.

Thawing of permafrost caused by construction or maintenance activities could result in slope failure, especially where fine-grained, ice-rich soils are encountered. As melting of interstitial ice (thaw consolidation) takes place, the volume of the thawing soil profile is reduced. If water is generated at a rate exceeding the discharge rate of the soil materials, the total soil mass may behave like a liquid.

Thaw consolidation must be considered as an annual event which takes place rapidly. Slope instability could be expected to occur throughout the operating life of the pipeline system. This would probably occur during the early summer necessitating repair work when the surface is thawed. Thaw consolidation would be caused by construction and operation of this pipeline and would in turn adversely affect the line.

Solifluction, defined as a shallow, downslope movement of water-saturated unfrozen sediments over a surface of frozen material, is probably the most frequent evidence of slope instability on the tundra of the Arctic Coastal Plain and Arctic Foothills. It usually occurs further south in tundra areas with permafrost and differs from other forms of slope instability, such as creep and rockslides since entire sheets or lobes of unconsolidated sediment move. Active only during periods of thaws, solifluction is a condition caused by the impermeability of permafrost and low evaporation rate. Downslope movements might be so rapid that a structure resting upon the area of movement will either be subject to large earth pressures or move passively downslope.

A shallow, downslope movement of soil and tundra vegetation, such as solifluction, probably would not affect the buried portion of the pipeline system. However, it could redirect surface drainage, accelerate erosion, and thaw permafrost. The impact of slope instability conditions is considered significant since slope failure would require repair and stabilization when the surface was thawed and most susceptible to vehicular damage from repair activities.

Other impacts from slope failure and repair would be disruption of vegetative cover, degradation of permafrost, increased turbidity in streams, and loss of water quality in streams draining the area.

"Skin flows" involve the detachment of a thin veneer of vegetation and mineral soil and subsequent downslope movement over a planar inclined surface. These generally are long ribbon-like tears in the surface vegetation which sometimes coalesce into broad sheets. This type of slope instability is shallow in comparison to its length. Skin flows can occur on both steep and low angle slopes. It is probable that construction of the proposed pipeline would increase the occurrence of skin flows where the surface vegetation is disturbed. Secondary impacts from new skin flows could be major in that the heat balance controlling permafrost in the head region of the flow would be disrupted. It is probable that thermal consolidation would increase on such areas which in turn could initiate either deep-seated creep or solifluction. Because "skin flow" movement is shallow, it probably would not affect pipeline integrity except indirectly if surface drainage is redirected. Impacts from skin flow are considered to be similar to those from solifluction in that movement of surface equipment during summer repair work could produce major impacts when the surface is thawed.

Deep-seated creep or mass wasting might occur in permafrost slopes where the underlying permafrost is warmed but not thawed. Under such conditions even thick deposits of materials may move farther down slopes. Along the pipeline ditch local conditions might be favorable to deep-seated creep. The matter for concern is the slope-pipeline interaction since deep-seated creep can cause movement of the pipeline. The impact of deep-seated creep causing pipeline failure would be significant, major, and adverse since the system could not deliver natural gas. Impacts to the local environment would be similar to those described for solifluction and skin flows if summer repair would be required.

The impacts of the proposed pipeline on slope stability could be very significant particularly in sloping ice-rich soil areas. Although impacts would be local, their proximity to water courses (where terrain is steepest) can have major secondary impacts on water quality through increased siltation. A tertiary effect resulting from slope instability would be to upset the heat balance controlling the underlying permafrost.

e) Coastal and Marine Related Erosion and Deposition

The Beaufort Sea would be little affected by the proposed pipeline project. Some incremental amount of sediment would reach the Beaufort Sea, due to construction activities in the drainage basins of north flowing tributaries. This impact could not be isolated from similar impacts caused by construction activities of the Alyeska oil pipeline and the producing companies in the Prudhoe Bay Field.

Deposition by the Yukon River of material eroded from construction areas within its basin would not significantly affect the coast in the area of its delta. The tendency of rivers to deposit excess sediment load on their floodplains would remove most of the additional sediment resulting from pipeline construction long before the extremely long transit to the Yukon River Delta is complete.

The construction disturbance in the Copper River Basin would result in negligible marine deposition for the same reasons stated above for the Yukon River.

Some fine sediment which would be entrained due to construction activities in the Lowe River Basin may reach the Valdez Arm. Its impact there should not be significant.

In Prince William Sound, sediment produced by the construction activities would reach marine waters in Port Gravina and Orca Bay. The effect in Port Gravina would be locally significant at river deltas whose basins are crossed by the proposed pipeline route. This local impact should be short-term, during and for 1 to 3 months after construction if proper erosion-reduction measure including revegetation are successful. In Orca Bay, overland drainage into the bay and drainage through Harris Creek would have a significant local impact due to clearing, stripping and other construction activities at the proposed LNG terminal site. Some sediment would be carried by Harris Creek from the pipeline construction in its basin. There would be an increase in erosional processes because of unprotected ground surfaces and the large amount of precipitation that falls in the area. This would increase the silt content of streams and estaurine areas to the detriment of freshwater and marine organisms.

This increase in waterborne silt in Harris Creek would cause increased deposition on its delta, with resultant delta front avalanches carrying sediment into the deep waters offshore. Thus bottom dwelling organisms, eggs and attached young of other free-swimming organisms would be impacted, not only in the near shore littoral zone but also in the bay bottom directly off Harris Creek.

The employment of the construction pier would alter the long-shore currents and wave movements in its immediate vicinity. There would be some sediment accumulation on its north side, with some increased erosion of shore materials southwest of the construction pier. The construction of the LNG loading pier would not have a significant effect on marine or coastal erosion and deposition.

f) Seismicity

The recorded earthquake history of Alaska is short, providing only a limited guide to future seismic risk. Earthquakes of magnitude 6 and higher on the Richter Scale are potentially destructive, and earthquakes of magnitude 5 may cause local damage. The seismic zonation along the route of the proposed pipeline is given in the description of the seismic environment. Only in the area between Prudhoe Bay and 67°N latitude is the possible maximum expected earthquake below the potentially destructive level.

The proposed route intersects several recognized major faults in the five seismic regions south of 67°N latitude; however, except for the Denali fault, which displays abundant geologic evidence of a large Holocene offset (Richter and Matson, 1971), the risk of significant tectonic movement of these faults is essentially unknown at present. Many additional faults are also postulated to exist, particularly in the segments 67°N to Donnelly Dome and Willow Lake to Gravina Point. Both of these segments are characterized by the frequent occurrence of sizeable earthquakes that have yet to be identified with individual faults.

Along the proposed route from Willow Lake to Gravina Point, there exists the problem of seismic vibration magnification and consolidation of alluvial sediments. The consolidation of alluvial sediment under seismic shaking occurs in both the vertical and horizontal dimensions, resulting in ground cracks. The region of ground cracks in alluvial sediments resulting from the March 27, 1964, Alaska earthquake is illustrated in Figure 62. Clearly this region includes a significant portion of the proposed route. The proposed route in the Lowe River Valley and the Gravina River

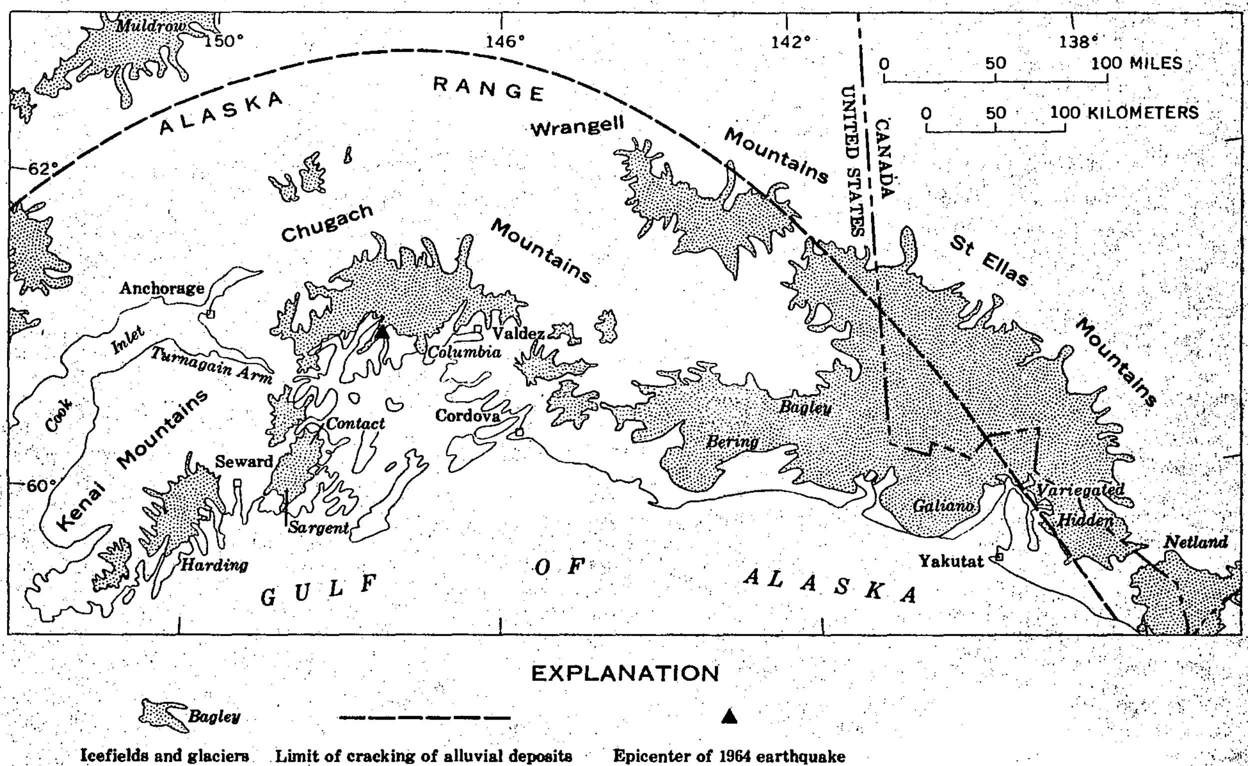


Figure 62. Map of South-Central Alaska Showing the Major Glaciers and Icefields and the Epicenter of the March 27 Earthquake.

valley would be particularly susceptible to the magnification of seismic shaking. This magnification of seismic shaking results from the internal vibration of the unconsolidated material and may result in ground acceleration twice that of the bedrock in the area. In addition, zones of fine-grained sediments in these valleys would be susceptible to liquefaction 1/ under seismic shaking.

The occurrence of large earthquakes is a potentially serious hazard to the integrity of the pipeline system. Seismic shaking or surface faulting accompanying a large shock could rupture the pipeline directly or cause failure in the foundation material that could lead to rupture. Furthermore, large earthquakes could trigger landslides and sea waves that could jeopardize the integrity of the pipeline, the LNG plant, loading dock, and tankers. The immediate environmental impact (of a pipeline failure resulting from an earthquake) would be dependent on the specific circumstances of the failure. The most serious direct impacts would stem from igniting the escaping gas and the resulting fire. Destruction of the vegetative cover could result in disruption of the thermal regime and initiation of erosion. The primary concern here would be the loss of vegetative cover, the disruption of the soil thermal balance where this is a problem, and the resultant erosion. Fire suppression measure would be instituted immediately upon location and movement to the failure site. Unfortunately, the experience in Alaska has been that fire suppression activities cause worse environmental impacts than a fire. (Slaughter, et al., 1971) Repair of damage to the pipeline would have a similar impact.

This impact, while the indirect result of the fire would stem directly from the use of heavy equipment in suppressing the fire and making repairs.

Above-ground facilities along the pipeline route, such as compression stations and block valves, would be susceptible to seismically-induced landslides and rockfalls. Final location of these facilities could in most areas of the route eliminate this problem, however, some danger would remain for facilities located on slopes within mountain ranges.

1/ Liquefaction is the phenomenon of the loss of strength of saturated soils during earthquakes. (Ghaboussi & Wilson 1973)

g) Glacial Impacts

The section of the Brooks Range which would be traversed by the proposed pipeline is free of glacial ice, except for a few small glaciers on the north-facing slopes of the higher mountains. Thus, no impact or interaction with glaciers is expected in the Brooks Range. Further south, however, the proposed pipeline route would pass adjacent to the termini of the Worthington Glacier in the Chugach Mountains and the Black Rapids, Canwell and Castner Glaciers in the Alaska Range.

The Black Rapids Glacier displays multiple looped marine patterns on the glacier's surface which indicate an alternation of regular and fast rates of ice flow, corresponding to quiescent and active phase of a surging glacier. The surface of the Black Rapids Glacier's accumulation zone is nearly 330 feet higher along some sections of the 1970 profile than it was in 1950. (USGS, 1972). Further work in 1971 indicated that the buildup for the next surge is proceeding, however, the timing and probable amount of advance of the surge is unknown.

Canwell and Castner Glaciers are characterized by a thick moraine cover and the absence of a strongly active ice front near their terminal zones. This indicates either a continuing retreat of the ice front or near-equilibrium conditions. Canwell Glacier, however, has a sinuous moraine ridge that suggests periodic surges on one of its large tributaries.

The Worthington Glacier has been in retreat since 1937. The terminal lake, now 800 feet long, was just beginning to form in 1953. This would suggest a rate of retreat of about 40 feet per year. Neighboring glaciers show a similar history of retreat.

Surficial geologic deposits downvalley from the terminal of these glaciers show that their active ice fronts have reached or crossed the Alyeska pipeline alignment within the past 300 to 350 years. The proposed natural gas pipeline route is on the side of the Alyeska pipeline alignment away from these glaciers. Therefore, the proposed pipeline would be less vulnerable than the Alyeska pipeline to damage by the possible advance of these glaciers. The proposed route is not far enough from the former termini to eliminate all possibilities of damage by a surging advance of one or more of these glaciers.

The pipeline route between MP 771 and MP 776 in the Chugach Mountains passes downstream of four small valley glaciers, four cirque glaciers and two possible snowfields. It passes within 0.2 miles of the indicated termination of one of the valley glaciers between MP 774.5 and MP 775. While there is no known evidence of surging by any of these glaciers, the lack of specific studies on them and their proximity to the proposed route prohibits dismissing the possibility of glacial advance damaging or destroying the proposed pipeline during its service life.

Gravina Site

The Department of the Interior shows the site area as being within a region with high potential for gold, silver, copper as well as other minerals. If the bedrock beneath the site were to contain such materials, they would be rendered inaccessible for the lifetime of the proposed facilities.

Potential impacts upon the facilities by the environment are mainly earthquake related, and include ground shaking, ground rupture, landsliding or slumping, displacement, soil liquefaction, and tsunami generation. As has been mentioned in the section on existing environment, there is disagreement or, more accurately, a lack of data concerning the existence of faults on Gravina peninsula. Moreover, there is, to date, very little information pertaining to the activity of the faults which are known. Because of the possibility of the existence of a fault within 2 miles of the property proposed for construction and the fact that this area is on the strike of the major faults involved in the 1964 event, it would be unwise to discount the possibility of ground rupture at the site.

The applicant has proposed to design the facility to withstand 0.6g of bedrock acceleration without loss of fluid from the storage tanks or processing equipment. An acceleration of 0.3g would be used for other components of the facility. This level of shaking could result from an 8.5 magnitude event at an epicentral distance of just over 20 miles (Davenport, 1972). It is not unlikely that such a combination of distance and magnitude would occur during the lifetime of the facility.

Ground rupture at the site may not be ruled out. The existing data does not deny the possible existence of a fault at the site. Absence of such a fault does not mean that rupture could not take place. Data from Bonilla, 1970, indicates that secondary faulting with 6 feet of offset could be expected to occur within 10 miles of the main fault associated with an event of magnitude 8.5.

Due to the low slope of the site and the proximity of bedrock, it may be surmised that the potential for earthquake induced landsliding or slumping is low. The accuracy of this assumption must be tested by foundation studies.

Tectonic displacement of the site area as a result of the 1964 event was shown to be substantial. The plant site was raised about 4.5 feet and translated 30 feet to the southeast (Plafker, 1969) in response to the regional thrusting. The earthquake epicenter was about 55 miles away.

The potential for soil liquefaction is probably low, however, a definitive statement must await the necessary foundation studies.

Tsunamis or seismic sea waves generated during the 1964 event had runups within Prince William Sound of 50 to 75 feet. A runup of 100 feet and wave heights of 65 feet have been postulated as being associated with the design event (Dames and Moore, 1973). The onshore facilities would be at a sufficient elevation to avoid damage from such a wave. A wave generated outside of the southern Alaska area would probably be noticed sufficiently in advance of its arrival to allow a tanker to be removed from the vicinity of the marine facilities. In the event of a wave being generated in or near the sound, it is unlikely that a berthed tanker could be so removed. It is possible that the vessel and terminal facilities would be destroyed by the design wave if the ship were still berthed.

4. Soils

The construction activities of trenching and grading would result in some of the topsoil being buried under the subsurface material. Since topsoils have better structure and are more fertile than underlying materials, revegetation could be more difficult on the less fertile subsurface material.

The soils involved in the proposed project would be subject to erosion resulting from the removal of the protective vegetative cover during the construction activities. Erosion would continue until the soils could be revegetated. Alteration of drainage patterns by the proposed project would also result in erosion.

Erosion can take place only when the soil is not frozen. Removal of vegetation would allow greater heat transfer through the soil and may thaw the permafrost. Alteration of drainageways could cause flowing water to come in contact with and melt the permafrost. If an ice-rich permafrost is melted, then subsidence, slumping, gullying and establishment of new drainage patterns may occur.

Vegetation removal on slopes would lower the permeability of the soil, resulting in increased runoff and erosion. In general, erosion potentials increase as slopes become steeper. Erosion of thin soils on steep slopes would make revegetation more difficult. The higher precipitation in the southern part of the route, as indicated in Section B-1 , Climate, would increase the erosion potential in that area.

The refrigeration of the gas in the pipeline is designed to provide a gas temperature of not more than 32°F and not less than -10°F. In areas which have permafrost free zones operation of the proposed pipeline could eventually result in the creation of permafrost in these zones. A higher permafrost table might cause the soil to become poorly drained. Some types of vegetation might be adversely affected. Erosion could occur until a type of vegetation adapted to a higher permafrost table or a poorly drained soil could be established.

Fuel and lubricant spills could occur along the entire pipeline route. Most spills would be small and associated with routine fueling and maintenance of construction equipment. Major storage areas for fuels, lubricants, and other toxic fluids would be necessary.

If a spilled petroleum product percolates into the soil, it could kill vegetation and contaminate groundwater supply. The extent of groundwater contamination would depend on the type and volume of spilled product, the presence or absence of impermeable compacted snow or frozen soil, the permeability of the soil, the depth of the water table, and the flow rate of the groundwater.

The most severe impacts to ground water would be in the many soils along the route where groundwater is close to the surface and the soil is permeable. Most of the soils along the route are coarse enough to allow passage of spilled petroleum products.

The process of biodegradation of a spilled petroleum product in the soil depends on the presence of oxygen and adequate plant nutrients. A spilled petroleum product could remain in the subsoil for years because of the low temperatures, low amounts of available nutrients, and excess soil moisture found in many of the subsoils along the route. Low temperatures and low amounts of available nutrients would impede the bacterial activity responsible for the biodegradation of the spilled petroleum product. Excess soil moisture would inhibit the decomposition process because oxygen diffuses through petroleum products more rapidly than through water. The rate of biodegradation could be increased by turning and mixing the soil to aerate it and by adding fertilizer, especially nitrogen and phosphorus.

5. Environmental Impacts on Water Resources

The proposed pipeline would cross approximately 550 streams, of which 20 have drainage systems of more than 1,000 square miles.

Although there are no reliable long-term water quality data for much of the proposed project area, the low level of human use and the limited data which is available suggests that the water quality is good. However, the water cannot be said to be pure in many instances due to natural influences such as seasonally high levels of silt and animal contamination.

a. Surface Water

The construction of the pipeline, access roads and support facilities would result in local alteration of surface drainage patterns. Such alterations would create new areas of wet and dry conditions. Secondary impacts of concentrating or re-directing surface drainage could result in increased local water quantities and velocities. These concentrated drainages would result in both thermal and surface erosion.

Snow/ice roads would also effect surface drainage. These roads would melt more slowly than adjacent areas and, accordingly, would temporarily block surface flow. In the arctic tundra, construction and use of these roads would also cause compaction of the vegetation mat and underlying soil. This compaction would cause depressions where surface water would start to flow. Increased flow could result in the formation of new drainage patterns.

The applicant estimates that approximately 6.7 million cubic yards of gravel and fill material would be required during construction of the proposed pipeline. This could place additional stress on stream systems in some areas already taxed by the gravel requirements of the Alyeska haul road construction and the Alyeska pipeline construction. Large-scale removal of gravel could result in accelerated and magnified streambed shifts until streambed equilibria was reestablished. This could cause disruption of aquatic life and spwaning beds and could increase sediment transport.

Construction in streams would increase the sediment load, and would cause physical disruption of stream channels and flood plains.

Operational impacts on surface water could result from the development of a frostbulb (mass of frozen soil surrounding a pipe containing gas at a temperature of below 32°F) at stream crossings.

The frostbulb could block groundwater flow under the stream and could lead to the formation of an ice anchor across the stream which would restrict surface flow within the stream. In winter this blockage could result in forcing the groundwater and streamflow up onto the surface of the ice causing icings and dewatering of the stream. Fish, fish eggs and aquatic organisms would be impacted by the water depletion downstream of the blockage. Icings could have secondary effects of forming a surface ice dam which would redirect surface drainage patterns. Formation of an ice dam would be conducive to stream channel modification; it could enhance ice scour; and it could affect, as a secondary impact, streambank slope stability.

Operation and maintenance access roads within the flood plains of major streams may cause flooding during spring breakup. Roads would also result in modifications of drainage patterns.

Repair of the proposed pipeline during the winter would produce hydrologic impacts similar to those described for construction. Summer repairs would accelerate erosion as vegetation was compacted by repair equipment, and as permafrost was exposed as the buried pipe was excavated.

b. Groundwater

A significant aspect of stream hydrology north of the Yukon River is that, in a large number of streams, the only winter waterflow occurs as groundwater movement in the aquifer under or adjacent to solidly frozen channel. This magnifies the severity of impacts which do occur. The applicant has indicated that if insufficient snow was available it would be necessary to supplement snow pad construction materials with water. The applicant has also indicated that, although it does not plan to draw water from fish overwintering habitats unless approved by the appropriate regulatory agencies, such withdrawals would be considered necessary under emergency conditions where no other source is near enough to meet the demands. Such withdrawals would have important impacts on the survival of fish and/or fish eggs, should water supplies necessary to life be unavailable or depleted.

Construction traffic on snow/ice roads would cause a compaction of the vegetation mat and soil and would result in the reduction of the insulating properties of these materials. This would increase the depth of the active layer and would accelerate deeper thawing of the permafrost. This disrupted thermal balance could have significant impact on groundwater drainage.

Subsurface drainage would also be impacted due to the formation of a frostbulb around the operating chilled gas pipeline. The development of a frostbulb would form a dam to subsurface movement of water. Consequently subsurface water would be ponded on the upslope side of the frostbulb. This would also accelerate thawing of the adjacent permafrost.

If subsurface flow would be completely blocked by the frostbulb, long-range secondary impacts on vegetation and pipeline safety would result.

Icings resulting from frostbulb blockages of groundwater flows beneath streambeds would have a significant secondary effect of smothering vegetation.

The frostbulb formation in fine-grained saturated silty soil could induce formation of ground ice. The impact of the formation of ground ice could be a serious threat to pipeline safety as frost heaving of the pipe could take place.

If summertime pipeline repairs were required there could be impact on subsurface water drainage. The movement of equipment and supplies across a thawed tundra surface could cause compaction and concentration of water.

c) Glaciers and Glacial Phenomena

The uncertainties concerning glacier surges (Meier, 1969) and outburst floods (Post and Mayo, 1971, 1972) make tenuous any prediction of their occurrence, frequency, or extent. However, the possibility of damage to the pipeline and possible rupture of the pipeline would exist due to the presence of the proposed pipeline within the area of potential effects of glaciers and glacier dammed lakes.

d) Water Quality

Construction of the proposed pipeline would result in substantial surface alteration for the entire right-of-way. Each construction activity (e.g., ditch excavation, spoil storage, snow-ice road construction) has significant potential to expose soil to erosion by water. This could then result in a lowering of water quality by the addition of silt.

Water quality reduction due to siltation would also occur as the result of excavation fill, borrow operations, and channel modifications in streams.

The proposed road crossings of streams would have more potential than the proposed pipeline corssings of streams for longer term erosion and siltation problems.

The effect of siltation and erosion on water quality would be an increase in suspended solids and turbidity, a decrease in dissolved oxygen and possible increase in nutrients.

Should a major spill of fuels, lubricants or toxic materials occur at storage sites or during water transportation along the Alaskan Arctic Coast or Prince William Sound, there could be long-term adverse impacts on water quality. The severity of the impact along the Alaskan Arctic Coast would in part depend on weather and ice conditions which could hamper remedial actions.

Repeated small spills of fuels and lubricants along the proposed pipeline route could be as serious a water quality problem as a single large spill.

Upsets in waste treatment facilities could increase the nutrient loading and possibly introduce undesirable elements into receiving waters.

The nutrient loading would also increase due to the nutrient material applied to the land surface during revegetation programs that subsequently enters the aquatic environment through runoff.

e) Oceanography

Construction and site preparation operations such as clearing surface vegetation and grading the site would result in increased erosion and potential leaching problems. The magnitude of this impact is potentially increased because of the large amount of precipitation that falls in the Prince William Sound area. Erosion would increase the silt content of Harris Creek and local estuarine areas. Construction-related petroleum products spills may also impact freshwater and marine biota by the introduction of these products into local watercourses via runoff.

Offshore construction of the proposed marine terminal would further result in temporary increases in turbidity.

The magnitude of impacts associated with the construction and existence of a proposed 600-foot long access road/breakwater and the proposed LNG terminal's wastewater discharge is dependent on local nearshore circulation. Because baseline information on nearshore circulation is insufficient, these impacts cannot be accurately assessed. However, the breakwater would affect local circulation patterns, and if circulation patterns in Orca Bay are such that waste discharges are concentrated, adverse effects to the waters of the bay would result. Expected characteristics of the operational waste discharge are presented in Table 27.

Spills of toxic substances such as acrolein or hydrogen chloride during plant operation could result in degradation of water quality.

Table 27

WASTE DISCHARGE FROM HOLDING POND TO ORCA BAY
DURING OPERATION OF LNG PLANT

Flow	GPM	MGD
Average 1/	1170	1.68
Normal 1/	738	1.06
Design 1/	8867	12.77

Component	PPMW 2/	LBS/DAY 2/
BOD_5	0.4	5.62
Phosphate ($PO_4^{=}$)	1.5	21.08
Chloride (Cl^-)	12	168.60
Oil	<1	14.05
Suspended Solids	5	70.25
Total Dissolved Solids	52	730.60

Temperature of discharge would be 61°F and pH would be 7.0

1/ Major portion of flow in storm water run-off from process units and LNG tank farm areas.

2/ Values given are for average conditions.

A tanker collision or grounding in the area of the plant site could release Bunker "C" fuel oil carried on the tanker. The adverse effects would depend on spill size, spill location, and existing meteorologic and oceanographic conditions.

Some fine sediment which would be entrained due to construction activities in the Lowe River Basin may reach the Valdez Arm. Its impact there should not be significant.

In Prince William Sound, sediment produced by the construction activities would reach marine waters in Port Gravina and Orca Bay. The effect in Port Gravina would be locally significant at river deltas whose basins are crossed by the proposed pipeline route. This local impact should be short-term, during and for 1 to 3 months after construction if proper erosion-reduction measures including revegetation are successful. In Orca Bay, overland drainage through Harris Creek would have a significant local impact due to clearing, stripping and other construction activities at the proposed LNG terminal site. Some sediment would be carried by Harris Creek from the pipeline construction in its basin. There would be an increase in erosional processes because of unprotected ground surfaces and the large amount of precipitation that falls in the area. This would increase the silt content of streams and estuarine areas to the detriment of freshwater and marine organisms.

6. Impact on Aquatic Biota

a. Siltation

The construction of the proposed pipeline and LNG facilities in Alaska would cause siltation in lakes and streams in the areas where construction would take place. This would be in addition to that created by the current construction of the Trans-Alaska oil pipeline. The siltation would be created by the excavating of granular material from streambeds for gravel pads; the crossing of streams and lakes with the pipeline and roadways; the erosion from revegetation failures that would occur from upland pipeline, road, and borrow sites; and from the crossing of streams by vehicles. During the construction of the LNG facilities soil erosion would occur during site preparation, road excavation, and construction and installation of the terminal structure and small boat harbor.

There are several potential adverse effects on freshwater fish from increased levels of siltation. These effects are direct mortality; indirect mortality, reduced growth rate, or decreased resistance to disease; modifications of migrations and movements; and reduction of available food because of decreased production due to increased turbidity. The most significant impact of siltation on fish populations would be the smothering of eggs and larvae in gravel beds. The mortality caused could have serious consequences on populations that spawn in any stream crossed by the pipeline. The silt would also reduce the escape cover of young fry and reduce the available food supply needed by the fry.

One investigator has found that additions of silt of more than 80 milligrams per liter (mg/l) of sediments decreased microinvertebrates to about 40 percent of normal. Increased drift of microinvertebrates from riffles was found to be directly proportional to the increase in suspended solids up to about 160 mg/l. It was found in studies performed outside of Alaska that microinvertebrates were able to repopulate an area rapidly. Since many streams in Alaska are subject to scouring during breakup in the spring and still maintain invertebrate populations, this rapid repopulation could be assumed for Alaska as well.

Each stream has an inherent capacity to recover from damage caused by siltation. The natural flushing or recovery action depends primarily on the velocity of flow and particle size and varies with each individual stream and situation. It has been found that the amount of fine particles in spawning beds increased temporarily but was not significantly greater 5 years after logging than before logging. However, in spite of this recovery capability, all sediments are ultimately deposited somewhere further downstream, in the mainstream, or in the ocean.

b. Reduced Dissolved Oxygen

The overwintering areas for fish in Alaska are limited to those streams and lakes which are deep enough to prevent the ice from freezing solid. These pockets of water are naturally low in dissolved oxygen due to limited exposure to surface air. Any changes in the local environment that would lower the oxygen levels could have major detrimental impacts on the organisms found there. Increased levels of organic matter in the aquatic systems would increase the biological oxygen demand and reduce the amount of oxygen available to the fish. Domestic sewage from construction camp would be an example of an extraneous source of organic matter. Any reduction of oxygen in the overwintering pools could reduce the numbers of fish that would be able to survive. Nutrient-laden silt eroded from areas where revegetation efforts are being carried on would also possibly increase the growth of primary produces such as plants and algae. Higher growth rates would utilize more oxygen and lower the amount of oxygen left for fish.

Another impact associated with the overwintering areas of fish is that of water withdrawal from these areas for ice on snow-road construction and camp water. These withdrawals could have major impacts on resident fish populations. In many cases, these pools contain concentrations of entire stream or lake populations that would be eliminated or reduced drastically by any change in the water level of the pool.

c. Toxic Chemicals

During the construction and operation of the proposed pipeline and LNG facility various chemicals would be used, such as gasoline, fuel oil, metal primers and paints. The possibility of spillage would be ever present and would constitute a threat to the local environment in the event of a spill.

d. Culverts

The proposed pipeline construction would require the placing of culverts in streams crossed by roads. These culverts can act as barriers to fish migrations. This would happen if the culvert is too narrow for the particular stream it is set in and the resultant increase in the velocity of the water as it passes through would be too strong for fish to swim against. The maximum current allowable would be related to the species of fish that must pass through,the size of the fish, and the temperature of the water. A poorly designed culvert could change spawning and migratory patterns to the detriment of area fish populations. Culverts are potentially more damaging to stream dwelling populations of fish, particularly grayling, than any other aspect of pipeline-related activity.

e) Marine Biota

Perhaps the most significant impacts resulting from the proposed operations of the LNG facility would occur on the marine environment. During operation of the LNG plant, about 658,000 gallons per minute of water would be drawn into the plant for the proposed once-through cooling water system. The effluent would be discharged by means of a pipe which would extend into Orca Bay and discharge at a depth of approximately 60 feet. Current specifications call for the effluent to be approximately 21°F above the ambient seawater temperature. Chlorine to be used as an LNG liquification facility anti-fouling biocide and brine from desalinization facilities would also be mixed into the effluent prior to its discharge into Orca Bay.

Due to the lack of baseline oceanographic data, temperature tolerance studies of the marine life inhabiting Prince William Sound, and the design features of the effluent outfall, neither the areal extent and magnitude of the influence of the thermal discharge nor the specific impacts on marine biota are known. However, some general comments can be made.

In general terms, several potential biological responses would result from thermal stress. Thermal stress may (1) cause motile organisms to physically remove themselves from the stimulation, (2) cause physiological adjustments to compensate for the temperature change, (3) cause the organism to assume some protective position or behavior, or (4) cause the organism to succumb. Persistently elevated temperatures have been suspected of causing other behavioral changes of species such as (1) alterations in natural vertical movement of organisms due to vertical stratification of the water column, (2) avoidance of thermal barriers in spawning and nursery areas, (3) seasonal changes in spawning and development, and (4) alterations in migratory behavior of anadromous fishes in coastal areas.

Bell (1973), in discussing the effects of temperature on fish indicates that disease organisms also respond to temperature by causing excessive losses to fish life. Heat shock, which can result in the fishes' loss of equilibrium, can occur when the fish is brought rapidly from lower to higher temperature.

Because of the effects of temperature on dissolved gas equilibrium in water, oxygen deficiencies can be created and nitrogen embolism can be caused. Swimming speeds are altered by changes in both temperature and oxygen concentration.

Observations made by Clarke, et al. (1970) on a desalting plant in Key West, Florida, suggests that the presence of heavy metals or chemical discharges during the descaling operations at the proposed LNG plant would be toxic to organisms living in the discharge area.

Jenson (1969) also suggests that within certain limits, the rate of change in temperature may be of greater significance to the survival of an organism than the amplitude of the change. If the shutdown of the proposed LNG facilities would result in a sudden temperature change in the area affected by the warm water discharge, insufficient time would be allowed to affect physiological compensation reactions to the thermal stress. The applicant indicates (Feb. 7, 1975) that knowledge of the effects of this type of thermal stress has been employed as a means of harvesting cultured salmon.

These general biological effects may be expected to be produced in several significant species of marine biota due to the proposed LNG facility warm water discharge. Adult pink and chum salmon and to a lesser degree, silver and red salmon migrate past the proposed Point Gravina site in large numbers during July and August. Of particular potential significance is the migration of pink salmon juveniles during the period of May through July. These young fish migrate at the water's surface and from 100 to 500 yards offshore.

On the basis of information available at this time concerning the proposed location of the heated water discharge outfall, it appears that the juvenile pink salmon migrations would encounter water, the temperature of which was significantly elevated above ambient due to the warm water effluent.

Additionally, large numbers of Tanner crabs, King crabs and, in smaller quantities, Alaskan pink shrimp are commercially harvested in the vicinity of the proposed LNG terminal. Those species could be impacted by the proposed heated water effluent in any of the several ways indicated earlier. Also, seaweeds and sea grasses, two important groups in Prince William Sound, are quite sensitive to changes in seawater temperature.

The applicant has indicated that utilization of the warm water effluent for aspects of an ocean ranching program holds promise in Alaska. In ocean ranching, salmon are raised in hatcheries (in which the heated effluent could be used to accelerate growth) and then released. They are harvested upon their return. Although ocean ranching could conceivably mitigate impacts resulting from the warm water discharge, no proposal for such a program has been made by El Paso.

The proposed thermal discharge would exceed temperature elevation limits established in the water quality criteria for the State of Alaska. These criteria state that in coastal waters temperatures may not exceed natural temperatures by more than $2^{o}F$.

Chlorine is proposed as an anti-fouling biocide. The applicant indicates that the residual chlorine content of the effluent from the seawater cooling system would be "less than or equal to 1 ppm." According to the U.S. Environmental Protection Agency's Proposed Criteria For Water Quality (1973), concentrations of free residual chlorine in marine or estuarine waters in excess of 0.01 ppm are unacceptable. The U.S. Corps of Engineers (1973) indicates that fish may avoid chlorine in concentrations as low as 1 ppm but, if locked into a situation where chlorine is present at levels of 0.1 ppm, they may choose to remain there, although the concentration may finally be lethal.

Based on the lack of oceanographic baseline data and outfall locations and specifications, any predicitions or calculations of the residual chlorine concentration that could exist in the vicinity of the outfall are impossible. This precludes a valid evaluation of the impacts that could occur. However, if these concentrations were to exceed 0.01 ppm, several studies indicate that significant impacts in the form of fish mortality and marine phytoplankton growth rate reductions would occur.

It is the staff's understanding that in compliance with the Federal Water Pollution Control Act, the applicant must obtain a wastewater discharge permit (i.e., a National Pollution Discharge Elimination System permit) from the Environmental Protection Agency (EPA). This permit would be subject to approval by the State of Alaska. Either state or Federal regulations pertaining to thermal and toxicant (e.g., chlorine) discharges would be incorporated into the permit depending on which agency's regulations are more stringent.

Impacts due to the operation of the cooling facility would also occur on marine biota by means not directly related to the warm water effluent. Plankton, including plant and animal, and larval and juvenile forms of fish and shellfish that would be drawn into the cooling system would experience nearly 100 percent mortality. The impact of this on juvenile and larval stages of salmon, shrimp and crabs is potentially severe.

In addition to the impacts associated with operation of the LNG plant, there are two potential impacts on fisheries in Prince William Sound that would result from the LNG tanker traffic. The proposed tanker route would cross one of the most productive tanner crab areas in Prince William Sound. Crabbing within the tanker route would be prohibited since the tankers would remove the marker buoys which are attached to crab pots located on the bay bottom. The crab pots which are used to capture the crabs would then be lost to the fishermen. The removal of this crabbing area in the tanker route would reduce the area available to crabbing. The areal extent of tanker influence to the crabbing activities would normally be confined to the 1½ to 2 mile wide traffic lane within Prince William Sound.

There is also the possibility of a tanker straying from the traffic lane and into the crabbing gear. This would not only be a financial loss to the fishermen, but there is some evidence that pots which are lost continue to catch crabs until the trap eventually rusts open. A significant number of crabs could be lost in this manner if enough traps are cut from their buoys.

Netting salmon by means of a net stretched outward from the shoreline is a popular form of fishing in the Gravina area. This activity could be impaired as a result of waves generated by the passage of tankers close to these fishing areas. This wave action could be of sufficient force to damage the nets and other related gear left on the beach.

7. Vegetation

a. Construction

I. Preparation of Right-of-Way

The first major impact on the vegetation of Alaska would occur along the proposed pipeline route during the preparation of the right-of-way for construction. For initial construction, a 150-foot wide, 809-mile long right-of-way totaling 14,712 acres would be required. An additional 1,475 acres would be temporarily utilized for construction of compressor stations, maintenance facilities, and the LNG facility. All brush and trees encountered along the pipeline right-of-way would be hand cleared. The work and spoil pads would then be constructed by pushing snow from along the right-of-way into piles next to the pipeline ditch. The applicant has stated that in the event of an early snowfall the snow along the right-of-way would be cleared using rubber-tired, low-ground pressure vehicles, with snowplow attachments, to accelerate freezing of the active layer. Where the terrain must be leveled by ripping and blading, the snow cover and organic surface layer would be removed and stockpiled.

The impacts caused by this portion of the right-of-way construction include the complete destruction of shrubs and trees, the disturbance and reduction in numbers of herbs and thalloid plants due to vehicular traffic and blading of snow, and an increase in the active layer due to reduced albedo and compaction of the organic surface layer resulting in reduced insulation. The amount of increase in the active layer is dependent on the vegetation type disturbed, the type of soil involved, the time of year and the intensity of disturbance. The change in the thermal balance caused by the removal or reduction of vegetative cover would result in thermokarst subsidence, slumping, rutting and other types of permafrost degradation. Once initiated these processes are long lasting and difficult to control.

The short-term effects of a snow road have been documented by Adam (1973). An ice-capped snow road and an ice road were subjected to the total load that would be expected from a pipeline spread. The amount of plant cover remaining was determined to be 10 percent under the road as opposed to a larger coverage of 45 percent on cleared areas where there was no traffic. Thaw was found to be 65 percent deeper on the road. The peat layer was undisturbed but about 25 percent more dense. Adam found that the roads withstood the tests without major signs of degradation or instability in the first summer. If properly built and maintained, snow roads should expose little mineral soil on level ground, but the ability of these roads to prevent damage on steep slopes has not yet been proven (Hernandez 1974).

Table 28 is a summary of the impacts on the right-of-way caused by construction.

The applicant has proposed to dispose of slash from the hand clearing of trees and shrubs by mulching. The proposed advantages of this method are that it minimizes the potential for outbreaks of insects such as bark beetles, it reduces the possibility of wildfire, it restores nutrients to the forest floor, and possibly provide some insulation.

II. Trench Construction

Because the majority of the pipeline construction would be done in winter the soil would be frozen solid. The applicant has stated that the so-called "super ditchers" would only be used in selected situations due to their uneconomical operation. Ditching would be accomplished by a combination of blasting and excavating with backhoes. The organic layer would be removed separately and stockpiled until the backfilling operation begins.

Any vegetation found in the trench in the form of roots or stems would not be expected to survive the blasting and excavating, and the exposure to low air temperatures. Approximately 77 percent of the route would require blasting. In addition, the backfill would be graded and contoured increasing the likelihood of very little vegetation surviving the ditching process.

III. Revegetation

The need for rapid revegetation is an important part of any pipeline construction. This is most important in Alaska which has an environment unique from any other found in the United States. From the tundra on the north coast, which can be described as an arctic desert which each summer is covered with a vast profusion of mosses, grasses and herbs; through the interior tiaga, where in the northern reaches it may take a spruce 30 years to reach 5 feet; to the south coastal region characterized by lush forests covered with pendulant moss; the vegetation of Alaska is a complex entity requiring special consideration before any type of construction is begun.

There are several reasons to restore vegetation to the pipeline right-of-way. One reason is to help control soil erosion. This would be extremely important in the Prince William Sound area where the amount of rainfall is quite large. The chance of a heavy spring rain causing extensive damage before the seeded grass had an opportunity to grow would be extremely likely. Another reason would be to help restore the natural thermal energy budget of the soil and to slow down the rate of permafrost degradation

TABLE 28 Summary of Impact (From How 1974)

PIPELINE SECTION: Casual Factor	Mechanism of Impact	Possible Consequence	South of Latitude 65° Severity of Problem	North of Latitude 65° Severity of Problem
Clearing	Removes trees and shrubs; compresses peat slightly; results in increased depth of thaw	Thermokarst subsidence ponding and slumping	Minor subsidence; local slumping	Minor subsidence
Grading (cut)	Exposes mineral soil to increased heat input; increases rate and depth of thaw	Subsidence, slumping, and gullying	Gullying by mechanical erosion; minor subsisdence	Subsidence, slumping, and gullying (active for more than 5 years)
Traffic on Winter Road	Reduces vegetation cover, compresses peat layer, and increases depth of thaw	Subsidence, ponding, and slumping	Minor subsidence; local ponding and slumping	Short-term effects - minor subsidence and ponding Long-term effects - uncertain
Traffic in Summer	Compresses, damages, and strips off peat layer; increases rate and depth of thaw	Rutting, thermokarst subsidence, ponding, and slumping	Minor subsidence; mechanical erosion of slopes to form gullies	Short-term effects of multiple passes of LPG vehicles - rutting and subsidence Long-Term effects - subsidence, gullying, and slumping

that would occur when the vegetative mat is disturbed during construction. A third reason for revegetation would be to help diminish the esthetic impact of the 809-mile long right-of-way scar that would run the length of Alaska paralleling the oil pipeline.

The applicant has not provided a definitive plan for revegetation of the pipeline right-of-way. The applicant has stated that it is committed to revegetation of all disturbed areas and that it would rely on the information and experience gained by the Alyeska oil pipeline project.

b. Operation

i. Effects of a Chilled Pipeline

Following the completion of the construction phase of the proposed project natural gas at a temperature lower than 32°F and higher than the dew point of the gas would flow through the pipeline. The chilled gas would cause a frostbulb, an egg shaped ring of frozen earth, to surround the pipeline. The frostbulb would reduce the amount of thaw of the active layer which would limit root growth, limit nutrient release, and lower the soil temperature. Any vegetation over the pipeline that had become established might not be able to survive the change in growing conditions. In any case, the frostbulb would probably prolong the time needed for successful revegetation to take place.

The frostbulb around the pipeline would also reduce or stop completely subsurface movement of groundwater. In permafrost areas the waterflow would be concentrated and ponded on the upslope side of the frostbulb. These artifically formed ponds or wet areas would drown existing vegetation that could not adapt to the changing environment. The opposite effect would occur on the downslope side where the blockage of water would change the growing conditions to a drier type. In non-permafrost areas the frostbulb would not act as a complete barrier as in permafrost regions, but would change the natural drainage patterns so that the water would go over, under, or along the pipeline. Water that would flow along the pipeline would erode channels. In winter, any water that would be forced up and over the pipeline berm would freeze, thereby changing existing drainage patterns and smothering vegetation in a blanket of ice.

The effectiveness of culverts and granular fills which are intended to allow normal drainage is questionable. G.T.S. How (1974) has stated that culverts are frequently blocked by icings. Finell and Johnston (1973) reported that in cold permafrost areas, coarse granular fill intended to allow seepage of water through roads became ice-choked in 3 years.

ii. Right-of-Way Maintenance

Of the 150-foot right-of-way needed for construction 53.5 feet would be retained as a permanent right-of-way. The rest of the right-of-way would be allowed to regrow and follow natural successional stages. During the life of the proposed project some means of shrub control would probably need to be formulated for certain areas of the pipeline. An abandoned road near Normal Wells in Canada built about 1945 now supports dense stands of willow, alder, poplar and occasionally birch along the roadside and cleared areas around abandoned camps. Some of the poplars have grown to heights of 25 feet and are 19 to 24 years old (Hernandez 1974). The same type of regrowth can be expected in similar areas of Alaska. The applicant has stated that to ensure good visibility of the pipeline route during aerial patrol for leak detection, and to permit access to repair and maintenance crews, any shrub growth along the permanent right-of-way would be eliminated. In addition, the vegetation controlled areas along the pipeline and around compressor stations would provide a buffer zone for protection against wildfires which are common in the interior of Alaska. The applicant has stated that herbicides may be used during the life of the project if no other suitable alternatives are found for shrub control. The removal of shrubs would prevent normal succession and maintain the vegetation at a lower successional stage.

iii. Emissions

There has been little work done on the long-term impact of air pollutants on the arctic and subarctic environments of Alaska. One problem that appears likely to occur and might already have started due to the extensive gas and oil gathering facilities is that of degradation of lichen by emissions of sulfur dioxide (SO_2). It has been known for a long time that lichen was sensitive to SO_2, but not until recently was the sensitivity measures and the mechanism explained.

The reaction of lichen to low concentrations of SO_2 was measured by LeBlanc and Rao (1973). They found that when the average concentration of SO_2 for 1 year averaged above .03 ppm there was acute damage to epiphytic lichen, between .03-.006 ppm chronic damage occurred, and below .002 ppm no damage. Long exposures to .05 ppm of sulfur dioxide are considered damaging to fruitcose Cladonia lichen (Schofield and Hamilton 1970) which is one of the most abundant lichen types in Alaska. It is known that lichen absorb moisture and elements from the air. The elements are accumulated in the lichen so that even small concentrations of pollutants would, over a long period, become concentrated in the cells. When exposed to SO_2 the lichen first absorb and then oxidize it into sulfuric acid. This chemical directly inhibits photosynthesis. As the concentration increases with time, the plant is unable to produce enough food and slowly dies. This process is enhanced by the presence of fog and ice-fog. The sulfur dioxide is scavenged by the water and ice droplets and directly deposited on the lichen and absorbed. This was proven experimentally by Rao and LeBlanc (1966) who found that the amount of sulfate in lichens increased with increased humidity. The possibility of dangerous concentrations occuring due to emissions from compressor stations, gas gathering facilities and other facilities exists in Alaska due to the high incidence of fogs, calms and inversions which would concentrate SO_2 emissions and thus damage lichen communities. At Barrow in northern Alaska the long-term annual average of days with heavy fog is 65 with most occurring in summer. In addition, there would be little mixing of pollutants in the tundra because of the flatness of the terrain and the low growing vegetation which offers minimal resistance to winds. So while it would appear from first glance that the .5 ppm peak emission rate from a compressor station is small and well within the standard for Alaska, the unusual nature of the Alaskan environment and the extreme sensitivity of lichen to sulfur dioxide would cause large-scale reduction in lichen communities during the operation of this proposed pipeline. Loss of lichen would have a detrimental impact on caribou populations since lichen is their primary winter food. Impacts on caribou populations would in turn affect any Alaskan natives who still depend on the caribou for sustenance.

iv. Emergency Repairs

The maximum impact of emergency repair service on the pipeline right-of-way would occur in the summer months when the gravel is not completely frozen. The different types of plant communities along the route would be impacted in various degrees depending on their sensitivity to disturbance. For example, in the tundra regions the wet vegetation communities are the most susceptible to disturbance of the types found there. The applicant has stated that all terrain vehicles would be the primary mode of travel to the repair area. If damage to the vegetation would be too severe with the use of these vehicles then helicopters would be used to ferry men and machinery to the repair site. From any one of the four proposed maintenance bases a maximum of 150 miles would be traveled to any site on the pipeline. The impacts associated with all-terrain vehicle traffic would include increased depth of the active layer due to the compaction of the peat layer and resulting loss of insulation. The thawed layer would be peeled off and underlying ice exposed where vehicles pass over the crests of hills and ridges. This would induce rutting and gullying down the slopes of the ridges. Where the all-terrain vehicles cross watercourses, bank erosion, thawing of frozen soil, and slumping would occur. The applicant has stated that damage caused by emergency repair would be corrected immediately and revegetated to as near the original condition as possible.

8. Impacts on Wildlife

The impacts of the proposed El Paso gas pipeline route would be expected to approach in nature those impacts encountered in the construction of the Alyeska oil pipeline which would be paralleled for the greater portion of its route. As in any such linear construction proposal the range of wildlife impacts would be great, and proportional to the diversity of the habitat traversed. The significance of impacts from pipelines in general is often regarded as minor due to the limited area (in this case, that of the right-of-way) involved. However, increasing concern has recently been voiced about the possibility of cumulative or synergistic effects in relation to the Alyeska pipeline and the El Paso proposal. Cumulative impacts could be expected from such facilities or requirements as borrow and spoil areas, human intrusion, water requirements, etc., the impacts of which will likely double existing pipeline effects. Initial and supposedly temporary impacts (i.e., the oil pipeline) would become prolonged and as a result more permanent. Certain impacted areas could be expected to recover over the short term; however, as time passes these areas would become less capable of reverting to their original condition. The location of the proposed pipeline completely underground would pose significant differences over the largely aboveground oil pipeline. For instance, no barriers to migrating wildlife would be created.

The generalizations above apply directly to the wildlife affected by the El Paso proposal because the well-being of the various populations of wildlife is a direct function of its habitat upon which impacts will be most direct. Many impacts hypothesized in the evaluation of the Alyeska oil pipeline are now known and likewise certain of the expected impacts have been proven unfounded. Still to be determined are such things as the length of time for impact recovery, actual operational impacts and the relative values of the mitigative and protective measures taken. In any case much has and will continue to be learned in the course of the oil pipeline construction and operation. These experiences can be projected and applied to the gas pipeline proposal with a good deal of reliability and result in improved methods of impact identification, prevention and mitigation. The result can be expected to minimize wildlife impacts over those encountered in the pioneer venture of the Alyeska proposal.

a. Mammals

The construction of the proposed El Paso pipeline system would affect wildlife populations through: (1) direct and indirect harassment or project-caused disturbance during critical periods of animal life cycles, (2) increased harassment and/or destruction of wildlife because of improved access to areas; (3) the introduction of pollutants to the ecosystem; (4) the inability of certain species of wildlife to adapt to man's presence; and (5) the direct or indirect destruction of wildlife habitats. Because this route would closely parallel the Alyeska oil pipeline, many of the impacts, e.g., noise and pollutants from gas compressor sites added to noise and pollutants from oil pump stations, would be cumulative. Because there is no precedent for such a combination of petroleum products transportation systems, the additive effects, while based on best judgment, are mainly speculative.

i. Caribou

The proposed route passes between the areas normally occupied by the Arctic Caribou herd (approximately 100,000 animals) and the Porcupine Caribou herd (110,000 animals). Animals from the two herds mingle on their wintering areas south of the Brooks Range and may use some of the same passes to travel to their calving and summer ranges on the Arctic Slope. The primary calving and summer areas of these two herds are west (Arctic herd) and east (Porcupine herd) of the route. A small group of about 5,000 caribou known as the Central Brooks Range herd is located between these herds and uses calving areas in the vicinity of Prudhoe Bay.

The route also crosses the spring-fall migration route of the Nelchina Caribou herd (less than 20,000 animals). During some years, the Nelchina Basin is an important wintering area.

Caribou are characteristically migratory throughout their ranges in Alaska and their well-being depends upon these movements. Although migration routes of caribou show some variation from year to year, there is a general consistency in areas traveled and in their timing. Obstruction to their movements, which could result in substantial delays or failure of the animals to reach traditional calving or seasonal grazing areas, would also likely alter the distribution of caribou in the future and account for the abandonment of portions of their range, to the detriment of the population.

Snow fences proposed to collect snow for temporary roads could become temporary barriers to seasonal caribou movements to the calving grounds in the spring and toward the wintering areas in the fall. The pipeline berm, and road and airfield embankments, would remain as permanent features of the landscape and potential threats to free movement of caribou.

If the pipeline facilities should cause any of the three herds to abandon its calving area, the herd might not be successful in calving elsewhere, and become incapable of maintaining its present numbers.

Another primary impact of pipeline construction and operation would be the reduction of caribou habitat because of the construction of permanent roads, airfields, compressor stations, communications sites, borrow pits, and other related structures; and the impact of these facilities on caribou behavior. The actual loss of forage plants can be considered minor in relation to the range now available. The presence of roads, structures, vehicles, compressor noise, and people would cause a larger, but unknown, area temporarily unattractive and unavailable to caribou. Spilled fuel and other pollutants would have severe site-specific effects on caribou forage plants, and sulfur dioxide exhaust emissions from compressor stations and campsites would have local detrimental effects on lichens utilized by caribou.

Summer pipeline repair and maintenance activities would increase the amount of caribou range disturbed and/or destroyed, but these impacts would be local. The extent of impact would depend on the length of line to be repaired and the amount of time taken to repair it.

The most severe primary impacts as a result of the proposed pipeline would be those affecting caribou behavior and population dynamics rather than habitat.

Winter construction activities would have a direct effect on individual caribou. The Porcupine and Arctic herds would be particularly affected. The structures built during the winter would remain to influence animal behavior at other times of the year, and indirectly, the herds' population.

Fixed-wing and helicopter aircraft would constitute a disturbance to caribou at all seasons. Caribou generally do not flee from aircraft flown above 500 feet, but they still experience fright reactions.

Aircraft disturbance would be experienced year-round and would be concentrated at the airstrips and helicopter landing pads. Disturbance during the summer by low-flying aircraft would affect a great number of animals, but it is the harassment of the caribou encountered in winter that can have the worst direct impacts on individual animals. In mid-winter, when the daily energy balance of a caribou is low, harassment by aircraft, snowmachine, or other project-associated vehicles could cause the animal to expend more energy that it could acquire from the available forage, thus placing the animal at a net energy deficit. Repeated harassment could result in the death of that individual. In the summer, disturbance by aircraft would be most critical during the calving period.

Another adverse effect includes increased access to a herd leading to increased hunting. There is no reason to expect that the improved access to areas associated with the proposed pipeline would produce other effects.

ii. Moose

Moose are abundant in some areas north of the Brooks Range. They concentrate in the riparian brush areas along stream bottoms during the winter and spread out over much of the Arctic Slope whenever they can find browse during the summer.

Moose are more numerous, though not abundant, in the Yukon River Basin. Here, also, they concentrate in willow covered stream bottoms during the winter and spread out on the countryside in the summer.

In the Copper River Basin, moose are abundant but south of Thompson Pass, moose are scarce because of the lack of suitable habitats.

During the winter moose concentrate in willow thickets along the major streams where they browse the buds and twigs of willow. Each borrow pit, road, pipeline, or other facility which crosses a stream or encroaches on the riparian willow thickets would reduce the winter food available to moose. Since natural winter range is already in short supply and the natural supplies have been further reduced by oil pipeline material sites, any further reduction would have a cumulative adverse impact on the moose population. If snow is collected to construct temporary roads from these streamside willow thickets, the damage done to the shrubs would also have an adverse impact on winter food for the moose.

Winter construction activities, besides destroying critical habitat may also disturb the moose gathered in the river valleys enough to displace them from the area. On an already limited range, this disturbance and displacement may adversely affect the individual's energy balance and subsequently may result in death.

While not considered migratory in the same sense as caribou, moose do undertake seasonal movements. Any obstruction of these seasonal movements as a result of pipeline construction and operation would reduce the efficient utilization of their habitat and could isolate essential components of their range which may result in a reduction of animal numbers.

iii. Dall Sheep

Dall sheep in the Brooks Range tend to concentrate in winter and spring on south-facing slopes in areas of reduced snow accumulation. Two such areas are immediately adjacent to this proposed system. They are the north side of Atigun Canyon and at the head of Dietrich River near the Chanadalar Shelf. Lambing also takes place in those areas. Mineral licks, used by the sheep in spring and early summer, are also located very near the proposed pipeline right-of-way. Mountain sheep populations utilizing these areas would experience considerable stress even under the best of construction and pipeline operation conditions. Past pipeline activities associated with Alyeska construction would already have had an adverse effect on these animals.

The Isabel Pass area in the Alaska Range is also known for its population of Dall sheep. The Wrangell and Chugach Mountains support good populations of sheep, with mountain goats replacing sheep from Thompson Pass south.

Sheep and goats in these areas generally occupy mountainous terrain unsuitable for pipeline construction and thus would not be directly displaced by pipeline construction activities. Nevertheless, a most serious and direct effect of pipeline activities would come from aircraft flights associated with construction and maintenance activities.

Sheep are usually frightened by aircraft. The noise is probably the main reason (Price, 1972), but the sight of the airplane may also play a role. Such disturbances disrupt normal behavior patterns and generate physiological stress. The significance of disruption of behavior patterns on the well-being of Dall sheep has not been fully evaluated, but it is known that disturbance immediately following birth can result in a substantial decrease in survival of the newborn young (Pitzman, 1970; Klein, 1973).

The reaction of goats to aircraft is largely unknown but is thought to be similar to that of sheep.

iv. Buffalo and Musk Oxen

Two small herds of buffalo inhabit areas adjacent to this pipeline route. One herd (200+ animals) is centered near Big Delta and the other (150+ animals) in the Copper River Basin near Copper Center.

The Primary impact of proposed construction and operation of the pipeline would be disturbance of these animals during critical periods of the year. Harassment by ground vehicles or aircraft especially during calving or wintering periods would be harmful to the herds well-being.

Most of these herds' range is far enough removed from the line so that actual reduction of food sources should be no problem. Attempts to re-establish musk oxen populations have resulted in musk oxen transplants in various locations throughout the state. One such population is noted to occur some 35 to 40 miles from the pipeline route. While construction is not expected to affect this herd its location should be avoided by any and all aspects of the construction proposal.

v. Deer

A small population of Sitka black-tailed deer inhabit the forested areas in Prince William Sound from the timberline in the summer to the beach areas in winter.

Construction of the pipeline to Gravina Point and the larger development there for liquifying and shipping the natural gas will reduce habitat for these deer and make them more vulnerable to hunting through increased access.

vi. Wolf

Wolves are present throughout the area of this proposed transmission system. Numbers depend on availability of prey species, time of year and presence of suitable denning areas. Construction and operation of the proposed pipeline would have adverse primary and secondary impacts on the wolf population and its habitat.

The primary impact of construction activities on wolf habitat would be the loss of choice den sites found in areas chosen as upland borrow sites for road and airfield and other materials. This impact would be significant in combination with the areas in the region already destroyed or otherwise made unusable by the construction of the Alyeska oil pipeline in the pipeline corridor.

Wolf dens are often used year after year because of the difficulties of digging in permafrost soils. Any construction or pipeline operation activity within sight, or hearing, of these established dens could cause their residents to abandon the den and avoid the sites as long as the human presence persists.

The presence of a large number of humans, particularly where very few have ventured in the past have direct effects on populations of wilderness species such as wolves, grizzly bear and wolverine. Wolves are vulnerable to hazing by airplanes and snowmobiles and increased hunting, and some individuals may be attracted to edible refuse and ultimately become somewhat dependent on such food sources.

Increased access to the area, and increased human presence would likely intensify hunting pressure and also increase the likelihood of illegal killing of wolves by those seeking such a trophy. Since wolves do not generally migrate out of an area, or hibernate during the winter they are exposed to harassment and hunting year around and would probably suffer their greatest losses during the winter seasons when the pipeline and ancillary facilities are to be built.

vii. Furbearers

Among the furbearers along the proposed pipeline route are Arctic and red fox, wolverine, martin, lynx, weasel, beaver, river otter, muskrat, and mink.

Impacts of construction and operation of the alternative pipeline would be to (1) reduce habitat by physically changing it, e.g., destroying denning areas or polluting waterways or feeding areas necessary for survival and (2) increase accessibility and making these animals more vulnerable to hunters and trappers.

viii. Bear

Polar bears inhabit only that portion of the Arctic Slope nearest the Beaufort Sea. Because of earlier development activities polar bears may no longer use the area associated with this gas transmission system on a regular basis.

Grizzly bear may be found throughout the area traversed by the proposed pipeline. That portion of the pipeline roughly between MP 780 and MP 800 would pass through intensive use areas, particularly along streams where bears congregate to fish for salmon. Since construction in this area is planned for the summer months, bears may be driven from these intensive use areas during the critical salmon runs. Grizzly bear do not tolerate human presence well and will suffer reduced numbers wherever human intrusion takes place. A few will be attracted to garbage dumps associated with the pipeline and some may even become accustomed to accepting handouts from construction personnel. Such feeding habits, as well as presence of humans in bear concentration areas, will tend to increase the probability that humans will be injured and that bears will have to be removed or destroyed.

Black bear are present in the area south of the Brooks Range. The greatest number are located in the heavily forested areas in the Fairbanks area and the Copper River Drainage.

While black bear are somewhat more tolerant of human activities than grizzly bear, they also tend to make more of a nuisance of themselves. Because of this and a certain trophy value, the construction and operation of this proposed pipeline could have an adverse effect on their numbers.

ix. Small Mammals

Throughout the area that would be affected by this route are a large variety of small mammals including shrews, voles, squirrels, hares, lemmings, marmots, pikas, etc. Construction of the gas transmission system would result in a reduction of habitat for these small mammals, thereby reducing their numbers. This could have the secondary effect of reducing the population of larger predators dependent on the species. The loss of habitat and population reduction would have different implications for each of the small mammal species, but this can be considered insignificant in relation to the amount of such habitat and numbers of small mammals resident in Alaska. Even the loss of this food source to the carnivore population is likely to have less effect on the carnivores than would the presence of human activities in their territories.

b. Birds

Approximately 352 species of birds can be found at some time of year in Alaska. Because of the wide range of habitats that the construction and operation of this gas transmission system would pass through, a large percentage of these species would be affected.

Potential conflicts between the proposed construction and bird populations can occur from disturbance, habitat destruction, pollution, and direct mortality. Some of these impacts are unavoidable. Many can be avoided, depending on the location of various facilities, construction practices, and scheduling of activities. Among the major potential impacts which could be avoided are those caused by aircraft and human presence at certain critical times.

The construction phase of this proposed gas pipeline system would not be devastating to bird populations in general, but it would contribute to an ever-increasing attrition of birds through exploitation and deprivation of habitat. This would be in addition to the habitat lost through construction of the Alyeska oil pipeline.

Oil and other pollutant spills occuring on land or water because of construction or maintenance procedures are detrimental to birds and their habitat. This threat cannot be evaluated, because the effect of spills would be related to the location and volume, and to the season of the year. Migratory birds that are adaptively restricted to coastal habitat are especially vulnerable to pollutants entering the Beaufort Sea from either the construction or operation of this pipeline system.

The proposed pipeline traverses several major and many minor drainages flowing into internationally important waterfowl production areas. Pollutants unintentionally discharged in and remaining within the drainages of the Sagavanirktok, Koyukuk, Yukon, Tanana, and Copper River could damage habitat and kill waterbirds unique to these areas. The occurrence of such events cannot be predicted nor the results evaluated because of the uncertainties involved. (USDOI, 1972).

One aspect of spilled and pooled oil affects birds specifically; birds are attracted to pools on the ground, shore or ice. Oil sumps are known to take a toll of ducks, shorebirds, songbirds and even raptors (King, 1953; Bloch, 1964). Waters that are polluted may be the first to become ice-free in the spring, because of the "black body effect," and attract early migrants.

Disturbance would probably drive away, at least temporarily, all birds from the sites of construction activity and some birds from adjacent areas. Although the tolerance of birds to disturbance varies with species, season, stage of nesting and type of disturbance it has never been quantified. Observations suggest, however, that geese, swans, loons, cranes, and raptors are generally less tolerant of disturbance than most small passerines, shorebirds, and some ducks. (USDOI, 1972).

Some species may adapt to new and increased disturbance, whereas the detrimental effects of increased disturbance could be cumulative on other more sensitive species, such as nesting whistling swans or raptors. The area of disturbance in this case would have already been disturbed by the construction and operation of the Alyeskan oil pipeline.

Disturbance could increase stress and alter normal behavior patterns during critical life history phases such as spring migration, nesting, molting, or fall migration staging; decrease reproductive success; or cause the birds to desert traditional areas such as molting areas or nesting sites for which there may be no alternative. The impact of disturbance on a particular species is a function of the type and intensity of the disturbance, the time of year, the location, the mobility of the disturbance source, the distribution pattern of the bird, and the species; sensitivity to disturbance. The major sources of disturbances associated with construction and operation of the proposed pipeline are aircraft traffic, construction activities and human presence, permanent facilities and water traffic.

c. Seabirds

Seabirds would be impacted by the same range of effects as the mammals with particular potential threats from "spills" and vapor clouds in the vicinity of the terminal.

It appears that many seabirds could outfly a vapor cloud by gaining altitude, but it is not clear that this is how they would react. Many seabirds are poor fliers and their natural instinct is to escape a hazard by diving and later surfacing to fly away. Also the rapidity with which a large spill propagates leaves some doubt that birds near the origin could outfly its associated effects. In addition, a number of seabirds are flightless for a time after their post nuptial molt. Immature seabirds such as common murres leave their breeding cliffs before they are thermoregulated and before their flight feathers have erupted. If a large spill occurred in an area where short-tailed shearwaters were feeding in the densities reported by Shuntov (1964) there could be as many as 26,500 birds of this species within an impact zone. Another potentially disasterous situation is the possibility of a spill occurring adjacent to a breeding colony.

The construction of a terminal at the Point Gravina site could result in the abandonment of some or all of 16 bald eagle nesting sites known to occur in this area. The terminal itself would not physically displace more than three to four nesting pairs, however the associated high level of vessel traffic would be the critical factor.

The effect of the operation of the seawater cooling system upon seabirds may be to provide an increased food supply. Dead, injured, and disorganized fish traumatized by the hot, briny, chlorine-treated effluent or trapped on the seawater intake screens could be expected to attract greater than normal concentrations of seabirds.

d. Marine Mammals

While the magnitude of environmental impacts in the marine ecosystem appears of minimal potential, marine mammals could be affected by the pool and vapor cloud or fire.

The scale of the impact would be in direct proportion to the number of animals caught within the zone of the spill pool. An unknown aspect of the spill is the speed of propagation of effects of the spill within the water column. It is possible that any of the larger more mobile species could evade the impact.

A sperm whale for example evades danger either by sounding or by swimming rapidly away. Sounding is the most common method of evasion and often when one sounds it is not seen again. Rice has timed one large bull which remained below for 62 minutes. Sperm whales which leave an area by rapidly swimming away usually swim into the wind (Caldwell, et al., 1966). There is little doubt, therefore, that a sperm whale is capable of evading even a large LNG spill. The unknown is the behavior response of a sperm whale caught in a spill zone.

The giant bottle-nosed whale is another species with the physical stamina to evade a spill. Among the other cetaceans there is probably a whole range of ability to evade a spill. Some of the porpoises and other marine mammals such as the sea otter, seals, and sea lions could possibly not avoid such a catastrophe.

The seawater cooling system would probably have little direct effect upon marine mammals since seals, sea lions, and sea otters may be expected to avoid the marine terminal area and its human activities. These animals can swim strongly enough to avoid the intake flow, and it is unlikely that the temperature and chemical content of the discharge flow could harm these warm-blooded, air-breathing animals. Indirect effects related to changes in the local environment and in the distribution of food species may have a more important impact on marine mammals than the direct effects of the heated effluent.

e. Unique Ecosystems

Several "unique area" studies have been conducted during recent years to identify and suggest protection of areas physically and/or biologically in as nearly an undisturbed condition as possible in Alaska prior to land development.

From studies conducted by the University of Alaska and several Federal agencies, the Joint Federal-State Land Use Planning Commission for Alaska recommended in 1973 that: a systematic statewide analysis of nominated Science Research and Natural Areas be undertaken to develop a balanced and representative statewide system of such areas.

Included among nine near the proposed route which were nominated is the Franklin Bluffs site.

The Franklin Bluffs site (size not specified), and a similar site near the town of Sagwon, are located along the Sagavanirktok River. These sites on the bluffs overlooking the river are nesting areas for the endangered Arctic peregrine falcon. Two or three pairs of falcons nest in the Franklin Bluffs area, while two more pairs nest near Sagwon. Nest locations vary from year to year, for the birds may choose from a total of eight or more different eyries at each of the two sites. Nests built by gyrfalcons and rough-legged hawks may be utilized by the falcons as well as the nests built by the falcons themselves. In 1975 the active nests at Franklin Bluffs were located to the east of the Alyeska oil pipeline (the closest is 3/4 mile from this pipeline) and were therefore even further east of the proposed gas pipeline route. At Sagwon one of the active nests was on the east side of the river and about ½ mile from the Alyeska pipeline, but the other active nest was on the west side of the river and may have been near the proposed gas pipeline route (Jim Hemming, personal communication).

Winter construction activities would not directly affect these birds, but they'd be adversely affected by disturbance from aircraft, or human presence, while nesting and raising their young. Thus, spring and summer operations and maintenance activities are most likely to affect the peregrine falcon.

To serve its original purpose as a natural study area this site would have to remain relatively undisturbed.

This site has been somewhat disturbed by the oil pipeline activities and would be subjected to additional disturbance by aircraft along with spring and summer operations and maintenance activities.

f. Endangered Species

The peregrine falcon nesting areas along the Sagavanirktok River at Franklin Bluffs and Sagwon are the only instances where an endangered species may be significantly affected by the proposed project, as noted above. Peregrine falcons also occur in the coastal zone near the marine terminals proposed in Alaska and California, but only as passage migrants. Other endangered species of birds which might come in contact with the marine terminals or LNG ships do not appear to be vulnerable. Short-tailed albatrosses are so rare that the probability of any impact is almost nil.

Southern bald eagles and brown pelicans occur only within the coastal zone of California and would come in contact with inbound LNG carriers only on the final approach to port. Aleutian Canada geese are passage migrants within the region under discussion and would make only fleeting contact with the traffic lanes used by LNG carriers. The probability of endangered birds being in a spill zone is very low.

The eight species of endangered whales which occur within the discussion area could become involved in a spill of LNG but the probability of such an involvement appears to be very low. As pointed out earlier some of the whales are physically capable of evading a spill.

9. Ecological Considerations

The environmental impact expected to occur as a result of the proposed pipeline is, due to its relative uncomparability with any similar undertaking, largely conjectural. The impacts upon the ecosystems are expected to be in general temporary and minor. Specific ecological impacts are discussed in greater detail elsewhere in this statement under the respective resource or category affected. Of most critical concern would be the welfare of rare and endangered plant and wildlife species. None in this category are known to be unavoidably affected. Extensive permafrost regions would be impacted upon; again, the effects remain unknown. Experience gained in the course of the Alyeska oil pipeline venture can be considered the most applicable data to be utilized in avoiding and minimizing significant ecological effects.

10. Impacts on Land Use

The primary gas transmission system starts in the Prudhoe Bay area within the oil development and transmission zone, follows the Federal-State Utility Corridor from its point of inception to an area south of Thompson Pass in the Chugach Mountains, and then proceeds to an LNG plant in the Cordova-Valdez area on Prince William Sound.

The 809 miles of the proposed facility passes through an unimproved wilderness. The first 170 miles, from north to south, would be in the treeless tundra. Another 25 miles of this condition appears in segments as far south as mile post 565. At mile post 170 some small brush and trees are notices. At mile post 190 some trees may be as much as 4-inches in diameter. The height, density and size of brush and trees increase farther southward. Trees with a 12-inch diameter start to appear in the vicinity of mile post 311. The last 33 miles of the proposed facility, in the Chugach National Forest, trees may be as much as 14-inches in diameter.

This route of the proposed facility would change unimproved land to pipeline right-of-way for the duration of the project. It would cross the proposed alignment of the Alyeska gas pipeline a number of places.

The land area which will be utilized on a permanent basis is estimated to be the following:

Twelve compressor station sites	216 acres
Pipeline right-of-way (809.2 miles long and 53.5 feet wide)	5,247 acres
Fifty sites for helicopter pads	10 acres
Fifteen sites for communication facilities	8 acres
Sites for four maintenance bases and two meter stations	26 acres
Sites for permanent storage of spoil from tunnel construction	100 acres
Roads providing continuous access to compressor stations (22 miles long and 50 feet wide)	133 acres

Roads providing access to construction camps and pipe storage yards (50 feet wide and 2 miles in length)	12 acres
Total area permanently removed from present land uses	5,752 acres

For the initial 767 miles this pipeline route would be basically parallel to the Alyeska gas pipeline and/or within the utility corridor designated for industrial land use. The route then passes through about 9 miles of terrain described as rough, sharp, choppy, flat and mountainous that supports dense medium timber to 12-inches in diameter and medium brush and timber to 4-inches in diameter before entering the Chugach National Forest.

The U.S. Forest Service has noted that cruise data available indicates 33,000 board feet per acre in timber stands. Since not all of the 33 miles of the route across the Chugach National Forest is timbered, they estimated that 6,000,000 board feet, or less, of timber would be lost to right-of-way clearing.

Additional land would be required to provide greenbelts for the 12 compressor stations (approximately 504 acres), the 15 sites for communication facilities (approximately 7 acres), and the 4 maintenance bases and 2 meter stations (approximately 9 acres). Such acreage would be utilized to provide additional work space during construction. On a permanent basis, the only maintenance to be performed would consist of minor vegetation control.

In addition to land required on a permanent basis for these facilities, the construction phase of the project would require the temporary use of more land.

About 53.5 feet of the proposed 150-foot wide pipeline right-of-way would be kept clear of tall shrubs and brush after construction is completed. The total additional right-of-way width of 96.5 feet required for construction which amounts to 9,465 acres along the pipeline route could be returned to present uses after construction.

Requirements for additional temporary land use during construction are estimated to be the following:

Additional construction right-of-way on pipeline 96.5 feet wide by 809.2 miles long	9,465 acres
Additional work space required at major river crossings	36 acres
Six construction camps at 22 acres each	132 acres
Borrow pits, quarries and other sources of construction materials	60 acres
Roads providing access to borrow pits, quarries and other sources of construction materials (50 feet wide and 226 miles in length)	1,370 acres
Major pipe storage and double-jointing yards at four locations	
Prudhoe Bay	20 acres
Pipeline Milepost 718	20 acres
Fairbanks	50 acres
Valdez	23 acres
Thirty-six intermediate pipe storage yards spaced at 20-mile intervals along the toute	72 acres
	11,248 acres

Land ownership along this route is State, either patented, tentatively approved, or pending; Federal, under Bureau of Land Management or Forest Service jurisdiction; and Alaskan Native selected, but not approved, under the Alaskan Native Claims Settlement Act.

The Alaska Native Claims Settlement Act provides for transfer of land and minerals to the Alaskan Native regional and village corporations that have identified lands they desire to be transferred.

Table 29 provides an indication of the ownership/jurisdiction along the pipeline.

Table 29

OWNERSHIP/JURISDICTION ALONG THE PIPELINE

Jurisdiction	Miles	Percent
U. S. A.	615.2	76.1
Alaska	56.8	7.0
U. S. A. (Alaska Selection)	41.0	5.0
U. S. Forest Service	34.1	4.2
Varied	26.9	3.3
U. S. Military	17.7	2.2
USAF	10.6	1.3
Undetermined	6.9	.9
TOTAL	809.2	100.0

The Alyeska pipeline project required a large influx of people into portions of Alaska and has served as a catalyst for more land use planning, especially in the more urban areas. This trend would likely be sustained with the development of the natural gas pipeline proposal.

Most of the El Paso route of the pipeline would be constructed within the utility corridor designated for use for the Alyeska Oil Pipeline. In view of this, the impact of such activity on total land use in Alaska, would be minimal. The construction of the facility would require the removal of numerous trees the majority of which are not large or especially desirable as timber products by national standards. Most of the commercially valuable timber is in the southeast and is used in the pulp industry. Although the corridor cuts through some interior forest, it remains to be seen whether new access would establish new logging enterprises.

Alaska requires a permit for entry of heavy equipment on state lands. Generally, heavy equipment is not permitted on the tundra until after the tundra is frozen and can support the vehicle or equipment. Usually, the heavy equipment would be allowed on the tundra from about mid-November to mid-May. In addition, Chapter 96 of Title 11 of the Alaska Administrative Code enumerates other general stipulations to protect the natural resources, e.g., excessive scarring or removal of ground vegetation cover should be avoided and disturbance of draining systems should be minimized.

About 1,200 acres of land in the Chugach National Forest would be required for the LNG plant. The fenced area of the plant would require about 395 acres. Outside of the plant auxiliary facilities would be constructed -- housing (40 acres), marine administration buildings, wastewater treatment facility, LNG plant administration building, a heliport and roads connecting such facilities to the plant. The total land required for these auxiliary facilities is estimated to be 55 acres. The 750-acre greenbelt encompassing nearly all of the land area of the LNG plant will remain basically uncleared; this will help to insulate the plant from possible future development. The 40-acre housing area for about 65 permanent homes would be located about three-fourths of a mile west of the greenbelt. (See Figure 1.3-1.) Each house would contain 2,500 square feet and located on a one-quarter acre site.

Offshore of the LNG plant would be two carrier berths. They would be about 1,200 feet from shore in about 51 feet of water. The overall length of the two berths would be about 2,600 feet, measured parallel to the shoreline. Approximately 115 acres would be required for the offshore facility (including the construction dock and small boat harbor of about 12 acres).

The construction worker would be brought to the site daily by aircraft or barge as there is no road to the area. The applicant does not indicate whether housing for the construction worker would be constructed at the LNG site. At the peak of construction activity about 4,200 workers would be involved. The applicant does however indicate that after the construction period some maintenance personnel will live in the 40-acre housing project just outside of the LNG plant.

Obviously the LNG plant would result in a change in the character of the area. The scene would change from a forested wilderness (and the possible official designation by the Secretary of Agriculture) and timber loss in addition to the estimate for the pipeline, to one of a permanent industrial nature.

Impacts witnessed by the Alyeska venture would likely extend into the effort of construction of the El Paso pipeline and LNG plant. Most of this would be in terms of overcrowding and would be especially noticed in housing, schools, transportation and a short-term decline in the quality of services. (See Volume I, subsection entitled Projected Socioeconomic Impacts in State of Alaska.) One might also expect opportunities to develop for agriculture, forestry, and mineral extractive efforts. After the construction period, the imbalances would gradually stabilize.

Perhaps the most significant impact would be the short term construction of the LNG plant and the pipeline in the Chugach National Forest. The serenity of the Forest would be disturbed by heavy equipment, cutting, felling and removal of trees, grubbing, burning of rubbish, and noises associated with digging, welding and building construction. Since the National Forest is recognized as a multi-purpose entity the recreational benefit of the Forest would be enhanced by providing an accessibility corridor (the pipeline route), similar to a fire break, into a portion of the Forest. After construction, the impact of such facilities would probably be less than that of a public highway through a national forest in the conterminous United States except for the LNG plant site which would change the land use completely from forest/recreational to industrial.

Some individuals might consider the possible deletion of the wilderness and/or roadless designations from part of the Chugach National Forest, prior to an official designation by the Department of Agriculture, as a long-term adverse impact.

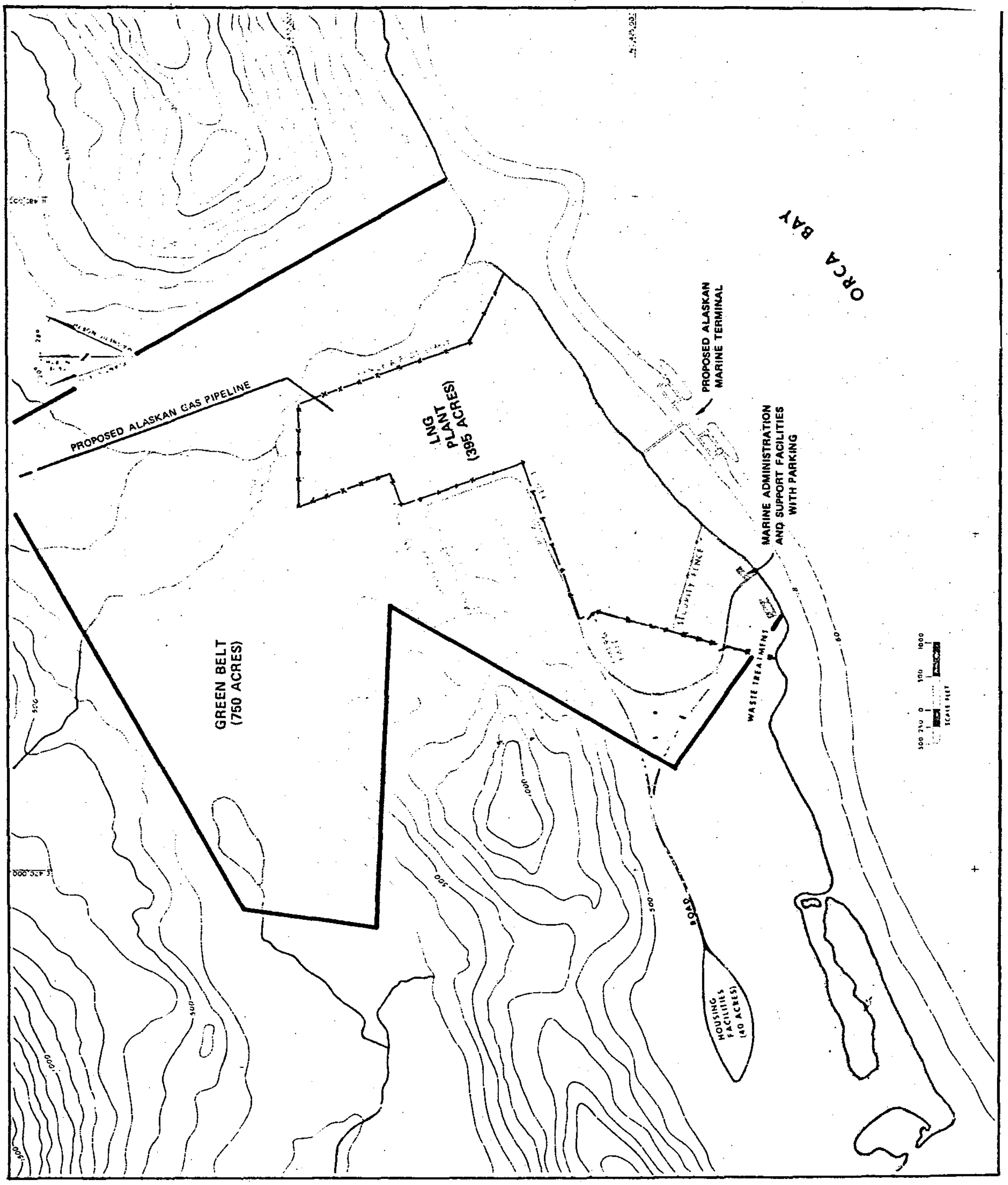


Figure 62A. LNG Plant Land Requirements

11. Archaeological Resources

Any analysis of the impacts of pipeline construction on archaeological resources is limited by several factors. First, the precise alignment of the pipeline has yet to be determined. Second, the existing data is of variable quality with the archaeological reports often differing in format, methodology, descriptive precision, and in the qualifications of the reporters themselves. The result is that frequently the exact nature and locations of reported sites are not ascertainable. Third and most important, no comprehensive field survey has been performed for the pipeline corridor, hence the actual number and locations of the archaeological resources present in the impacted areas cannot be known. Indeed, the consultants to the FPC have estimated that only 6 percent of the potential sites are known, leaving the overwhelming majority of archaeological resources yet to be identified.

While it is impossible to define with any precision the impacts of pipeline construction on Alaskan archaeology, what can be discussed is the nature of the impacts that can be expected along with an assumption of a worst case impact on the archaeological resources. The impacts associated with construction would be both direct and indirect. Direct impacts would arise from the actual construction of the pipeline and its associated facilities: the right-of-way, access roads, compressor stations, borrow areas, the LNG facilities and terminal, and contractors camps and construction yards. The proposed right-of-way would be 150 feet wide with a normal ditch for the pipe of at least seven feet in depth and five to six feet in width. There would be a total of 12 compressor stations, four maintenance bases and the LNG plant and terminals. The activities associated with the construction of these facilities would include trenching, land clearing, the leveling of land in some areas by blasting, ripping and blading and mining for gravel and rock. Such activities would degrade and in many instances destroy any archaeological remains in the affected area.

Indirect impacts would arise from activities outside the actual construction of the pipeline. Foremost among these would be the greater likelihood of site disturbance from souvenir hunters as hitherto remote archaeological sites are exposed to human intrusion. Other indirect impacts could come about through soil creep and erosion or chemical alterations in soils which would affect the integrity of archaeological sites.

Approximately 160 known sites have been located along the proposed pipeline route in a corridor 10 miles wide and 809 miles long. An additional 1,300 potential sites have been estimated within the corridor. Assuming the worst case, approximately

1,460 archaeological sites would be affected directly or indirectly by construction of the pipeline and its appurtenant facilities. However, it is much more likely that far fewer sites would be impacted with serious impacts limited to certain areas. The latter would seem to hold true for two areas. The second segment of the pipeline (see Section B) would pass through areas rich in archaeology and through terrain -- Atigun Pass -- where the feasibility of altering the pipeline route is severely limited. A second area of site concentration appears to be along segment nine from Delta Junction south to Copper Center, although along this route there is more room for rerouting the pipeline.

On the subject of alternative routes, Iroquois strongly recommended against only one, the Anaktuvuk Pass Route (Segment Four). "The seven prehistoric and thirty-five historic sites known from Anaktuvuk Pass represent one of the most complete cultural sequences known from the American Arctic." In addition, the people of the pass live primarily by subsistence hunting little different from their ancestors. As a consequence, invaluable information on the culture of late prehistoric Eskimo hunting bands has been reconstructed from ethnographic and archaeological sources which would be endangered by any pipeline through this area. (Humphrey, et al., Vol. I, pp. 87-88.)

It should be noted, however, that in the case where a comprehensive mitigation program, i.e., survey and salvage, if carried out before and during project construction, the incidence and magnitude of adverse impacts would be greatly reduced. (See Recommendations, Section I.)

12. Historical Resources

The Sourdough Lodge at Sourdough appears to be the only National Register property that may be affected by the pipeline, although the route would pass to the west of the settlement. No other National Register properties appear to be endangered.

The Alaska Heritage Resource Survey lists 65 historic sites and 49 historic trails within the 10 mile by 809 mile pipeline corridor. Impacts of construction on these sites could result in the destruction of some or, in cases where compressor stations or maintenance yards are located nearby, in the permanent alteration of the environments around these sites. Since the pipeline would be buried much of the visual impact with the exception noted above would be short term, limited to duration of construction. In some cases however, where sites are in wooded areas for instance, the land clearing of the right-of-way would produce a more permanent visual intrusion.

13. Recreation and Aesthetics

a. Recreation

This transmission system would extend from Prudhoe Bay to Gravina Point through an existing utility corridor for most of its length and through an unoccupied area of the Chugach National Forest for the remainder.

Recreational use along the road associated with this route from Livingood south to the Valdez area is heavy, as reflected in Section B. The recreation facilities are primarily highway oriented and many more are proposed (see Section B). From Fairbanks north to the Yukon River, recreation use has been increasing rapidly because a portion of the oil pipeline road was constructed several years ago and is open to traffic.

The area from the Yukon River north to Prudhoe Bay has only seen light recreational use, consisting of fly-in type recreation, primarily for hunting and fishing. When the new road associated with the TAPS Project is open to the public recreation use along this scenic route is expected to increase.

The proposed gas pipeline route runs parallel to, or a few miles away from, the main road along its route. Lateral access roads from the existing highway to the proposed route would, if open to the public, very likely be used by recreationists. This access would extend the area and amount of use that already exists and could significantly increase the recreational opportunities.

During construction, there would be moderate recreational use of areas along the pipeline by construction workers. Desirable recreation for travelers and vacationers on highways along the route might be temporarily altered during the construction period. Most of the recreation activity would occur in the late spring, summer, and early fall months. However, there would be some increase use even in the winter months where roads are kept open and maintained.

Recreation use includes hunting, fishing, boating, hiking, mountain climbing, cross-country skiing, snowmobiles, sightseeing, photography, and other similar related activities. Unless steps are taken to provide adequate recreation facilities, campgrounds, picnic areas, overlooks, boat access sites, trail leads, parking areas, turnouts and rest stops, damage to the terrain from uncontrolled recreation use and a general degradation of recreation and aesthetics could result.

Unregulated use by all-terrain vehicles, trail bikes, snowmobiles, and other off-road-vehicles could have a significant adverse impact on recreation and aesthetics by permanently scarring the landscape, damaging the vegetation, compacting the soil, causing erosion, and harassing the wildlife.

With increased awareness of recreational opportunities created by pipeline-related activity, there would be increased recreational use and demand for recreational facilities with the attendant impacts described above. It is anticipated that this will also be reflected in the 1975 Alaska Staff Comprehensive Outdoor Recreation Plan (SCORP) when it is released. New recreational resources would be discovered with resulting demands for exploitation and/or preservation. Impacts on the Chugach National Forest would include increased recreation use and demand for facilities which would be in the direction of achieving a multi-purpose justification for the Forest.

Project increased recreational use assumes that gas pipeline construction and operation would bring increased potential for recreational use of the area because increased numbers of people will become aware of the recreational possibilities of the area through publicity and personal association (employees). Assuming that increased use would bring increased control, recreationists might experience such things as reservation systems, reduced options for types of experiences, and restrictions on places they may go and their length of stay.

A more direct impact of the construction of the alternative pipeline on the recreation resource would be the scars resulting from the buried pipeline construction or the visual impact if certain areas had to be located aboveground. In all cases this gas pipeline would be at least a "third" utility to be located in a corridor area, consequently it is not like building a new line across an area previously undisturbed by man.

Nearly all the proposed line south of the Brooks Range would require the clearing of brush and forest cover. This would significantly alter the natural environment and would degrade recreation value of the corridor particularly where long straight clearings are visible from the road.

Recreationists within several miles of the line would have their recreational experience affected by increased noise levels from construction and operation of the line. Noises would result from blasting (temporary and short-term), aircraft, vehicle, and compressor operation (nearly continuous and lasting throughout the life of the pipeline).

Such facilities as the communications towers, buildings at compressor sites, the block valves ports, etc., would be visible from the ground for great distances. At times, even the pipeline mound would be visible from great distances to those hiking in the mountains. Lights on communications towers and at compressor stations would be visible over long distances at night.

The regular (i.e., non-natural) shape of compressor site gravel pads, airstrips, and roads would give man-made appearance to the present natural landscape.

The degree of acceptance of many of these impacts would vary according to the individual perceiving them. For example, the presence of pipeline-related airstrips would be considered desirable by reactionists who feel this "safety feature" in emergency situations is necessary to a reasonable recreational experience. Airstrips would be adverse for those wishing maximum wilderness as a part of their recreational experience.

Without defined trails (the present situation), it is possible that hikers and skiers would pass over borrow pits, access roads, quarries, and other off-the-pipeline right-of-way disturbances as well as the pipeline itself. Those passing over the pipeline would see the exotic plants used to stabilize the pipeline ground cover.

Boaters on and hikers near rivers might notice places where the pipeline crosses rivers and might have their recreational experience affected by barge traffic and gravel extraction sites.

Artificial odors would be evident from engine exhausts, fuel areas, and camps.

It is expected that air quality would be affected by the operation of the construction equipment. The release of water vapor from the construction and operation activities would probably be sufficient to create periodic fogging and icing conditions in and adjacent to the pipeline right-of-way and maintenance station pads.

Game populations would be affected by the construction and operation of the proposed project and by increased pressure from hunting and/or "viewing" harassment. This would reduce the total numbers available and reduce the recreational potential of the area.

The impact of the pipeline activity would serve as a catalyst to open-up many planned and unplanned frontiers of recreation opportunities and experiences for people who would be attracted to the area because of increased access.

Increased visitation would bring increased costs to taxpayers. These costs, however, could be offset or eliminated by increased tax revenues created by increased income in the tourism sector of the economy and by the benefits of recreation to an increased number of people.

b. Aesthetics

This transmission system would be built in a utility corridor, with an existing road, railroad or with other utilities except where it crossed the undeveloped area of the Chugach National Forest. Aesthetic impacts would be significant in the forest.

The traveler using the main State ferry and tourship routes in the Prince William Sound would be aware of the snow-capped mountain peaks, Sitka spruce and fishing and crabbing activities. As the vessel travels near Orca Inlet, one might notice construction of the LNG plant. After the construction period, one would see the LNG plant and tankers at the marine terminal or underway.

Many of the aesthetic impacts have already been discussed under recreation. The major impact to many people would be those features seen from the air, during hiking, driving on the main roads, and boating on rivers and inlets. These would include the long straight clearing along rights-of-way, compressor stations, special stream crossing facilities and any borrow areas that are not hidden from view.

For those people whose appreciation of aesthetic qualities are those related to beauty, pure feels or sensations, or to the congruity of the environmental features, the proposed project would have a significant adverse effect on the resource.

14. Impacts on Air and Noise Quality

a. Increased Air Pollutants

The gaseous pollutants from compressor stations along the route consist of combustion products, mainly nitrogen oxide and hydrocarbons. There may be intermittent emissions of hydrocarbons particularly methane as a result of leaks, venting and other accidental emissions. Sulfur oxide and particulate emissions from compressor stations are very small. Typical emissions are shown in Table 30.

Table 30

Emissions From Gas-Fired Turbines in Compressor Stations (lbs/MMBTU)

SO_2	0.01
NO_x	0.69
CO	0.04
Particulates	Trace

Since these are within the limits of any known standards of the Alaska Environmental Protection Agency, the applicant has not incorporated any special measures to further mitigate such emissions.

The source parameters for the LNG plant listed in the following table were modeled using the Environmental Protection Agency's Air Quality Display Model.

Table 30A

LNG PLANT

STACK EMISSION SUMMARY FOR AVERAGE OPERATIONS OF EIGHT TRAINS(1)

Service	Total Units Operating	Excess Air % wt.	Stack Height, ft.	Total Heat Input MMBtu/hr (HHV)	Total Flue Gas Rate, MM lb/hr	NO_x (as NO_2) lb/hr (each unit)	NO_x (as NO_2) lb/hr (Total)	NO_x (as NO_2) lb/MMBtu
Gas Turbines for Propane Compressors	8	287	(2)	(2)	(2)	(2)	(2)	(2)
Supplemental Fired Waste Heat Boilers	8	120	150	10,850(3)	13.76	271	2168	0.20(4)
Gas Turbines For Electric Power Generators	6	287	100	1304.1	3.738	150	900	0.69
Regeneration Gas Heaters	8	20	100	111.3	0.106	2.8	22.4	0.20(4)

(1) Stream-day basis (345-day on-stream factor for each train). Operations when loading an LNG tanker make up 40% of the operating time. The fuel gas has a total sulfur content less than 1 grain/100 scf.

(2) Propane compressor turbine exhaust gases are discharged to the supplemental fired waste heat boilers.

(3) The total heat input of 10,850 MMBtu/hr includes a heat input of 4710 MMBtu/hr to the propane compressor gas turbines and a heat input of 6140 MMBtu/hr from supplemental gas firing in the boilers.

(4) Based on waste heat boiler and process heater manufacturers meeting the EPA "New Source Performance Guidelines" of 0.20 lb. NO_x/MMBtu for gaseous fuel burning equipment.

This model will compute the annual average concentration in the locale near the compressor stations. Cordova and Middleton Island are the two nearest meteorological stations to Gravina Point; meteorological data from Cordova was used as input to the program. This meteorological data is listed below:

Table 30B

SUMMARY OF ANNUAL STABILITY WIND ROSES:
CORDOVA, ALASKA; HOURLY OBSERVATIONS, 1959-1962

Stability Class	Mean Wind Speed (knots)	Frequency of Occurrence	Percent Occurrence	Percent Calms
A	(calm)	43	0.01	0.1
B	2.5	1000	2.80	1.3
C	3.6	3272	9.30	3.6
D	6.1	21914	62.50	10.5
E	5.4	1463	4.20	-0-
F	1.4	4001	11.40	7.2
G	0.5	3347	9.60	7.8
Total	4.6	35040	100.00	30.6

Table 30C

SUMMARY OF ANNUAL STABILITY WIND ROSES:
MIDDLETON ISLAND, ALASKA; HOURLY OBSERVATIONS, 1959-1962

Stability Class	Mean Wind Speed (Knots)	Frequency of Occurrence	Percent Occurrence	Percent Calms
A	(calm)	49	.01	0.1
B	4.1	689	2.00	0.4
C	5.3	2074	6.00	1.2
D	13.0	26702	77.00	3.5
E	6.7	2590	7.50	-0-
F	3.2	1976	5.70	1.8
G	0.5	3347	9.60	1.4
Total	11.1	34699	100.00	8.6

Although differences in terrain at those stations and at Gravina Point may lead to significant differences in directional frequency of stability conditions and wind speeds, stability classes and wind speeds probably fall between those of Middleton Island and Cordova. The following assumptions were made in order to carry out the calculations:

1) The emissions of all sources were assumed to come from one point, even though the individual sources were located some distance apart, and

2) Continuous operation at full load was assumed.

The calculated annual average maximum ground level concentration of NO_2 was approximately .001 ppm with all sources operating at the same time, which is well below the ambient standard set for this pollutant.

b. Increased Noise Levels

Compressors would be audible for 6,000 to 7,000 feet and the degree to which their noise annoys people would depend on their location with respect to human habitation. Periodic venting of high-pressure gas from the pipeline and compressor stations would cause temporary, but severe, increases in sound levels. These maintenance checks on emergency blowdowns would occur about once a year and last for 45 minutes on the pipeline and 5 minutes at the compressor.

The noise level from gas blowdown was high and was estimated at a maximum of 140 dB(A) at a distance of 100 feet from the stack. This noise occurs infrequently, however, and with a stack silencer it could be brought down to 80 dB(A).

The additional noise from the gas collection and processing facilities at Prudhoe Bay would contribute to other operations related to oil production.

Where the pipeline passes near towns and farms, construction equipment noise could be quite loud and annoying to many people. There are at present no Federal regulations specifying permissable noise levels for stationary gas turbines.

15) Analysis of Public Safety

The most significant hazard that could occur during the operation of the proposed LNG terminal would be the formation of a combustible vapor cloud and its subsequent dispersion and drift downwind into populated areas. The vapor cloud would be formed as the result of a spill of LNG. The larger the spill, the larger the vapor cloud and the further it could travel downwind over populated areas. A spill could occur over water from an LNG ship collision, or over land from a rupture of an LNG storage tank.

Although there is little actual experience with the hazards to the public from LNG import terminals, there are data available from experiments involving small LNG spills, and analytical techniques for calculating vapor dispersion and drift. There is also available the accident experience involving the marine transportation and land-based storage of other flammable liquids. This material has been used in the analysis given here. Some of the properties of liquid methane, which is the major component of LNG are given in the following table.

Selected Properties of Liquid Methane

Molecular wt. = 16 gm/mol
Density of gas @0^{o}c = 0.717 gm/liter = 0.45 lb/ft^3
Density of gas @112^{o}K = 1.75 gm/liter = 0.11 lb/ft^3
Density of liquid @109^{o}K = 415 gm/liter = 25.9 lb/ft^3
Boiling point = 112^{o}K = -161^{o}c = -260^{o}F
Heat of vaporization = 138 cal/gm = 248 BTU/lb

In order to assess the risk of casualties near the proposed LNG terminal in Prince William Sound, Meteorology Research Inc. has performed an analysis, which is given in Attachment 1. This analysis includes the effects of a massive (2,000,000-gal) LNG spill from the storage tanks at Point Gravina onto water. Plume analyses were made on seasonal and annual bases for this site using climatology data and a Gaussian model for plume dispersion. For 5 mph winds the flammable plume extends about 9 km (5.6 miles) downwind, which is predominantly from the east the year round. The population at risk to such a plume is believed to consist of plant employees, ship personnel, and fishermen in the vicinity, and is estimated to be less than 100 people.

Tanker Operations in Alaska

In order to assess the risk to the public from LNG tanker operations in Alaska, an analysis has been performed, which is presented in Appendix D.

H. ALTERNATIVES TO THE PROPOSED ACTION

This section discusses the alternatives to implementing the proposed project. These alternatives include:

1) Alternate Pipeline Routes
2) Alternate Sites for the LNG Facilities
3) The Alternate of No Action
4) Alternate Modes and Systems
5) Alternate Sources of Energy
6) Energy Conservation

Alternatives 1, 2 and 3 are covered on the following pages. The discussion of alternatives 4, 5, and 6 are adopted by reference from the U.S. Department of the Interior's Final Environmental Impact Statement issued in March 1976 for the Alaskan Natural Gas Transmission System.

1. Alternate Pipeline Routes

This section explores the advantages or disadvantages of various alternative gas pipeline routes which could be used to transport natural gas from the fields at Prudhoe Bay to a coastal-based gas liquefaction and tanker loading terminal farther south. (See Figure 72.)

Nine engineering criteria have been identified in selecting a best route from a standpoint of technological feasibility and construction and material costs.

Factors which should be minimized are:

(1) Total pipeline distance.

(2) Routing in areas requiring substantial grading for right-of-way preparation.

(3) Number of stream, highway, and pipeline crossings.

(4) Routing through terrain which is subject to flooding or erosion.

(5) Routing in areas with special hazards such as avalanche or slope instability.

(6) Routing in areas where construction and operation of the pipeline would conflict with other established land uses.

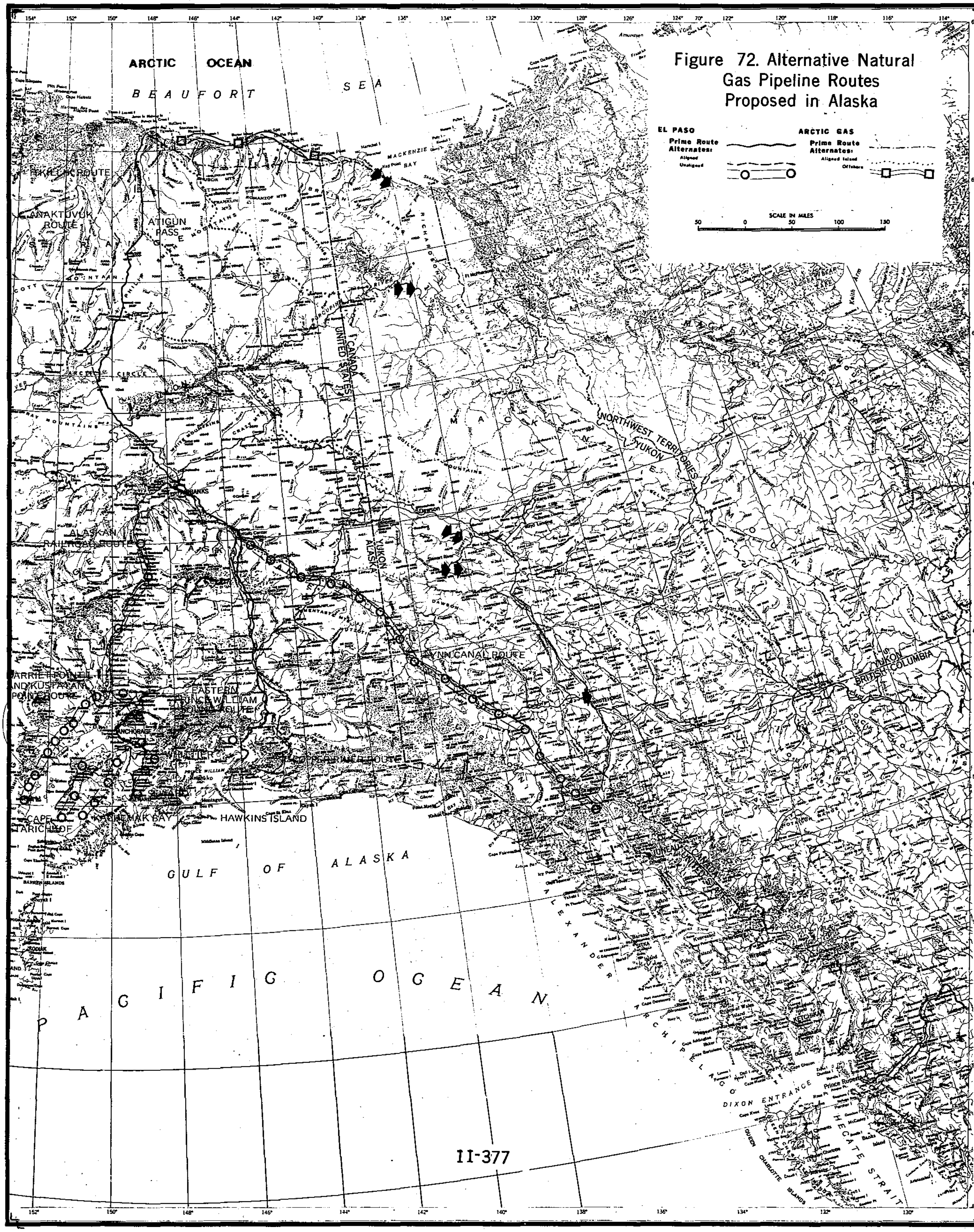


Figure 72. Alternative Natural Gas Pipeline Routes Proposed in Alaska

Factors which should be maximized are:

(7) Routing in areas having favorable pipe supporting soils and excavation characteristics.

(8) Availability of granular borrow.

(9) Use of existing transportation facilities for construction material supply and maintenance access.

The minimizations and maximizations of these factors, although based mainly on engineering principles, would also aid in mitigating the severity of the environmental effects of construction.

a) Brooks Range

The first major geographic obstacle that the pipeline must pass on its way south from Prudhoe Bay is the Brooks Range of mountains. Pipeline construction through mountainous areas generally follows the contours of valleys and river courses in order to avoid high relief land forms. There are therefore a restricted number of routes through mountain ranges which are feasible for pipeline construction. Three such potential rights-of-way were identified in the Brooks Range. The first is by way of the Atigun Pass, as previously discussed in the "Proposed Action" section of this statement.

A route further west through the range and termed the Itkillik Route was considered as an alternative. From the Prudhoe Bay origin, the route travels south across the North Slope, crossing the Putuligayuk and Toolik Rivers on its way to the eastern edge of the White Hills. The Toolik River is then paralleled across the western edge of the Toolik Basin until reaching Kakukturat Mountain where the route proceeds toward the headwaters of the Kuparuk River. The Kuparuk River is crossed just north of Imnaviat and Itkillik Mountains and enters the Itkillik River drainage basin, following low hills and small valleys to Itkillik Lake. From Itkillik Lake the route crosses the Itkillik River and follows the western edge of Itkillik Valley to the Continental Divide at Snowheel Mountain. The North Fork of the Koyukuk River is then followed until the southern edge of the Brooks Range is reached near Florence Creek Lake where the route proceeds southwest until the edge of the Kanuti Flats where it turns southeast to join the proposed route at milepost 290.

The second alternative route lies further west than the Itkillik Route and is called the Anaktuvuk Route. From the Prudhoe Bay origin it follows the primary proposed and Itkillik routes in a southerly direction for about 25 miles before turning southwest. The route crosses the Toolik River, then parallels the Kuparuk River until reaching the White Hills. It then edges the north side of the White Hills and continues southwest across the Kuparuk, Itkillik, and Nanushuk Rivers before entering the Anaktuvuk Valley near Rooftop Ridge. At milepost A-148 the route turns southward about 45 miles before entering the Brooks Range at Nasaurak Mountain. The Anaktuvuk River Valley is followed south to Anaktuvuk Pass at the Continental Divide, then down the John River Valley to Button Mountain on the south side of the Brooks Range. The route then proceeds southeastward for 57 miles through low hills and the northeast edge of the Kanuti Flats until reaching the primary proposed route at milepost 290.

Neither route would pose any unusual or difficult construction problems over those anticipated for the Antigun Pass proposal. However, neither route offers any significant environmental advantages over the primary proposal which would justify traveling their extra lengths (9 miles for Itkillik and 22 miles for Anaktuvuk). Therefore, the first criterion identified earlier would not be satisfied by either alternative. Additionally, by constructing in areas further from the established utility corridor for the Alyeska crude oil line, criterion nine would not be satisfied.

b) Pipeline to Western Alaskan Ports

This route was considered as a means of shortening the pipeline length, thereby reducing construction costs. It would pass through the Brooks Range in a southwesterly direction from Prudhoe Bay to Norton Sound on the central western coast of Alaska for a distance of approximately 750 miles. Difficulties would be encountered in constructing in the discontinuous permafrost area which underlies the entire route. Increased access and awareness of this western area of Alaska would occur if this alternative were selected. Recreational use of the area would accelerate, with the first users being construction personnel. If the construction road were opened to the public, an area which has received little use would be probably visited by recreationalists.

Pipeline construction would have significant impact on the visual integrity and natural quality of the landscape. Sport hunting and fishing might increase significantly, with trophy species facing a reduction in numbers. Construction activities would reduce wildlife habitation potentials, and thereby the recreational attractiveness of the area. A "Gates of the Arctic" National Park in the Central Brooks Range is proposed by the National Park Service to protect a diverse array of arctic scenes and varying landscapes. Although the park is not yet established, constructing a major pipeline and roadway across this area would be contrary to the spirit of criterion six. Building away from the Alyeska utility corridor would not satisfy the requirements of criterion nine.

Even if a satisfactory route were available, there appear to be no LNG terminal sites with acceptable siting characteristics along the western coast of Alaska. The most significant deterrents to such a location are the ice conditions in the Bering Sea, which would restrict reliable LNG tanker operations, and the increased sailing time of several days as compared to south Alaskan port sites.

Therefore, a pipeline to any western Alaskan port was not considered to be a viable alternative to the primary proposed pipeline route.

c) Pipeline to Lynn Canal

This route was considered primarily because it avoided a crossing of the Alaska Range north of Anchorage and paralleled existing highways to Lynn Canal in the Alaskan panhandle. This pipeline route would follow the existing Alaska Highway from Fairbanks to Haines Junction, then along Haines Highway to Haines or Port Chilkoot. Construction requirements for the portion of the route between Fairbanks and the Alaskan-Canadian border would pose no unusual problems over those already considered for the primary proposed route. Landsliding, slope failure, avalanches, and mud-rock flows are forms of natural erosion which are common in the southeastern area of Alaska and could pose a threat to pipeline integrity of the route after Haines Junction. The area of Haines is characterized by high seismicity with a history of earthquakes and active faults. There also exist steep unstable slopes and seismically sensitive marine clays that could endanger the pipeline during disturbances.

Acquisition of rights-of-way for the route to Lynn Canal would be difficult. Unlike many other land ownership patterns for Alaska, most of the route from Fairbanks to the Canadian border is not Federal land. The State of Alaska controls the land over much of the route with the Native villages of Healy Lake, Dot Lake, Tanacross, Tetlin, Northway, and Charlieskin being the other large landowners. The Canadian portion of the route would require the approval of the Canadian government before any route acquisition could begin in that country. Siting of an LNG terminal on the Lynn Canal was determined by the U.S. Department of the Interior to offer no special advantages over a location in Cook Inlet.

In light of those reasons, the extra 210 miles of route length would not be justified in choosing the Lynn Canal alternative. Pipeline routing criteria one, four, and five would not be satisfied.

d) Pipeline to South-Central Alaskan Ports

Two main routes were considered in order to reach south-central ports of Alaska from the proposed gas pipeline route that follows Alyeska into central Alaska. From a point about 50 miles northwest of Fairbanks near Livengood, one route would deliver gas to one of nine potential LNG terminal sites identified around Cook Inlet and the western side of Prince William Sound. The other route would essentially follow the Alyeska crude oil pipeline route south to the area of Valdez and the eastern side of Prince William Sound where six potential LNG terminal sites were identified. The feasibility of all these alternative routes was based primarily on considerations of acceptable terminal sitings with suitable route characteristics being a secondary consideration. Therefore, a potential terminal site needed to be acceptable before a route evaluation to that site was made.

e) Pipeline to East Prince William Sound

For the pipeline to the eastern side of Prince William Sound, six possible port sites were identified: Gravina, Hawkins Island, Valdez, Bidarka, Bomb Point, and Jack Bay.

The route to Gravina has been described in the Description of the Proposed Action, Section A of this statement.

Hawkins Island was determined to be an acceptable location for the proposed LNG plant. Just south of the Taylina River crossing at milepost 674, the route to Hawkins Island would depart from the proposed gas pipeline route and continue to parallel the Alyeska pipeline route within the Copper Basin. After crossing Richardson Highway, the pipeline would travel between the highway and the Copper River for about 27 miles until crossing the Copper River 1 mile upstream of the Tonsina River's confluence with the Copper. The route continues for

16 more miles where it then crosses the Chitina River and proceeds through the Chugach Mountains via the Copper River canyon. Taral Creek is crossed after about 3 miles, then the route continues for approximately 6 miles to the point where the Copper River is again crossed 2 miles south of Canyon Creek. For the next 26 miles the right-of-way of the abandoned Copper River and Northwestern Railroad is followed along the banks of the Copper River. The pipeline would turn briefly inland at a point 1.5 miles south of Cleve Creek to avoid the widest portion of the alluvial outwash of the Tasnuna River. Leaving the Tasnuna River Valley after crossing the Tasnuna River, the route would again parallel the Copper River for the next 12 miles past Allen Glacier and Miles Lake. At the outlet of Miles Lake, the route crosses the Copper River to follow the right-of-way of the Copper River Highway for the next 43 miles. This route largely includes the Copper River Delta and associated alluvial soil deposits as well as numerous glacial outwashes. The Heney Range is crossed by utilizing a pass 1 mile north of Heney Peak, then following Heney Creek Valley for 2 miles until turning southwest to parallel Heney Range for 7 miles. The route turns northwest for the last mile approach to Orca Inlet. The 3-mile long pipeline crossing Orca Inlet would be entirely buried before the reaming 4-mile segment crosses the ridge of Hawkins Island to the plant site at the middle of the island. The total length of this possible route to Hawkins Island is approximately 195 miles measured from milepost 674 of the primary route proposal for the gas pipeline.

Numerous difficulites in construction are anticipated for a Copper River route. Particularly difficult areas are the crossings of the Copper River near Canyon Creek, and the area between Allen Glacier and the Copper River. The steep canyon walls and numerous water crossings encountered along much of the Copper River make accessibility and general construction difficult. The requirements of criteria two, three and nine would not be fulfilled by this route. The 60 miles of extra route length of this alternative would also not satisfy criterion one.

Another approach to Hawkins Island would be to utilize the proposed gas pipeline route to a point near MP 795, east of Port Gravina. It would then continue south, skirting the northeastern reaches of Simpson Bay until arriving at Orca Bay. A buried pipeline crossing of Orca Bay would be made in water depths of 240 feet approximately 1 mile southwest of Channel Island. Upon reaching Hawkins Island, the pipeline would proceed along the northern side of ridges that run the length of the island until reaching the plant site.

Although utilizing the designated Utility Corridor to a great extent, this route would be longer than that to the Gravina site. Additionally, the segment past Point Gravina must negotiate several streams and choppy terrain as well as make a deepwater crossing of Orca Bay. Such difficulties would not meet the requirements of criteria one, two, and nine.

The route to the possible Valdez plant site would follow the length of the Alyeska pipeline route, which ends at the Alyeska marine terminal adjacent to the LNG site. Most of the factors dealing with the nine pipeline construction criteria would be fulfilled. However, the unsuitability of the site topography and seismic characteristics and the unavailability of adequate anchorage areas caused the Valdez terminal site and, consequently, gas pipeline route to be rejected.

The other three potential LNG terminal sites were not considered to be satisfactory for project operations or for preserving environmental integrity. (See Section H-2, Alternative LNG Terminal Siting.) Consequently, routing characteristics were not individually evaluated. However, since these sites lie along the general routes of previously discussed alternatives, the conditions which would be encountered would be expected to be similar in nature to those previously discussed.

f) Prudhoe Bay to Cook Inlet

Five general corridors were considered for bringing gas from Prudhoe Bay to the Kenai Peninsula-Cook Inlet area. One of these corridors would follow the proposed El Paso route from Prudhoe Bay to a diversion point near the proposed route at some point south of the Yukon River. Beyond these diversion points a nearly straight-line right-of-way would be followed, given the usual constraints of avoiding glaciers, exclusionary zones (such as Mt. McKinley National Park), rough topography, and unstable conditions which could make construction difficult and expensive.

The corridor diverging from the proposed route near Glennallen would then proceed southwest to the Cook Inlet area along the Glenn Highway. This corridor was determined to be unacceptable because of glacial risks along the highway and the excessive additional length (over 120 miles) of the required pipeline. The other corridors would generally follow the DOI designated Multimode Utility Corridor (MMUC), 1/ Alaska Railroad and State Highway 3 from the diversion point south of the Yukon River to the Kenai-Cook Inlet area. One of these corridors, which would proceed down the west

1/ Department of Interior, Bureau of Land Management, Multimodal Transportation and Utility Corridor Systems in Alaska, 1974.

coast of the inlet, was eliminated because glacial flooding on several rivers, four active volcanoes, and two active faults along this side of the inlet would endanger the integrity of the pipeline. Another corridor running around the northeast end of Cook Inlet was eliminated because of possible conflicts with urban development and an aquifer recharge area east of Anchorage, as well as the need for difficult side-hill construction along the north shore of Turnagain Arm.

Two broad corridors remained which received a more detailed evaluation. One would require the crossing of Cook Inlet just west of Anchorage in order to reach LNG terminal sites on the east side of Cook Inlet. The other corridor, which would cross Knik Arm north of Anchorage and Turnagain Arm southeast of Anchorage, could be used to reach a site on Resurrection Bay. As is discussed in detail in Section H-2 of this report, the Cape Starichkof site was chosen as the preferred LNG terminal site. Viable pipeline alternatives were also evaluated to Nikiski and Resurrection Bay. On the basis of topography, geology, soil conditions, and land use, the Nikiski and Cape Starichkof routes were considered most acceptable, with the Resurrection Bay route the least favorable of the three.

The Cape Starichkof route is 47 miles longer than the Nikiski route and would consequently present a greater impact potential to the Kenai National Moose Range and biotic communities along its length. Additionally, there would be a greater disturbance to urban and agricultural areas located along the western coastal zone of Kenai Peninsula. However, these increased impacts attributable to the longer route are not considered to be of such magnitude as to outweigh the benefits of increasing the public safety that are gained by siting the LNG terminal at Cape Starichkof.

The route to Resurrection Bay would traverse the Chugach National Forest, Fort Richardson Military Reservation, possible Capitol Site Selection Development north of Anchorage, and urban development north of Seward. A summary of the comparative ranking of the three routes for six environmental factors is presented below.

	Topography	Geology & Soil Conditions	Biotic Communities	Land Status
Nikiski	1	1	1	1
Cape Starichkof	2	2	3	2
Resurrection Bay East	3	3	2	3

	Population	Length	Overall Rank
Nikiski	1	1	1
Cape Starichkof	2	3	2
Resurrection Bay East	3	2	3

The suggested alternate would divert from El Paso's proposed route at milepost 389.5 near Livengood and extend south to Dunbar, and follow the MMUC south to Cape Starichkof on the Kenai Peninsula. The distance from the diversion point to Cape Starichkof would be approximately 422 miles. This portion of the route would cross 159 small creeks, 4 major rivers [the Tanana (1,320-foot crossing), Healy Creek (990-foot crossing), the Kenai River (660-foot crossing) and Susitna River (660-foot crossing),] Cook Inlet (approximately 16 miles), and would require a 660-foot aerial crossing of Hurricane Gulch.

A more precise alignment of the route was performed utilizing favorable environmental conditions such as level topography and stable soils and indicated by a set of location criteria. Variations from these criteria were introduced to allow for straightening and shortening of the pipeline. The location of surface facilities was determined using El Paso's proposed spacing for such facilities to select a general area and then determining a favorable construction site within this area. Compressor stations would occupy approximately 60 acres and be spaced approximately 60 miles apart. Where convenient, and when road access is good, maintenance and construction camps would be sited with compressor stations. To the extent possible, the pipeline would avoid hazardous zones such as near volcanoes, floodplains, wetlands and unstable areas, and would follow existing railroad, highway and powerline rights-of-way.

Among the broad considerations in the choice of the suggested route were the avoidance of the following: difficult terrain, unstable soils and subsurface conditions, active faults, glaciers and glacial flood areas, exclusionary zones such as Mt. McKinley National Park, areas in which biotic communities and unique environmental conditions would be disturbed, residential areas and agricultural areas.

Utilizing these criteria, a broad corridor was established from Livengood to Cape Starichkof. (See Figure 73.) The selection of a definite route was made within the confines of this corridor. Among the considerations for selection of a definite route were the following.

1. Land areas with firm surface and subsoils.

2. Land areas easily accessible from main transportation routes.

3. Lands which provide a sufficient amount of working space for construction camps and equipment.

4. Lands which would afford easy rights-of-way in terms of status use and ownership conditions.

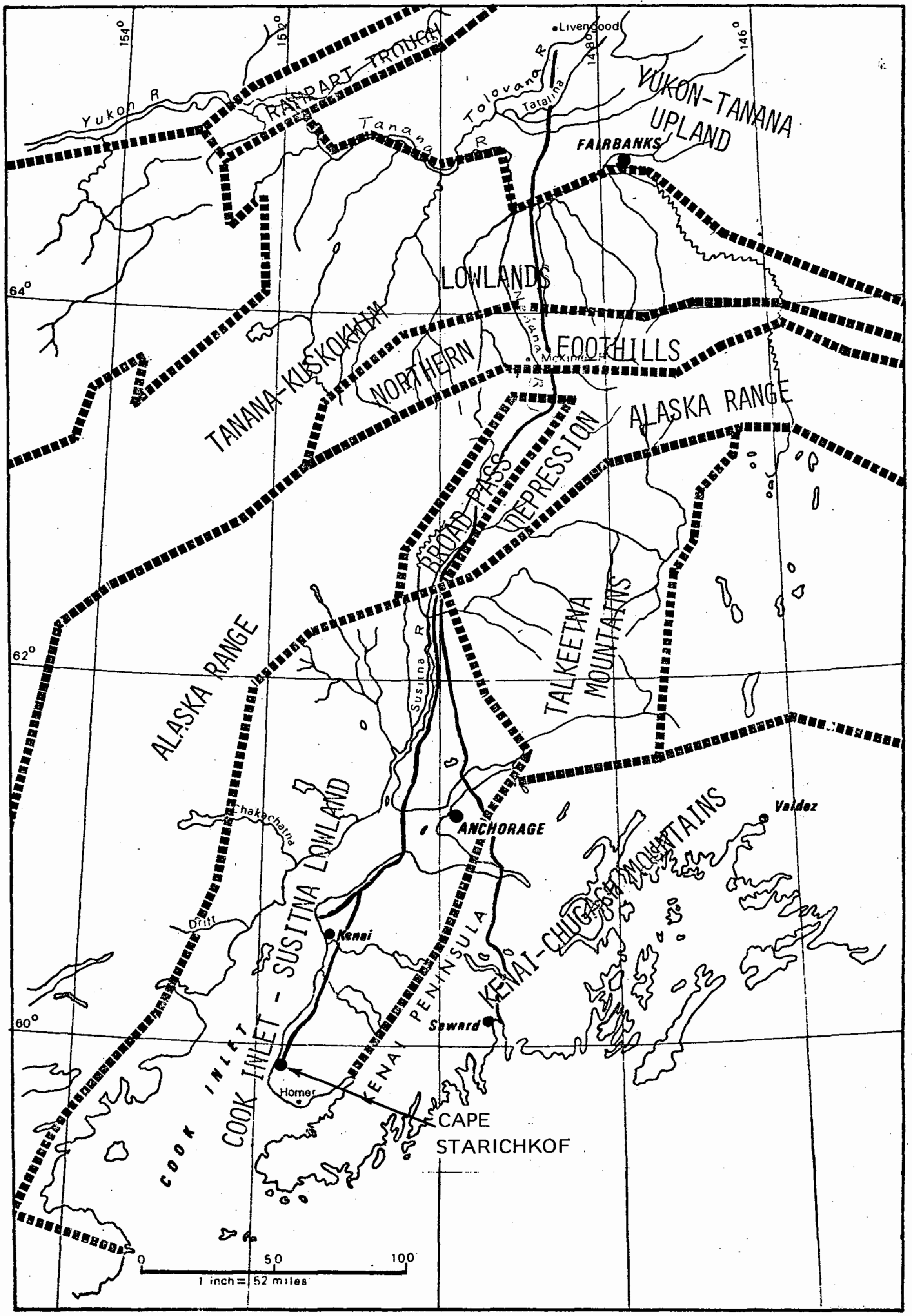


Figure 73. Physiographic Provinces of Alternate Pipeline Routes

5. Lands which afford space to locate surface facilities.

6. Lands with easy grades free of slides.

Using these criteria specific deviations from the rail corridor were made.

The suggested alignment of the alternate route is shown on Figures 74A through 74K. These figures are a series of strip maps. Each map covers approximately 40 miles of pipeline length and a corridor 15 miles wide with descriptions of local land use, topography, geology, soils, vegetation, fauna and special conditions. The geologic and land classification symbols shown on these figures are explained in Tables 33 and 34.

The climate along the suggested route would be similar to that described in Section B.1 of this report for the El Paso proposed route. The alternate route would traverse areas which are predominently undeveloped and used primarily for recreation with some agricultural usage mainly along the southern portion of the route.Some relocation of rural residences might be necessary even though residential areas would be avoided for the most part. The route would avoid urban areas and significant commercial-industrial areas to the extent possible.

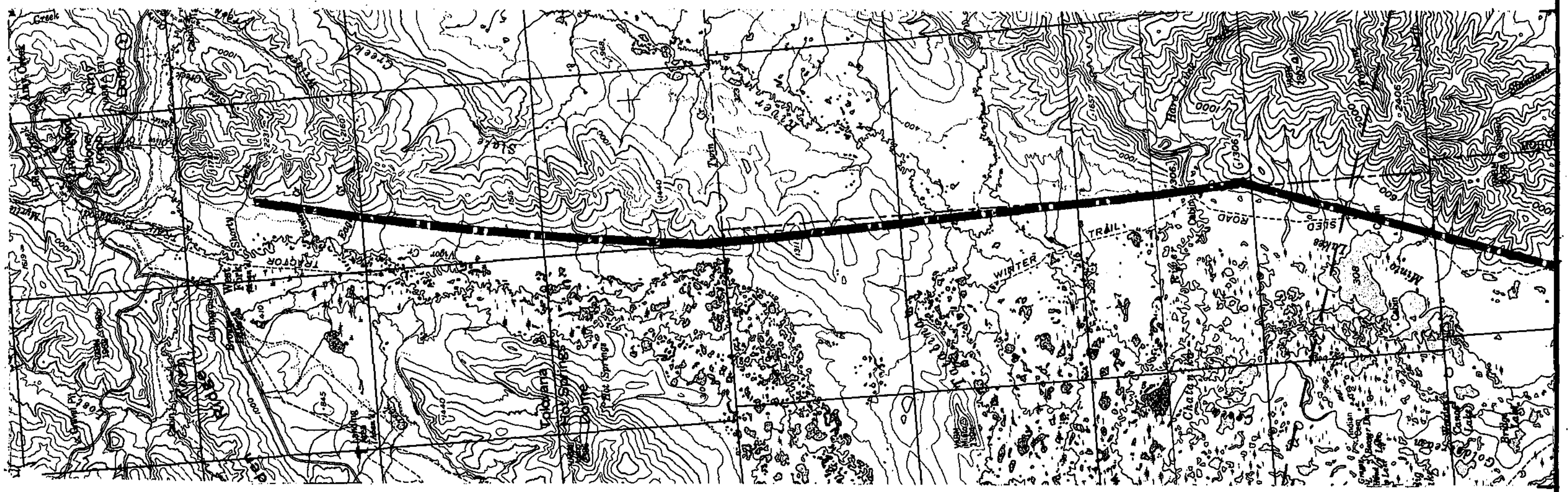
Table 35 lists all communities along the pipeline (within 15 miles of the route) with populations greater than 50 and other significant areas such as air fields and gravel pits. In addition to the population listed in Table 35 there are approximately 625 dwellings along the suggested route. These are found as single dwellings and in clusters ranging from 3 to 30 dwellings each.

The route, beginning at Livengood and heading southward, would travel through potential agricultural lands for a distance of approximately 75 miles south of Fairbanks. The route would then proceed through the Alaska Range where there are no potential agriculture lands. Emerging from the south side of the Alaska Range, the route would enter the upper Susitna Valley, where it would again enter potential agriculture lands.

North of Anchorage the pipeline would cross the Matanuska Valley which is Alaska's most intensively developed agricultural area. Today, the area has primarily family farms producing grain, hay, and quality vegetable crops. Dairy operations supply some of the needs of the Anchorage area.

Portions of the route on the Kenai Peninsula have agriculture potential, but for the most part lie within Federal reserves.

LAND USE & STATUS	Recreation UC / Recreation SS
TOPOGRAPHY	well-drained benchland along valley margin, level line on moderate slopes / crossing of ridge & knoll, some grading required 1200' el. / Flood plain & portion of perma-frost basin / well-drained benchland along valley margin, level line on moderate slope
SPECIAL CONDITIONS	LIV 026, 004, 005, 006
GEOLOGICAL CONDITIONS	C_z
SOILS CONDITIONS	IAHP/1m - HYP, E-2 Generally underlain by discontinuous permafrost / Generally underlain by moderately thick to thin permafrost
VEGETATION	muskeg / upland spruce hardwood forest / muskeg
SELECTED FAUNA	moose / black bear / intense waterfowl nesting



PIPELINE SCHEMATIC

M.P. 389.5

CS

M.P. 420.7

COMPRESSOR STATION NO. 7

match line M.P. 426.6

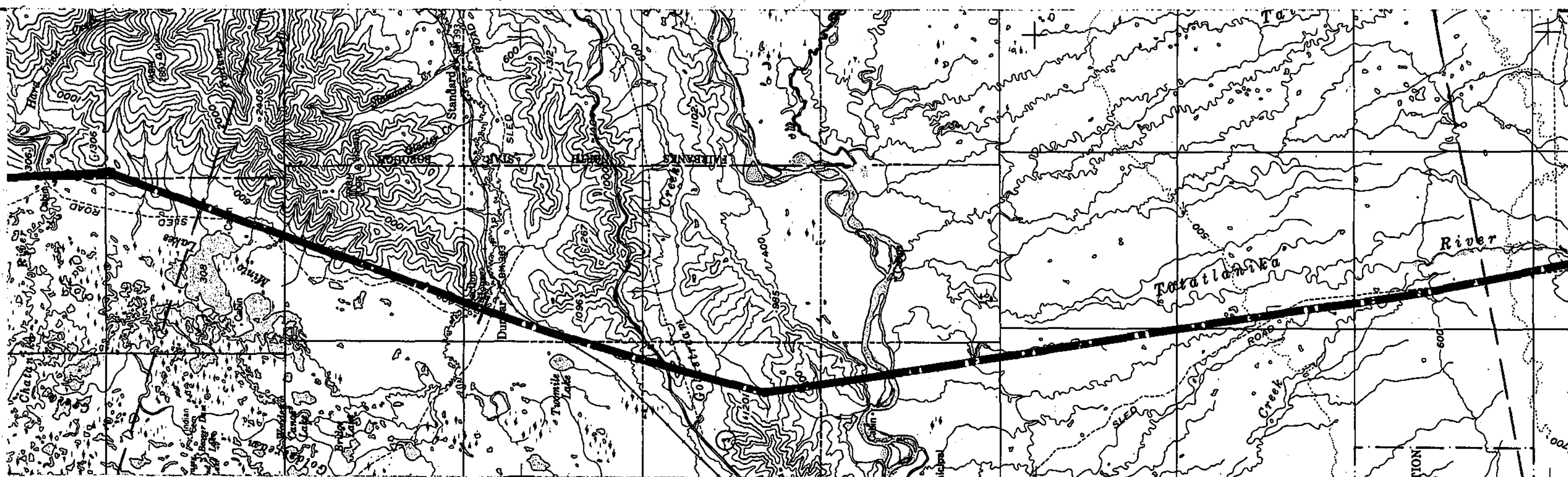
CONSTRUCTION DETAILS

Stream Crossings - Tatalina River
Washington Creek

Stream Crossing
(Chatanika River)

Figure 74A. Strip Map along ALternative Pipeline Route from Livengood to Cape Starichkof

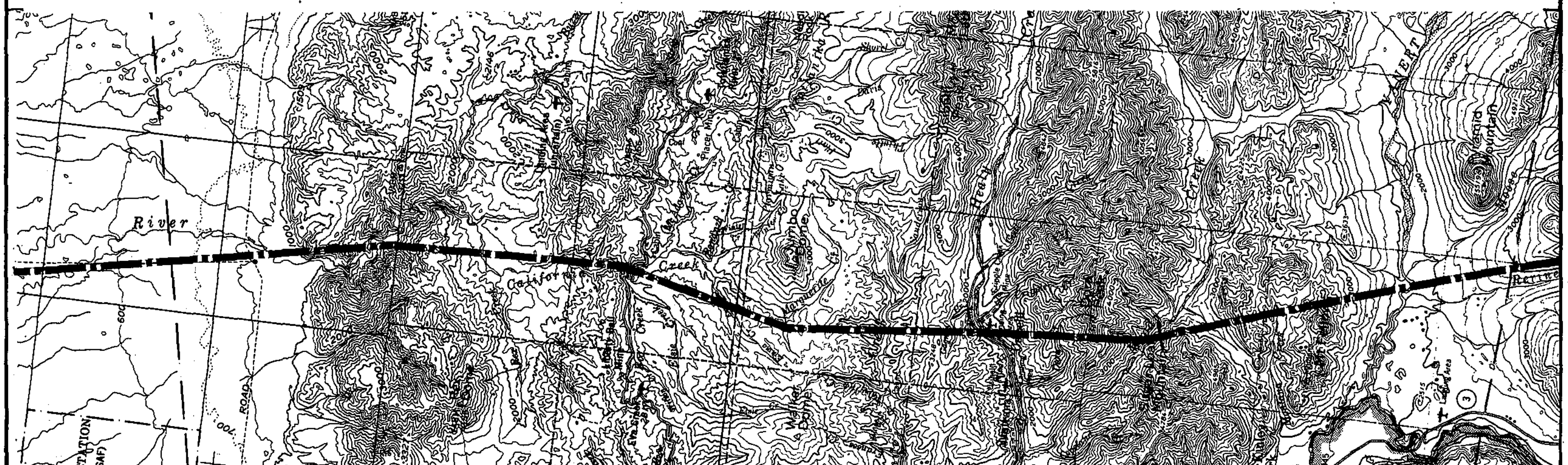
LAND USE & STATUS	Recreation, Railroad, Utilities, Recreation; SS | ST | SS | NYD
TOPOGRAPHY	well drained benchland along valley margin, level line on moderate slope. | ridge 800' some grade required | maj river flood pl stbl bank | gently sloping plain rising 20 - 50 feet per mile to the south. Moderatley well drained river terrace Alluvial outwash from Alaskan Range.
SPECIAL CONDITIONS	FAI 008, 013, 016; U.S. Air Force Gunnery Range
GEOLOGICAL CONDITIONS	
SOILS CONDITIONS	IAHP/1m - HYP, E-2 | ICF/2m - IAHP/1m, E-2, 3 | IAHP-EFT/1m E-2 | IAHP/1m, E-2 | ICT/1g - IAHP/1m, E-2; Generally underlain by numerous isolated masses of permafrost
VEGETATION	muskeg | upland spruce hardwood forest | spruce poplar | high brush | upland spruce hardwood forest | high brush
SELECTED FAUNA	winter moose concentration | moose; intense waterfowl nesting; black bear | win. m. con. | moose; intense waterfowl nesting; black bear



PIPELINE SCHEMATIC	M.P. 426.6 match line; M.P. 436.8; match line M.P. 471.2
CONSTRUCTION DETAILS	Stream Crossing (Goldstream Cr.); Alaska Railroad Crossing; Highway Crossing (State Route 3); Stream Crossing (Little Goldstream); Major River Crossing Tanana River

Figure 74B. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	NVD | SS | ST | Mining SP | Coal Mining Town ST | Recreation SS | NVW
TOPOGRAPHY	gently sloping plain | steep canyon entering foothills region slopes 30-50% | parallel ridge-and-valley topography occasional steep slopes to 30% | higher, more massive ridges, slopes to 30% | River Valley Flood Plain
SPECIAL CONDITIONS	Alternate Capitol Site "preliminary designation" | HEA 008, 0010, 007, 009, 001 | HEA 004 | Scenic
GEOLOGICAL CONDITIONS	C_z | P_z | Fault M_zP_z
SOILS CONDITIONS	ICT/1g - IAHP/1m, E-2 | IAP - ICP/2g, E-2,3 | IAP - EOL/2g, E-2 | RM | ICT/2g IAHP/1m E-3; generally underlain by discontinuous permafrost
VEGETATION	upland spruce - hardwood forest | high brush | upland spruce - hardwood forest | high brush | alpine | high brush | alpine tundra
SELECTED FAUNA	moose wtrfwl nest black bear | moose, concentrated fall caribou; brown grizzlybear; black bear | Dall Sheep | moose | Dall Sheep | concentrated moose fall & winter; Caribou, winter range



PIPELINE SCHEMATIC

M.P. 471.2 match line — CS — M.P. 474.5 — M.P. 505.2 — match line M.P. 517.4

COMPRESSOR STATION NO. 8

CONSTRUCTION DETAILS

Road Crossing - Liberty Bell Mine Road

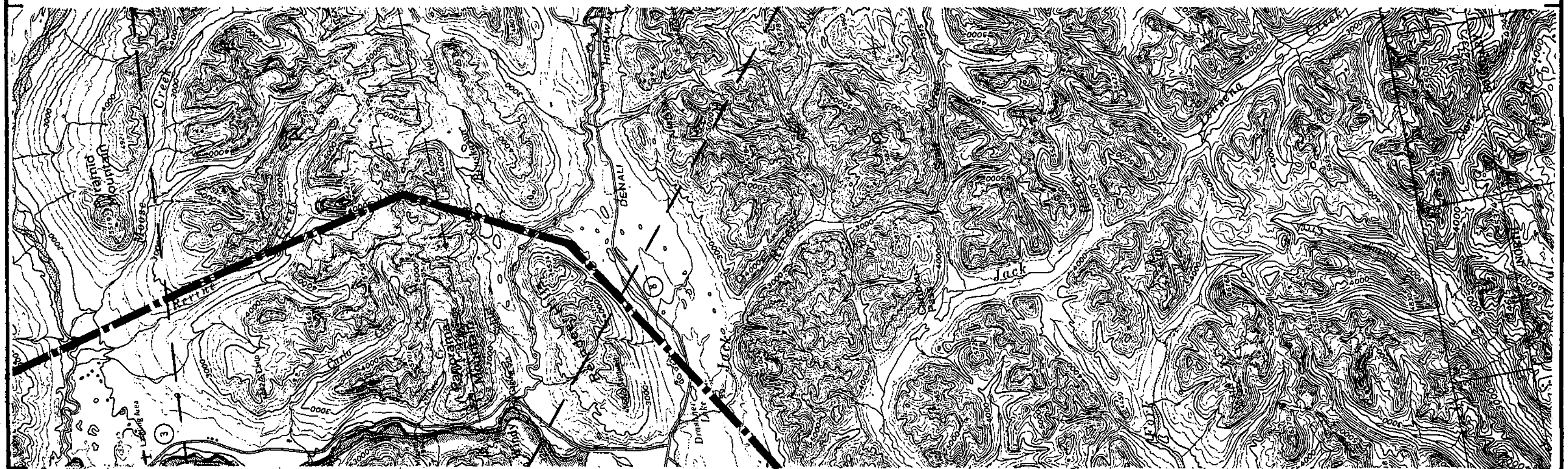
Road Crossing - Usibelli Coal Mining District

Stream Crossing Healy Creek

Stream Crossing Yanert Fork

Figure 74C. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	SS | UNRESERVED | SS
TOPOGRAPHY	Main Spine of Alaska Arrange very rugged and high massive uplifts, slopes to 50% | river valley fld. pl. | broad glacial trough low relief, moraine topography Broad Pass Depression
SPECIAL CONDITIONS	Scenic
GEOLOGICAL CONDITIONS	M_zP_z | DENALI FAULT SYSTEM
SOILS CONDITIONS	RM generally underlain by discontinuous permafrost
VEGETATION	high brush | alpine tundra | high brush | bottomland spruce-poplar forest
SELECTED FAUNA	Dall Sheep; caribou, winter range; brown grizzly bear | moose; black bear



PIPELINE SCHEMATIC

M.P. 517.4 match line

CS

M.P. 536.5

match line M.P. 534.4

COMPRESSOR STATION NO. 9

CONSTRUCTION DETAILS

SUMMIT OF ALASKA range 5200' el. (highest pt. on route)

River Crossing Nenana River

Figure 74D. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	Highway Small Town Small Town Utilities Small Town Utilities Utilities Recreation SS | NVW core | SS | UNRESERVED | SS | UNRESERVED NVW | SS | ST
TOPOGRAPHY	HEA 002 major glacial trough, Broad Pass Depression, characterized by parallel trending drumlins, elongated kettle basin lakes, moraine topography, moderate relief, benchlands well drained | entrenched stream | high benchland
SPECIAL CONDITIONS	
GEOLOGICAL CONDITIONS	Denali Fault System | C_z | M_{z1} | M_z
SOILS CONDITIONS	SOP - IAHP/1g, E-2 | SOU/2g, E-1, 2 generally underlain by discontinuous permafrost
VEGETATION	bottomland spruce poplar | high brush | bottomland spruce - poplar | high brush | bottomland spruce | high brush | bottomland spruce - poplar
SELECTED FAUNA	brown grizzly bear moose caribou, winter range | caribou | moose, concentrated fall & winter black bear

PIPELINE SCHEMATIC

M.P. 534.4 match line

M.P. 550.4

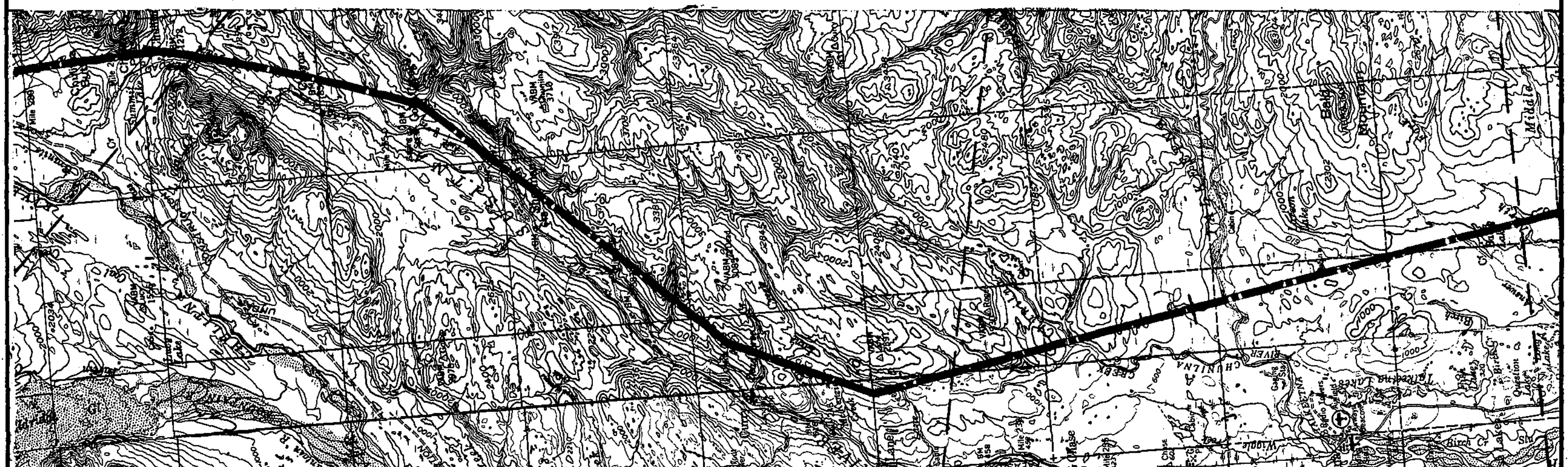
match line M.P. 583.0

CONSTRUCTION DETAILS

Denali Highway Crossing | Stream Crossing Jack River | Bering Sea/Pacific Divide | Stream Crossing Middle Fork Chulitna River | Stream Crossing East Fork Chulitna River | Stream Crossing Honolulu Creek | Aerial Crossing Hurricane Gulch | Chulitna Pass

Figure 74E. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

	Scattered Settlement section	Recreation section
LAND USE & STATUS	Scattered Settlement ST	Recreation SP; NVW
TOPOGRAPHY	narrow glacial valley, subsequently incised by stream erosion benchlands of moderate to steep slopes, well drained	valley margin, low to moderate relief, generally well drained with some localized areas of poor drainage, stream outwash fans and plains
SPECIAL CONDITIONS	TLM 002; TLM 001; TAL 001, 004	TAL 003
GEOLOGICAL CONDITIONS	M_z	Q_{al}
SOILS CONDITIONS	SOU/2g, E-1, 2 generally underlain by discontinuous permafrost; Underlain by isolated masses	SOT/1m - HY(B) q, E-1, 2; SOU/2g, E-1, 2 of permafrost; generally free of permafrost
VEGETATION	bottomland spruce poplar; upland spruce hardwood; moinst tundra; upland spruce hardwood	bottomland spruce - poplar; upland spruce hardwood
SELECTED FAUNA	moose, concentrated fall and winter; moose; caribou brown grizzly bear black bear	moose, con. fall & winter; moose; fish use brown grizzly bear black bear



PIPELINE SCHEMATIC

M.P. 583.0 match line — CS — M.P. 591.7 — match line M.P. 612.6 — M.P. 621.5 — match line M.P. 632.7

CONSTRUCTION DETAILS

COMPRESSOR STATION NO. 10

Susitna River Crossing

Stream Crossing Gold Creek

Stream Crossing Chunilina River

Talkeetna River Crossing

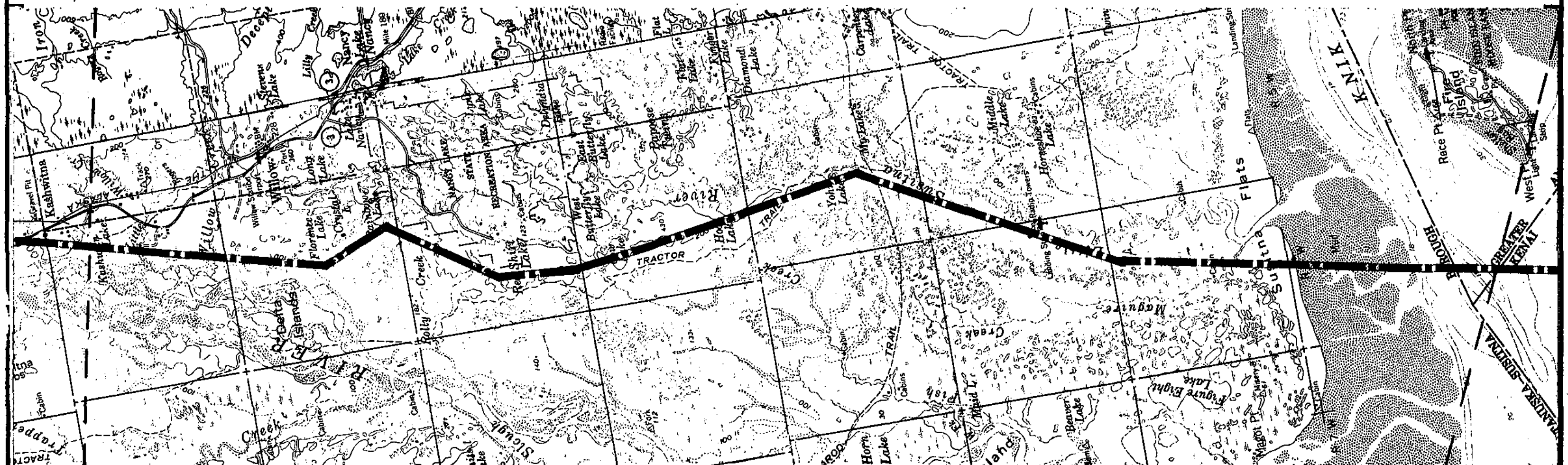
Figure 74F. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	Satellite Tracking Station SP; Small City; Scattered Residential NVW core; Highway Railroad; Small Town SP; Highway; Small Town
TOPOGRAPHY	valley margin, low to moderate relief, drainage fair, areas of poor drainage, ponds and lakes. Stream outwash fans and plains | low poorly drained terrain | river terrace, moderate drainage east bank Susitna River
SPECIAL CONDITIONS	New Capitol Site Alternative "preliminary designation"; TAL 006; TAL 005; suited for settlement limitation slight
GEOLOGICAL CONDITIONS	M_z | Qal
SOILS CONDITIONS	SOU/2g E-1, 2 | SOT/1m - HY(B)G, E-1, 2; generally free of permafrost
VEGETATION	upland spruce hardwood forest | bottomland spruce - poplar forest | upland spruce - hardwood and lowland spruce - hardwood mixed forest | wet tundra
SELECTED FAUNA	moose, concentrated winter | moose caribou | moose, concentrated spring-summer and winter; brown grizzly bear black bear; brown grizzly bear black bear

PIPELINE SCHEMATIC	M.P. 612.6 match line; M.P. 652.2; COMPRESSOR STATION NO. 11; match line M.P. 660.5
CONSTRUCTION DETAILS	Talkeetna River Crossing

Figure 74G. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	small town ¦ NVW — rural residential — small town — Recreation — SP — Airfield ¦ ¦ utilities
TOPOGRAPHY	stream terraces of moderate drainage, slight relief, seperated by low swampy areas,. lakes. major river flood plain. scattered deposits of sand, well drained. — tide lands
SPECIAL CONDITIONS	TYO 014 — New Capitol Site Alternative "preliminary designation" — Occasional and Intermittenet Uses. Recreation, sport hunting and fishing, subsistence, seasonal residences, and resource exploration.
GEOLOGICAL CONDITIONS	Qal — Fault
SOILS CONDITIONS	SOT/1m - HY(B)G, E-1, 2 generally free of permafrost
VEGETATION	upland/lowland spruce-hardwood ¦ wet tundra ¦ upland / lowland spruce - hardwood forest ¦ water
SELECTED FAUNA	moose con. sp.-sum. & win. ¦ moose, concentrated winter ¦ moose, concentrated spring & summer ¦ summer salmon brown bear; black bear ¦ brown, black bear, intense spr use ¦ beluga whale



PIPELINE SCHEMATIC

M.P. 660.5 match line

CS

M.P. 699.1

COMPRESSOR STATION NO. 12

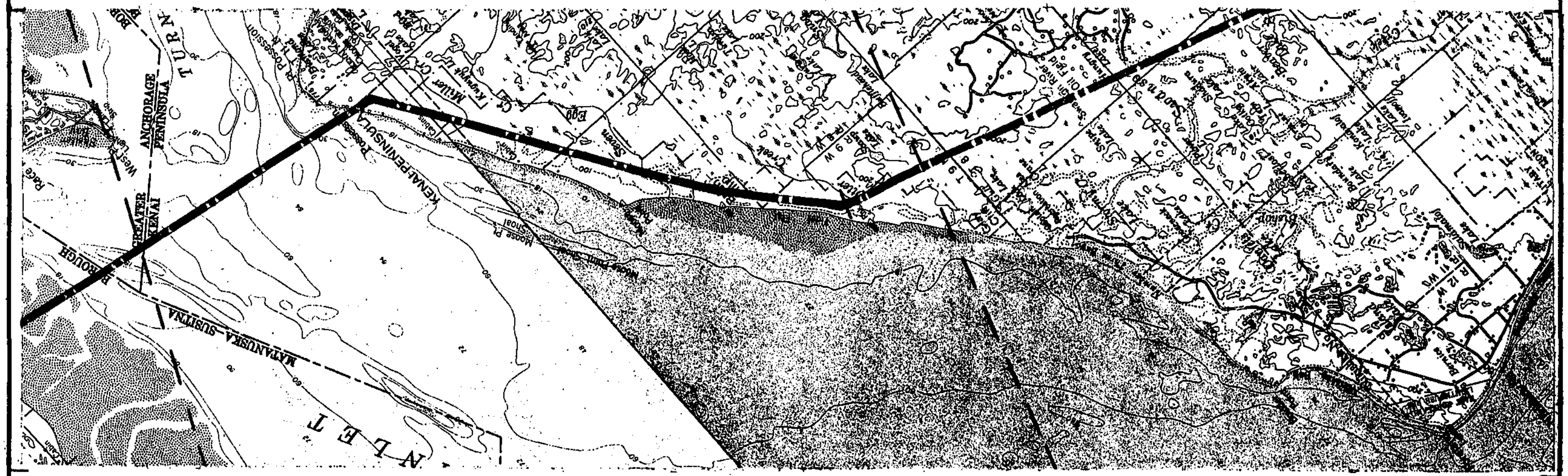
match line M.P. 709.8

CONSTRUCTION DETAILS

Submarine Crossing Cook Inlet

Figure 74H. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	Fishing · SP · Fishing · Kenai Moose Range	NVW · Kenai Moose Range · oilfield · NVW · Residential Mobile Homes · SS
TOPOGRAPHY	slightly elevated berm at crest of coastal bluff, 50-100' above sea level little or no relief	Inland area lower than coastal berm. stagnant ice topography moraines slightly elevated above glacial depressions, lakes, and ponds. poorly integrated drainage.
SPECIAL CONDITIONS	TYO 015 Native Allotment · Occasional and Intermittent Uses. Recreation, sport hunting and fishing, subsistence, seasonal residences, and resource exploration.	SEE ACCOMPANYING MAP
GEOLOGICAL CONDITIONS	Qal	" " "
SOILS CONDITIONS	SOT/1m - HY(B)G, E-1, 2 generally free of permafrost	" " "
VEGETATION	Water · upland / lowland spruce - hardwood forest	" " "
SELECTED FAUNA	salmon, beluga whale · moose, black bear; brown bear	" " "



PIPELINE SCHEMATIC

M.P. 709.8 match line

M.P. 737.9

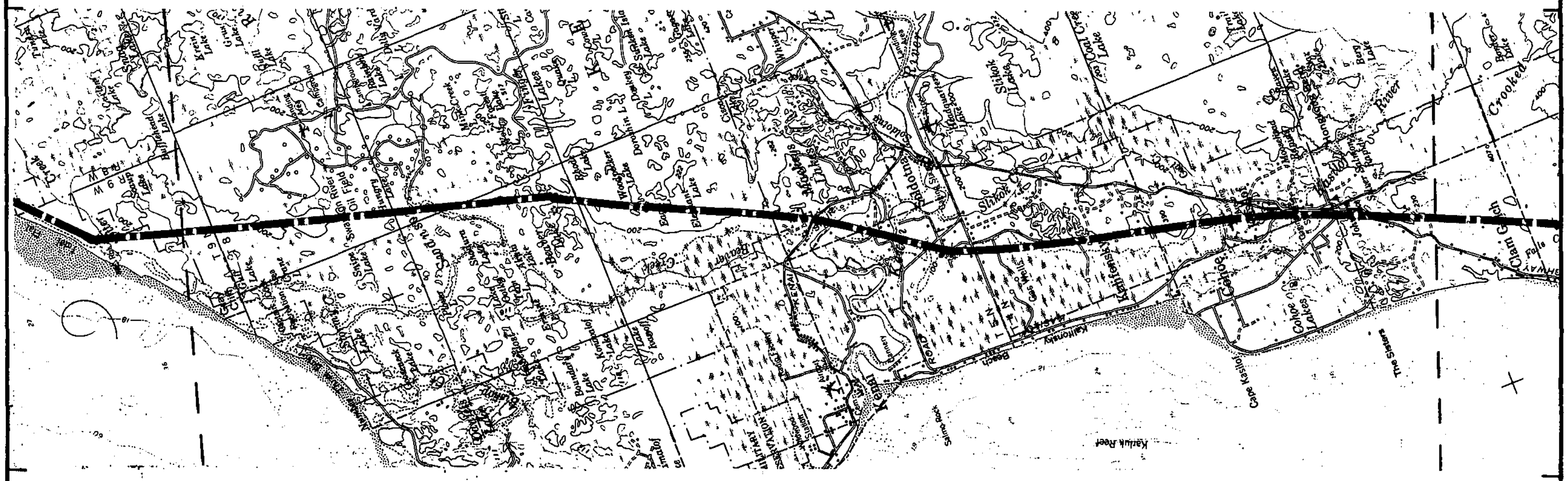
match line M.P. 738.6

CONSTRUCTION DETAILS

Submarine Crossing
Cook Inlet

Figure 741. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

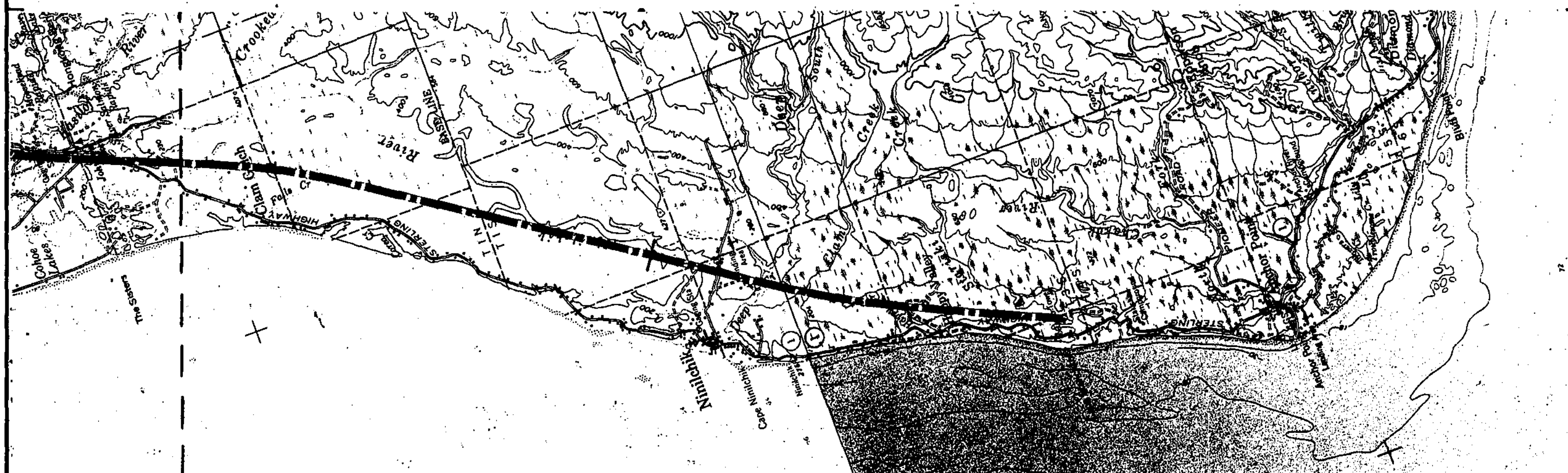
LAND USE & STATUS	Kenai Moose Range: NVW; oilfield: NVW; Residential Mobile Homes: SS; agricultural, Kenai Community College, amenity lands: SP; agricultural, Rural Settlement: NVW core; Small City: SP
TOPOGRAPHY	stagnant ice topography with drumlin fields, kettle bogs, shallow stream courses with low terraces. Almost level, with continuous, slight variations in elevation of less than 50 feet. Some man-affected topography in Kenai - Soldatna and Kasilof areas (filling for roads and other construction). Poorly integrated drainage.
SPECIAL CONDITIONS	KEN 015, 020, 014, 007, 022, 033, 025, 029, 040, 028, 021, 023, 026 036, 035, 024, 016, 018, 019, 017, 039, 030, 038
GEOLOGICAL CONDITIONS	Qal
SOILS CONDITIONS	SOT/1m HY(B)G, E-1, 2; SOT/2m - HY(B)G, E-1, 2; SOT/1m - HY(B)G, E-1, 2; generally free of permafrost
VEGETATION	muskeg; upland / lowland spruce - hardwood forest; lowland spruce hardwood forest; upland / lowland spruce - hardwood forest; high brush (burned)
SELECTED FAUNA	moose; moose, concentrated all year; caribou, summer range; black bear; brown bear



PIPELINE SCHEMATIC	M.P. 738.6 match line; CS (M.P. 758); match line M.P. 781.6
CONSTRUCTION DETAILS	COMPRESSOR STATION NO. 13B; Highway Crossing North Kenai Road; River Crossing Kenai River; Road Crossing Kalifonshi Beach Rd.; Road Crossing Kalifonshi Beach Rd.; Stream Crossing Kasilof River; Highway Crossing Sterling Highway

Figure 74J. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

LAND USE & STATUS	Rural Settlement — Small City — Rural Settlement — Radio Tower — Rural Settlement — Small City — Small City; SP — NVW core — SP
TOPOGRAPHY	generally level with slight variations in elevation 50 ft. extensive poorly drained areas alternating with moraine features, moderately well-drained — low swampy — coastal berm moderately well drained
SPECIAL CONDITIONS	KEN 045, 032, 031, 046, 044
GEOLOGICAL CONDITIONS	Qal — Cz
SOILS CONDITIONS	SOT/1m - HY(B)G, E-1, 2; generally free of permafrost
VEGETATION	up / lowland spruce hardwood — muskeg — upland / lowland spruce - hardwood forest — muskeg — spruce hardwood — muskeg — upland / lowland spruce hardwood
SELECTED FAUNA	moose — moose, con. winter — moose; black bear; brown bear



PIPELINE SCHEMATIC: M.P. 782 match line — M.P. 798 — M.P. 812 — LNG PLANT AND MARINE TERMINAL SITE

CONSTRUCTION DETAILS: Stream Crossing Deep Creek — Road Crossing Ninilchik

Figure 74K. Strip Map along Alternative Pipeline Route from Livengood to Cape Starichkof

Table 33 Geologic Explanation For Figures 74A - 74K*

	Sedimentary and Volcanic Rocks
Qal	Alluvium
Cz	Cenozoic rocks
Mz	Mesozoic rocks
Mzpz	Mesozoic & Paleozoic rocks undifferentiated
Pz	Paleozic & older rocks
Pmu	Paleozoic rocks undifferntiated
	Intrusive rocks
Czi	Cenozoic Rocks
CzMz	Cenozoic & Mesozoic Rocks
Pzi	Paleozoic & older rocks
Mzi	Mesozoic rocks
Ui	Undated rocks

* Compiled from an unpublished map at Joint Federal-State Land Use Planning commission, State of Alaska.

Table 33 (Con't.)

Soils	Brief Description
EFT	Well drained soils in stratified materials on flood plains and low terraces
EOL	Well drained gray soils; shallow bedrock
Hy(B)G	Poorly drained fibrous peat; shallow permafrost table
HYP	Poorly drained fibrous peat; shallow permafrost table
IAHP	Poorly drained soils with peaty surface layer: shallow permafrost table
IAP	Poorly drained soils: shallow to deep permafrost table
ICF	Well drained brown soils: contains lenses of fine grained material.
ICT	Well drained brown soils: nonacid
SOP	Well drained strongly acid soils: deep permafrost table
SOT	Well drained strongly acid soils
SOU	Well drained acid soils; very dark subsoil
RM	Very steep rock or ice-covered land

Example: IAHP/1M

IAHP- soil
1-- Slope group
M-- Textural Group

Table 33 (Con't.)

Slope Groups

1 -- Soil identified in symbol has slopes dominantly les than 12%

2 -- Soil identified in symbol has slopes dominantly steeper than 12%

Textural Groups

c -- Sandy
f -- Clayey
g -- Loamy (medium)

Erosion Potential

E-1 Low
E-2 Medium
E-3 High
E-2W Moderate Wind Erosion

Table 34 Explanation of Land Classification Categories

Notation	Explanation
MW	Major withdrawals prior to Alaska Native Claims Settlement Act (ANCSA) (Dec. 18, 1971) - Lands set aside by the Federal Government for particular purposes such as parks, military installation, forests, and wildlife refuges.
SP	State selections-patented-Lands conveyed and deeded to the State of Alaska.
ST	State selection-tentatively approved-Lands selected by the State of Alaska which have been approved by the Department of the Interior for transfer to the State.
SS	State selections-pending-Lands selected by the State of Alaska which have not been acted upon by the Department of the Interior.
UC	Utility corridor-Lands withdrawn for right-of-way for proposed transportation and utility purposes.
NVW	Withdrawals for Native villages-The 25 townships around a Native village from which village selections may be made.
NVD	Village deficiency withdrawals-Lands withdrawn for villages which cannot meet their selection entitlement from the Native village withdrawal.
NRD	Regional deficiency withdrawals-Lands withdrawn for Native regional corporations which cannot meet their selection entitlement from the withdrawals in their region.
NA	Native allotments-Homesteads of a maximum 160 acres of nonmineral land granted to Eskimos and Indians under law in 1906. Aleuts included in 1956.
FIR	Former Indian Reserves (elected to be acquired under Sec. 19, ANCSA)-Lands set aside before ANCSA for the use of certain Native groups. These reserves were revoked by ANCSA, but the people living on them had the option to acquire title to these lands rather than participate in the Settlement Act.

Table 34 (Con't.)

Notation	Explanation
DT	Withdrawals for classification and public interest (d) (1)-Land withdrawn for classification by the Department of the Interior under Section 17(d) (1) of ANCSA.
D2	Withdrawals for possible inclusion in the four national systems (d) (2)-Lands withdrawn under Section 17(d)(2) of ANCSA for study and recommendation as possible additions to national forests, parks, wildlife refuges, or wild and scenic rivers systems.
DW	Dual withdrawals for (d)(2) and Native regional deficiency (Sec. 17(d)(2)(E), ANCSA)-Land withdrawn for Native regional selection which if not selected will remain in (d)(2) category.
22-E	Withdrawals for possible addition to national wildlife refuge system-Lands withdrawn as replacements to refuges from which lands have been removed by Native selections.

TABLE 35

COMMUNITIES ALONG LIVENGOOD - CAPE STARICHKOF ROUTE

Settlement	Population	Proximity of Pipeline	Comments
Livengood	L	6 mi. N	
Cripple Creek Mine	L	1 mi. E	ALC
Usibelli	177	½ mi. W	Largest coal mine in Alaska, ALC
Suntrana	67	3 mi. W	ALC
On Nenana River Mt. McKinley Nat'l. Park Airport	L	4½ mi. W	ALC
Cantwell	62	3½ mi. N	ALC, ARR
Summit	34	2½ mi. N	ARR Station
Colorado	L	1 3/4 mi. N	ALC
Curry	L	1¼ mi. W	ALC, ARR
Old Streambed Susitna River	L	2¼ mi. N	Gravel Pit
Talkeetna	182	5½ mi. N	Airfield, ARR
Old Streambed Susitna River	L	2¼ mi. W	Gravel Pit
S. of Sunshine	L	3¼ mi. W	Gravel Pit
Montana	33	2 3/4 mi. W	AAR, ALC
S. of Caswell	L	0	Crosses ARR
Kashwitna	L	3/4 mi. E	Gravel Pit
On Little Susitna River W. of Horseshoe Lake	L	0	ALC, Radio Tower, Tanks
Kenai	3,533	5½ mi. W	
Soldatna	1,202	3 mi. SE	

LEGEND

ALC - Aircraft Landing Area
ARR - Alaska Railroad
L - Less Than 50 People
6 mi. N - 6 Miles North of Pipeline

The forestry resource occurs on roughly the same lands that are the potential agriculture lands. The heavier stands of commercial forests occur surrounding the Cook Inlet area.

The Alaska Division of Lands regularly conducts timber sales for harvest of the renewable forest resources in areas adjacent to the route. Principal timber sale areas are between Fairbanks and Nenana, in the Susitna Valley, and on the Kenai Peninsula. The Forest Service timber harvest program is primarily in areas away from the route. The U.S. Fish and Wildlife Service occasionally sells timber from the Moose Range for habitat conversion purposes.

In the upper Susitna Valley area, the route passes close to a proposed hydroelectric power project. This project is known as the Susitna River or Devil's Canyon Project and could include a total of four dams.

A primary industry of the Cook Inlet area is oil and gas production. It is estimated there may be as much as 7.9 billion barrels of oil and 14.6 trillion cubic feet of gas reserve in the Cook Inlet Basin.

The Cook Inlet and Gulf of Alaska ports available to this route are the terminal areas for the shipping and transportation industry in south-central Alaska.

Anchorage is also a center for international air transportation. Due to availability of transportation, the entire region traversed by the route is a primary center for the state's third largest industry -- tourism and recreation.

North of the Alaska Range the primary mineral extraction area is the Usibelli coal mine near Healy. In addition to this, there is ongoing production of gold, lead, silver, zinc and antimony in areas around Mt. McKinley National Park. South of the Alaska Range the oil and gas produced in fields in the Cook Inlet Basin have far exceeded other minerals in value. Coal is present in Susitna, Matanuska, and Kenai fields. The total coal resource is estimated to be approximately 2 1/2 billion short tons.

Geothermal potential is considered to be high south of the Alaska Range. Clay deposits which could be used for commercial brick manufacturing occur at several locations within the Susitna-upper Cook Inlet area. Gypsum and limestone deposits occur in several locations within 50 miles of this route. Metallic materials are present in several districts. The only large-scale operation in the past has been a gold operation in the Willow Creek area. In the southern Alaska Range metallic sulphide minerals are common. Minor amounts of gold have been taken from placer gold locations throughout the area. Several types of iron ores, copper ores, and chrome deposits also exist in the Cook Inlet subregion.

The Susitna River and the other large rivers in the subregion are the locations of gravel deposits. No estimate of the gravel volumes is available. Sand and gravel supplies in the Anchorage area are in high demand and short supply.

An integrated electrical power system operates within the area through which the pipeline would pass. Natural gas exists in commercial quantities in the area and is the major fuel for the production of electricity by Chugach Electric Association (CEA), which serves 34,600 members and the city of Anchorage with 14,300 customers.

Modern long-distance communications facilities available in the subregion are highly developed compared with other areas of Alaska, although some elements of the system are considered out-of-date.

Sewer and water utilities are relatively well-developed in some of the urban areas of the subregion. The city of Anchorage provides potable water for both the city and central Alaska. Utilities serve users in the Anchorage Borough outside of the city's service area. There are a number of small private water utilities serving subdivisions. The Greater Anchorage Area Borough is responsible for sewage collection and treatment. A primary sewage treatment plant is located on Point Woronzof.

Palmer is the only community in the Matanuska-Susitna Borough with community water and sewer utilities. Community water and sewer utilities are available in Homer, Kenai, and Soldotna. Tyonek has a community water utility.

Wells and septic tanks or cesspools are used in the more rural areas of the subregion and the need for more modern facilities is becoming acute in Wasilla, the Fishhook Road area, Talkeetna, and Big Lake. 1/

1/ Resource Inventory, Transportation, South-central Region, 1974.

i. Topography and Land Features

The route south of the point of diversion from El Paso's prime route is quite varied, crossing six recognized physiographic provinces. These, as shown on Figure 73, are as follows:

ii. Yukon-Tanana Upland

The El Paso proposed line ascends from the Yukon River crossing in Rampart Canyon (Rampart Trough Physiographic Province) into a broad upland region lying between the Yukon and Tanana Rivers.

The entire province is in the Yukon Drainage Basin, with streams flowing north to the Yukon River or southwest to the Tanana River, largely paralleling structural trends. The Tolovana River, with its several tributaries such as the Tatalina and Chatanika Rivers and Goldstream Creek, forms the largest subbasin in the western part of the province.

The diversion point selected is the upper Tolovana River Valley about 7 miles south of Livengood. The exact location is El Paso MP 389.5, a point on the east bank of the Tolovana between Shorty Creek and Winters Creek, 2 miles from the abandoned settlement of West Fork near the Elliot Highway. This would be most convenient location for a diversion, both from the standpoint of topography and overall directness of route. From here the pipeline corridor would trend southward in a straight line along the eastern margin of the Tolovana Valley, surmounting the end of a ridge at 1,300 feet elevation, descending to and crossing the Tatalina River. The route would then follow the eastern margin of the Minto Flats, crossing the Chatanika River, Goldstream Creek, the Alaska Railroad near Dunbar, and State Highway 3 (Anchorage-Fairbanks Highway). This valley margin route was chosen to minimize mileage in floodplains and to avoid poorly drained bottomland which, in the case of the Minto Flats, contains many swamps, bogs, and lakes characteristic of a permafrost basin. Instead, the suggested corridor would utilize river terraces, benches, and gently sloping valley sides which are well drained.

South of Little Goldstream Creek the corridor runs slightly eastward, crossing a ridge immediately north of the Tanana River at an elevation of 800 feet, marking the southern edge of the province. See Strip Maps 74A and 74B.

iii. Tanana-Kuskokwim Lowland

The Tanana-Kuskokwim Lowland is a broad depression lying north of the Alaska Range. The northern and western boundaries are marked by the Tanana and Kuskokwim Rivers, which border upland provinces to the north and west. It is formed largely of alluvial material originating in the Alaska Range. Coalescing outwash fans from that range slope 20 to 50 feet per mile northward to floodplains of the major axial streams of the lowland. Principal of these is the Tanana River, the largest tributary of the Yukon. Its floodplain averages 5 to 10 miles in width, with an active streamway 1 to 3 miles wide except where topographically confined. The river in this region is characterized by shallow, multiple, shifting channels, with many interspersed islands and sand bars.

The proposed pipeline route would cross the Tanana 6 miles east of Nenana at a point where the river is partially confined by a bedrock ridge on the north side and a moderately high, stable bank on the south; the river is approximately one-third mile wide at this point. From here the line would strike southward along the Totalanika River, ascending a gentle slope to the base of the Alaska Range Foothills. This route was chosen in preference to an alignment up the Nenana River Valley because it would be shorter and more direct, would avoid engineering problems in the Nenana Canyon, and would avoid land use/land status problems such as the Clear MEWS site and the entrance to Mt. McKinley National Park. See Strip Maps 74B and 74C.

iv. Northern Foothills

The Northern Foothills of the Alaska Range are flat-topped, east-west trending ridges, 2,000 to 4,000 feet in elevation, 5 to 10 miles wide, with intervening valleys of like width. The foothills are largely unglaciated, but some valleys have been widened by glaciers from the Alaska Range.

The pipeline corridor would enter the foothills via the gorge of the Totatlanika River and California Creek. This section would cross extremely rugged terrain with placement slopes as steep as 50 percent. Transverse slopes greater than 50 percent are generally unsuitable for pipeline placement unless the pipeline can be anchored to bedrock. (Lateral slopes can be greater than 50 percent, if stable, assuming that the pipeline can be accommodated by grading.) Bedrock exposures in this section should permit secure foundation.

From the Totatlanika Drainage the corridor would cross a ridge between Walker and Jumbo Domes, and descend to the Healy River at Usibelli. From here the line would continue south, crossing higher ridges of over 4,000 feet elevation before dropping to the 5-mile wide valley of the Yanert Fork. South of the Yanert Fork the corridor would enter the main spine of the Alaska Range. See Strip Map 74C.

Alaska Range

The Alaska Range consists of parallel, rugged glaciated ridges 5,000 to 9,000 feet high, surmounted by extremely rugged, ice-sheathed mountains which are grouped into identifiable massifs such as the McKinley massif in the west-central part of the range, which reaches an elevation of 20,269 feet, and gives rise to large valley glaciers, 5 to 40 miles long.

The corridor would cross one of the lowest portions of the range, lying between these massifs. The region is characterized by west-flowing tributaries and upper courses of the Nenana River. From the Yanert Fork the route would climb Revine Creek to a major summit at 5,200 feet, highest point on the entire pipeline. Here again, very rugged terrain is encountered with transverse placement slopes to 50 percent, but general presence of bedrock should assure secure anchoring. From the summit ridge the line would descend to the Nenana River, crossing near the mouth of Bruskasna Creek. See Strip Maps 74C and 74D.

v. Broad Pass Depression

The Broad Pass Depression, 1,500 to 2,800 feet in elevation and 5 miles wide is a trough whose floor is marked by pronounced glacial topography. It extends from the uppermost valley of the Nenana River west and southwest into the upper Chulitna Valley. The bordering mountain walls of the trough are 3,000 feet and more in height. Long, narrow, drumlinlike hills and moraines on the floor of the valley parallel its axis; depressions between them contain elongated lakes. The trough opens at its mouth into the Cook Inlet-Susitna lowland.

The pipeline corridor would enter this province at the Nenana River crossing, where it would turn southwestward along the southern edge of the Reindeer Hills, crosses the Denali Highway and re-enter the railbelt corridor just south of Cantwell. In this area the line would cross the McKinley strand of the Denali fault system, a major structural feature.

Broad Pass itself, at an elevation of about 2,700 feet, is the nearly imperceptible divide between the Interior-Bering Sea (Yukon) and Cook Inlet-Pacific (Susitna) Drainages. From here the line traverses the upper Chulitna River Valley, staying a couple of miles east of the railroad and highway on well-drained, gently sloping terrain. Through this area the pipeline would cross Hurricane Gulch.

South of the town of Hurricane the line would cross Chulitna Pass to the upper Susitna River Valley and then follow the Alaska Railroad to the vicinity of Curry. This alignment would be more direct than that of the state highway, which continues in the Chulitna Valley to the west; also it would avoid possible hazards of glacial surge or outwashing flooding by the Ruth and Eldridge glaciers which closely approach the Chulitna River from the west in Denali State Park.

vi. Cook Inlet-Susitna Lowland

A description of the Cook Inlet-Susitna Lowland Physiographic Province is contained in Section H-2.

The pipeline corridor to the West Kenai sites would stay just above the poorly drained lowlands of the broadening Susitna Valley on slightly rising benches and ridges. The line would cross the Talkeetna River about 4 miles east of the town of Talkeetna and just to the east of the Bartlett Earth Satellite Receiving Station. Near the town of Montana, the route would veer slightly to the west, crossing the railroad and highway south of the Kashwitna River. From here the line would follow the east bank of the Susitna, avoiding the active streamway and where possible utilizing the better drained, wooded, river terraces. The corridor would pass just west of the Nancy Lake State Recreation area, cross over to and follow a wooded, sandy terrace along the west bank of the Little Susitna River, reaching the shore of Cook Inlet in the Susitna Flats at a point between the mouths of the two rivers.

About 10 miles north of the inlet, the Castle Mountain fault system would be crossed; however, its exact location or the possible presence of active faults in the area has not been determined because of the depth of overlying alluvial material.

A submarine crossing of approximately 16 miles is contemplated at a point about 1½ miles west of Point Possession at the northern tip of the Kenai Peninsula. From here, a direct route 1 to 4 miles inland from the shore would be followed to either of the two potential LNG plant sites on the peninsula. The Nikiski route would avoid the Kenai National Moose Range except for a short section near Stormy Lake. The Cape Starichkof route would be approximately 22 miles longer through the moose range than the Nikiski route.

No active volcanoes exist along the proposed pipeline route. However, the intensity of seismic activities along the route is very high. An earthquake of magnitude 8.0 near the Denali fault could be expected. Major faults are the Denali fault in the Alaska Range, Castle Mountain fault in the Talkeetna Mountains, and Eagle River fault in the Chugach Mountains. The route could not avoid all the above fault lines.

Glacier and glacier-oriented floodplains would be avoided by the route. Geological explanations in the pipeline strip maps are shown in Table 33 . The separation of highway and railroad by a ridge would allow the use of a pipeline alignment which would avoid glacial flooding.

vii. Special Conditions

The Alaskan State Capital Site Selection Committee has made preliminary designation of three sites ranging in size from 200 to 550 square miles. Two of the preliminary designations are aligned with the pipeline near the towns of Talkeetna and Willow.

The Talkeetna vicinity includes a large glacial floodplain west of the Susitna River and bare rocks in the mountains east of the highway and railroad. This general relationship continues south to Willow. The pipeline would be located away from the highway and railroad to avoid conflict with rural development. Consequently, the alignment might conflict with prime sites for the new capital of the State of Alaska.

Since the suggested route traverses areas of Alaska rich in history, dating back to the Russian exploration and settlement, surveys of the corridor could reveal important historical resources. The Kenai Peninsula has two sites on the National Register of Historic Places -- at Kenai, the Church of the Assumption of the Virgin Mary, and at Hope, the Hope Historic District. The Dry Creek Archaeological District, a National Register property at Lignite, north of Mt. McKinley National Park, would be along this alternative.

Few known archaeological sites are located along this route, yet the discovery of microblades, large worked blades, and lanceolate points indicates that archaeological surveys along this alignment should be thorough. Artifacts of this description are typical of other early archaeological sites in Alaska. Careful survey is also required due to the presence of recent Tanana sites which may be of value in ethnohistorical and ethnoarchaeological studies of the region.

viii. Existing Recreation Facilities

Recreational use of this region of Alaska is high and there are many high quality recreation areas available. The state's population is concentrated along the route and access to the area is more highly developed than any other area of Alaska. See Section B-13 for description of the recreation and aesthetic resources of interior Alaska.

Adjacent to this route, the 2 million-acre Mount McKinley National Park lies roughly midway between Anchorage and Fairbanks. It is a scenically splendid area with the awesome form of Mount McKinley, surrounding mountains, and rolling alpine tundra and abundant wildlife resources.

In 1974 (January through September), approximately 162,000 recreational visits were recorded in Mount McKinley National Park, accounting for a total of 104,037 overnight stays. Visitors engage in wildlife viewing, camping, hiking, mountain climbing. Facilities in the park include a concessionaire-operated lodge with accommodations for 488 persons a night, campgrounds for campers, trailers, and tent campers along the park road with a total of 208 camping units. Data on recreational overnight stays at Mount McKinley National Park for January through September are as follows:

Concessionaire Lodging	28,026
Park Campgrounds	56,635
Park Backcountry	17,105
Youth Hostel and Group Camp	2,271

The State of Alaska has developed high quality recreation areas along this route. Visitor statistics for specific areas are unavailable. The following is a list of recreational areas administered by the Division of Parks, State of Alaska. Recreational uses, size, and location are given.

Big Lake (South Wayside) - Wasilla, 16 acres
Camping, picnicking, canoeing, boating and fishing

Big Lake (East Wayside) - Wasilla, 19 acres
Camping, picnicking, swimming, canoeing, boating and fishing

Rocky Lake Wayside - Wasilla, 48 acres
Camping, picnicking, canoeing, and boating

Nancy Lake Recreation Area - Willow, 22,685 acres
Camping, picnicking, canoeing, and fishing

Nancy Lake Wayside - Willow, 35 acres
Camping and fishing

Willow Creek Wayside - Willow, 40 acres
Camping and fishing

Denali State Park - Cantwell, 282,000 acres
Camping, canoeing, fishing and swimming

Chugach State Park - South-central Alaska, 495,204 acres
Camping, picnicking, fishing, canoeing and hiking

Mirror Lake Wayside - Eagle River, 90 acres
Pincicking, boating, fishing, canoeing, and swimming

Peters Creek Wayside - Eagle River, 52 acres
Camping, fishing and picnicking

Bernice Lake Wayside - Kenai, 7 acres
Camping, boating, canoeing, fishing and swimming

Captain Cook Recreation Area - Kenai, 3,620 acres
Camping, boating, canoeing, fishing and swimming

ix. Proposed Recreation Facilities

Mount McKinley National Park was established in 1917. A proposal exists to add approximately 3.18 million acres to the present park which now includes about 2 million acres. About half of the proposed additions are to the north of the existing park, and constitute critical wolf, sheep, moose and caribou range necessary to ensure the continued viability of the ecosystem of the Mount McKinley area. The area also has important waterfowl values. The remaining half of the proposed acreage is to the south of the park. These additional areas would be managed as natural areas with the primary objectives of preserving the large mammal ecosystem and the scenic beauty of the area; development would be minimal, with emphasis on the recreation potential of the area in its natural condition. Park Headquarters would be relocated from its present site north of the Alaska Range to the south side of the range.

A cooperative planning and management zone, adjacent to the south and east boundaries of the expanded park, has been designated on the maps referred to in proposed legislation (H.R. 7900). This area encompasses the lands on the threshold of Mount McKinley.

It is anticipated that the proposed additions, combined with developments in nearby Denali State Park and in the Cooperative Planning and Management Zone would serve to meet a significant portion of the growing demand for recreational opportunities on the part of residents of south-central Alaska.

x. Aesthetics

The area through which this alternate system would pass has undergone intensive development, including construction of a highway, railway, and a small-diameter natural gas pipeline. The most densely populated area of Alaska lies along the route. With the exception of the pipeline's southern terminal, the impact of gas pipeline construction would not add significantly to the impacts already existing from previous development. Some inconvenience would be imposed on travelers and vacationers while construction is underway.

The Kenai area is already a center of petrochemical development. The addition of personnel involved with construction and operation of this project would add to recreational demand of surrounding areas. Recreational facilities of this area, however, are presently overused during many of the summer weekends.

The most adverse aesthetic impacts of this project would be most noticeable where the pipeline passes close to Mount McKinley National Park, the area west of Anchorage, and in the recreation areas and streams in the Susitna Basin and the Kenai Peninsula.

xi. Soil Conditions

Wetland was avoided along the route as much as possible. However, some wetland would be crossed. Wintertime construction would be required in such wetland due to better soil conditions during winter.

Permafrost areas would require special engineering considerations. A detailed discussion of permafrost and the impacts of pipeline construction on permafrost areas are presented in Section B-3 and C-3. Surface soil conditions along the route are summarized on pipeline route maps. An explanation of soils denoted on pipeline strip maps is shown in Table 33.

xii. Vegetation

Vegetation Along the Pipeline Corridor

Vegetation communities in Alaska are commonly separated into 10 different types of life zones. They are coastal forest, bottomland spruce-poplar forest, upland spruce-hardwood forest, lowland spruce-hardwood forest, high brush, low brush bog-muskeg, moist tundra, wet tundra, and alpine tundra barren. Each of these types is present somewhere along the corridor. The coastal forest, moist tundra, wet tundra, and alpine tundra are described in Section B-7 of this report. The remaining communities are described below. The occurrence of these communities is shown in the pipeline strip maps, Figures 74A through 74K.

Bottomland Spruce-Poplar Forest

This is a tall, dense, mixed forest found on floodplains, low river terraces, and warm south-facing slopes, usually in the interior regions. Balsam, poplar, and black cottonwood invade floodplains and deglaciated valleys where they are eventually succeeded by white spruce if no further disturbance occurs. The dense undergrowth, typical of this community, includes berries, willows, roses, Labrador tea, grasses, lichens, and mosses.

Upland Spruce-Hardwood Forest

This is a fairly dense forest of white spruce and hardwoods found on higher parts of interior valleys and better drained lowland areas around Cook Inlet. Hardwoods include poplar, with Alaska paper birch and aspen being successional species. Black spruce may replace white spruce on poorly drained sites and north slopes. Typical understory plants are willow, alder, cranberry, raspberry, currant, ferns, and mosses.

Lowland Spruce-Hardwood Forest

This is a dense to open stand of black spruce and hardwoods on shallow soils, outwash plains, and north-facing slopes. The tree species are the same as for upland spruce-hardwood forest and the two types are often mixed around Cook Inlet. Mature spruce-hardwood forests provide lichens in open stands for caribou winter range. Shrub stages are used extensively by moose and black bear.

High Brush

This is a dense deciduous brush community that may have a few small trees. Several subtypes are found. Coastal alder thickets occur on the east side of Cook Inlet and on the coast. Floodplain thickets are found between the timberline and the alpine tundra and are more open in form with considerable lichens and heaths.

Low Brush Bog-Muskeg

A few trees, dwarf shrubs, sedges, mosses and lichens make up this bog type found in lowland, flat, wet basins. Around Cook Inlet, muskegs may have western hemlock and cedar on drier parts. Interior bogs have no trees, and are characterized by patches of grasses. Waterfowl make extensive use of this vegetational community.

The standard for locating the pipeline was to use well-drained vegetation to minimize the problems encountered in piping water along the trench in critical locales such as aquifer recharge areas. The vegetation does provide wildlife habitat and the concentrations of the latter were avoided rather than any particular vegetation community.

The basic impacts of the pipeline construction would be vegetation removal and human intrusion with possible introduction of toxic pollutants along the corridor. The vegetation removal would be most noticeable in forested areas. Approximately two-thirds of the proposed pipeline lies in forested area. Details concerning impacts of pipeline construction on vegetation in the Alaskan environment are covered in Section C of this report.

The major animal species impacted by construction along the suggested route are listed in Table 36. The relative values used as criteria for assessing impact are found below.

Efforts were made to keep the pipeline routes out of concentrations of major species, but this was not always possible. Breeding and calving concentration areas are examples of critical areas that were avoided because of the prospects of interrupting reproduction activities.

The fauna along the pipeline corridor include all the major species found in central and south-central Alaska. Details on these species are presented in Section B of this report. The abundance and distribution of the animals depends on the habitat encountered. Table 21 gives a list of the major animal species found along the pipeline route. The list of major species in the table is broken down according to the habitat usage and approximate pipeline milage for each species. The value of a particular habitat area varies with the type of use it receives and its geological location. Each habitat was given a relative value of high, medium, or low. Their values were established according to the following criteria:

1. High

    a. species population density high

    b. endangered status for the species

c. habitat type is a limiting factor for the species

d. intense use of species by humans

e. habitat or animal has legislative protection

2. Medium

a. species population density medium to high

b. habitat receives concentrated use but is not limiting

c. general use of species by humans

3. Low

a. species population density low

b. habitat receives general, dispersed use

c. little use of species by humans

A detailed analysis of the impact of pipeline construction on Alaskan wildlife is provided in Section C of this report.

The impacts of construction and operation of the suggested pipeline alternative on topography, soils, land use, socio-economic environment and on the air, noise and water quality would be similar to those previously discussed for El Paso's prime route proposal.

It is the staff's opinion that the previously described pipeline route from Prudhoe Bay to Cape Starichkof is a viable alternative to El Paso's proposed route and does not present any significant environmental disadvantages relative to El Paso's prime route.

g. Alternative of Additional Summer Construction

A summary of those areas where El Paso contemplates that construction would be limited to only the summer season is given in Volume II of the Application, Pages 2.2-4 through 2.2-12. The areas identified amount to approximately 134 miles, or some 17 percent of the total length. While the environmental staff essentially agrees with the applicant's analysis as presented in those pages, it is felt that in view of the difficulties experienced during winter construction by Alyeska, the winter construction rates anticipated by the applicant may be overly optimistic. If and when El Paso did indeed find this to be the case, only a limited number of alternatives would be available. Equipment and manpower could be substantially increased in an attempt to keep abreast of the presently proposed construction schedule, possibly in conjunction with a time extension of the schedule. This alternative would tax the project's feasibility. The other alternative would be to increase the amount of construction scheduled during the summer, which would result in a less intensive construction program but probably a far greater environmental impact.

The environmental staff assumes that significantly more than the 134 miles of summer construction proposed by the applicant would be necessary. It follows that increased impacts on the topography, soils, vegetation, wildlife, water resources, and aquatic biota would be expected, the degree of which would depend on and be determined by how much additional summer construction is necessary and where the construction takes place. The environmental staff therefore recommends that El Paso consult with Alyeska and state and Federal authorizing officers on the scheduling of construction during both the summer and winter seasons.

2. Alaskan LNG Sites

a) Introduction and Methodology

The discovery of vast recoverable natural gas reserves on the North Slope of Alaska coupled with the continually expanding energy requirements of the United States has provided the stimulus for the development of natural gas transmission, storage, and liquefaction systems which would be capable of providing additional sources of energy to meet the demands of the country. Conversely, the rising concern over the protection and preservation of unique and sensitive environments as well as the need for efficient human safety measures has tended to decelerate the rapid development of such facilities without extensive research into the resulting environmental impacts from projects of this magnitude. The resultant effect of these two trends has been to require that potential LNG terminal sites be selected with equal consideration allotted to the feasibility of the site to comply with the basic economic and physical requirements of the project, as well as the ability of the project to operate harmoniously with existing environmental and social conditions.

In an effort to determine the most suitable location for development of the LNG terminal, from both environmental and project success standpoints, a multi-faceted site selection analysis was conducted by the Federal Power Commission staff. Certain basic physical requirements necessary for the success of the project were combined with environmental and safety-related concerns to formulate several criteria that were applied to areas on both a regional and local level.

The initial process of the site selection analysis involves the study of the physical conditions characteristic of the coastal regions of Alaska to determine if these conditions are conducive to development of the facility. The nature of the proposed project, which necessitates the marine transportation of liquefied natural gas (LNG) in coastal waters and the consequent construction and operation of offshore docking and loading facilities, dictates that the oceanographic and climatological conditions in the area must be moderate enough to permit safe and economical operation of transport vessels with minimum periods of adverse, nonoperational conditions.

When a region under study was determined to exhibit generally favorable physical characteristics conducive to the operation of the marine components of the project, the area was divided into subregions, and the scope of the study was expanded to include an investigation into the availability and suitability of land areas within the subregion, which would be necessary to support the land-based components of the project. Since a coastal location is a necessity for LNG terminals, a correlation between the physical characteristics of land areas and adjacent watercourses, and the basic requirements of the project are analyzed on a subregional level. Within each acceptable subregion, suitable tracts of land are identified, and each tract was considered a potential terminal site and subjected to a site specific analysis.

The site specific analysis correlates the physical and environmental characteristics of each identified site with the requirements of the project and with the demands or stresses the project would place upon the existing environmental and social conditions. Each site is initially rated as to its physical ability to support the proposed facility, and those sites displaying the most favorable characteristics are subjected to further in depth analysis. In order for a site to be considered suitable for development, it must satisfactorily comply with the basic requirements necessary for the success of the project, and it must exhibit a degree of environmental and ecological stability such that the project could be implemented with a minimal amount of environmental disruptions.

b) LNG Terminal Siting Criteria

The following discussion provides detailed descriptions of the physical criteria that were applied to formulate the evaluations and ratings of each potential site as to its ability to accommodate the proposed project. Wherever possible, actual maximum or minimum limits of acceptability have been assigned in the definitions of the criteria, and both general and specific requirements are included in the definition. In many instances, however, the subjectivity of the criteria or the number of offsetting factors involved would not permit the assignation of such limits. In these instances, the criteria are presented solely on a general, subjective basis.

An ideal site would meet or exceed all the requirements established in the criteria; however, it should be realized that the possibility of locating such a site is remote. Therefore, the terminal site considered most suitable for development would be the one whose physical characteristics correspond most closely to the requirements set forth in the criteria.

i. Topographic Conditions

The potential site should satisfy certain topographic requirements which have been imposed to insure the integrity of the plant and to minimize preconstruction site preparation.

The minimum elevation of the plant site should be 100 feet above sea level in order to avoid damage to plant structures from seismically induced sea wave run-ups.

The slope of the site should be minimal so as to avoid the need for additional booster pumps and appurtenant equipment used to circulate seawater for cooling purposes, but should still permit adequate site drainage. Poorly drained sites could increase the potential for the disruption of groundwater regimes as well as increase construction costs.

The site should have few topographic irregularities such as hills, valleys, or terraces to preclude extensive preconstruction site preparation. The presence of large topographic irregularities or sites which would require excavation into the bases of mountains would necessitate the hauling of large quantities of spoil material and the consequent development of spoil disposal sites which would increase costs as well as increase the potential for additional adverse impacts.

ii. Foundation Conditions

Foundation conditions at the site should be such that adequate stability would be provided during both static and dynamic conditions.

Soils should be dense and granular to provide strength and well graded for resistence to settlement.

If bedrock is present, it should be relatively close to the surface in order to preclude high tension pile loads, but at a sufficient depth to avoid interference with preconstruction site preparation.

iii. Seismic Considerations

The plant site should not be located on or adjacent to any active fault zones which could jeopardize the structural integrity of the facility through ground movement or other related events which could accompany a major seismic disturbance.

The soils at the site should not be subject to liquefaction during seismic events, and should retain their foundation stability under dynamic stress.

The site should not be located in or near areas where unstable submarine slopes could undergo sliding during seismic events. The potential for subaqueous landsliding implies a high potential for developing destructive waves of local origin.

The site should not indicate a potential for extensive shoreline damage from tsunamis. Areas with past histories of shoreline damage could pose a threat to the integrity of a marine terminal and/or storage facility.

iv. Atmospheric Conditions

The plant site should be relatively well sheltered and should permit safe and economical year-round operation with minimum periods of down-time resulting from adverse climatic conditions.

Winds exceeding a velocity of 30 miles per hour should have a low frequency of occurrence and should be of short duration. High winds could hinder LNG carrier maneuvering, and wind loads imposed upon the mooring lines or on the fendering system could require a ship to vacate its berth. (The mooring system at each berth would be designed to hold an LNG carrier in winds up to 60 miles per hour.)

Periods of reduced visibility resulting from fog and/or precipitation should also have a low frequency of occurrence and minimal persistence. Extended or frequent periods of reduced visibility could increase the risk of ship accidents (collisions, groundings, etc.) or require temporary suspension of docking or loading procedures.

v. Oceanographic Conditions

The site should offer as much protection as possible from exposure to waves and currents of magnitudes which could hinder the safe operation of LNG tankers.

Swell heights in excess of 4 feet should have a low frequency of occurrence at the site. Wave action can cause ship movement at the berth and increase the potential for hull and berth damage.

vi. Distance to Deep Water

The minimum acceptable water depth at the berth at mean lower low water should be 47 feet in areas not susceptible to wave action. Areas exposed to wave action should have a 50 to

60-foot water depth at the berth to accommodate increased vertical ship movements. The distance from the berths to the shore should be as short as possible to reduce both costs and revaporization problems that would be associated with a long cryogenic transfer line. Modern technology would allow for a transfer line approximately 2 to 2.5 miles long before revaporization problems would be encountered.

vii. Navigational Suitability

The nature and configuration of the approach channel should be such that navigation would not be hampered at any time.

The size of the approach channel should be three times the beam of the ship when traffic is limited to one-way movement, and six times the beam of the ship when two-way traffic is operating. Minimum channel depths should be 47 feet in areas sheltered from waves and 50 to 60 feet in areas subject to wave action. All turns along the channel should be gradual and should not require any unsafe maneuvers.

Areas with minimal amounts of vessel traffic congestion would be preferable. In areas where there is a moderate to heavy concentration of vessels, traffic patterns should be well defined.

Areas in which established traffic safety systems are in service should be utilized whenever possible. The systems generally consist of two separation lanes, with each lane used for traffic moving in a single direction, and with a buffer zone between the lanes.

The land bordering the areas in which the LNG carriers would maneuver should be well marked or capable of being marked with lighted aids to navigation.

viii. Anchorage Suitability

At least one area suitable for anchoring the LNG carriers should be available in the vicinity of the marine terminal site.

The bottom conditions at the anchorage area should be firm enough to provide good holding power, and the water depth should not exceed 200 feet.

The anchorage area should be away from vessel maneuvering areas or channels and should be of sufficient size to permit the ship to swing with the wind or current.

ix. Ice Conditions

The formation of sheet ice or the passage of ice floes of a magnitude which would prevent the safe and economical year-round operation of the LNG carriers should not be characteristic of the waters in which the ship would travel.

x. Land Use Conflicts

The proposed site should not be located where conflicts would arise between operation of the proposed project and existing, planned, or potential land uses on or near the proposed site, including commercial, recreational, or conservation-oriented activities.

c) Regional Overview

For the purpose of correlating the general physical characteristics of the coastal areas of Alaska with the fundamental requirements of the terminal project, the coastline of Alaska has been segregated into five distinct regional units. Each unit has been delineated on the basis of its combined relationship to the climatic zones of the state, the regional planning units as designated by the Joint Federal-State Land Use

Planning Commission, and the geographical extent of the oceanic bodies bordering the Alaska coasts. The location and extent of each regional unit are shown in Figure 75, and the following discussion describes the physical environment of each unit and an evaluation as to its suitability to accommodate year-round marine transport operations.

i. Region I

Physical Environment

Region I encompasses the northernmost coastal area of Alaska, and is bordered in part by both the Arctic Ocean and the Beaufort Sea. Climatic conditions may be characterized as Arctic in nature, but may be very unpredictable. During the winter months, the north coast of Alaska often experiences winds up to 55 knots and occasionally to 65 knots (near Barton Island). Average wind speeds are approximately 13 knots. Precipitation is usually light, averaging from 4 to 10 inches, although snowfalls measuring 46 inches and 27 inches have occurred at Barton Island and Barrow, respectively. Whiteouts due to ice fog are common occurrences when temperatures drop below $-20^{o}F$. Fog is common during the summer months and occurs on an average of 65 days per year.

Sea ice conditions reach their maximum extent in the arctic waters during the winter and into early summer (April through June). The blanket of ice that covers the Arctic Ocean varies greatly in extent and nature from year to year, and is greatly influenced by variances in meteorological conditions. The maximum thickness of annual ice along the coast varies from 6 to 7½ feet, while multi-year ice averages about 11 feet in thickness. Individual icebergs vary greatly in size, and some have reached 700 feet in height above water and extended to ocean depths of over 1,000 feet. During its period of minimum extent, during the third quarter of the year, considerable numbers of floating ice masses are present in open water areas.

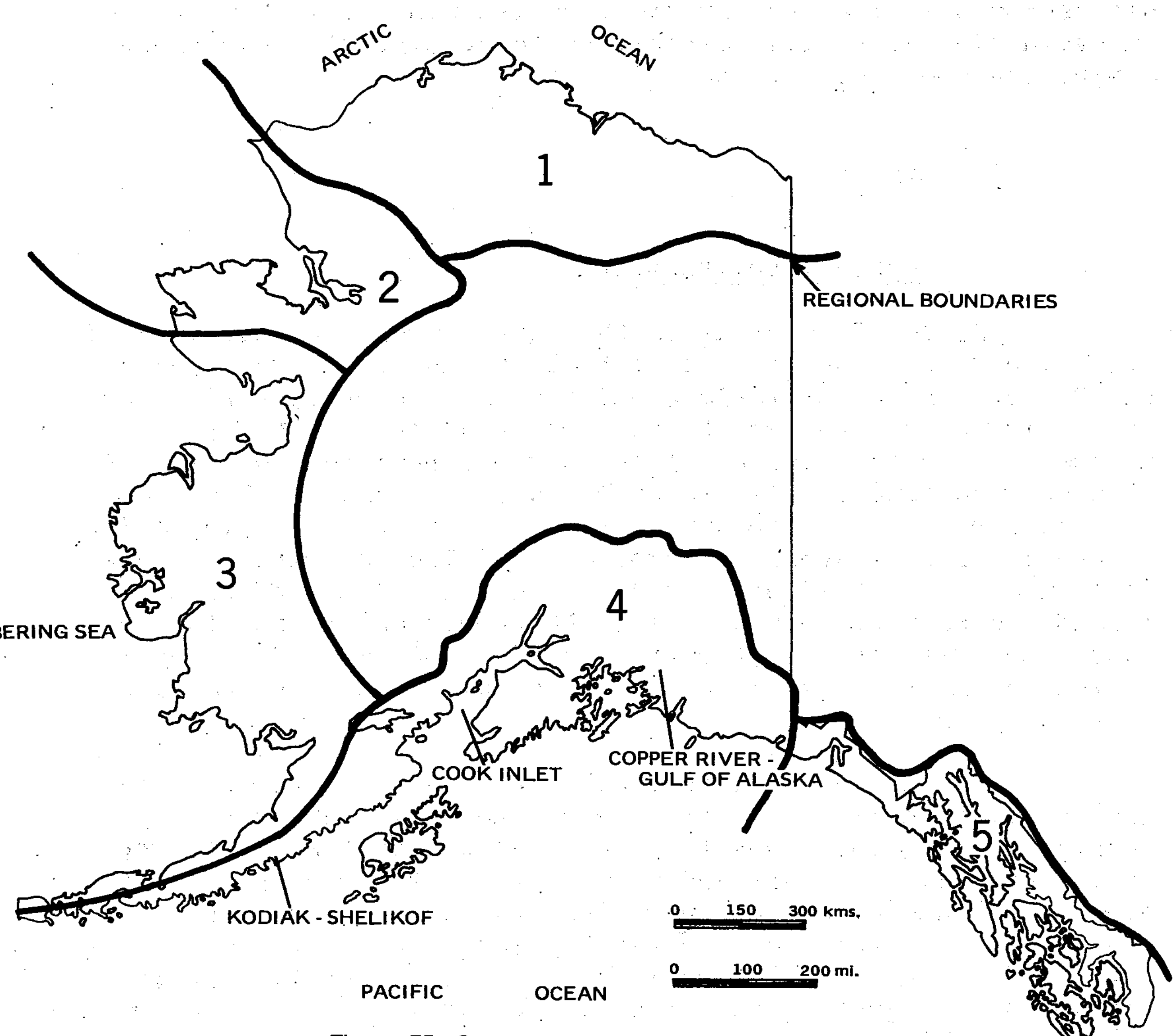


Figure 75. Coastal Regional Divisions of Alaska

Navigation in Arctic waters is difficult from mid-October to late July, and ship movements are usually suspended from early December to early July. In general, the continued unpredictability of ice movements, closing of leads, and wind direction changes make year-round navigation in Arctic waters hazardous. Figure 76 shows the distribution of sea ice during its minimal and maximal extent along north and west Alaska.

Evaluation

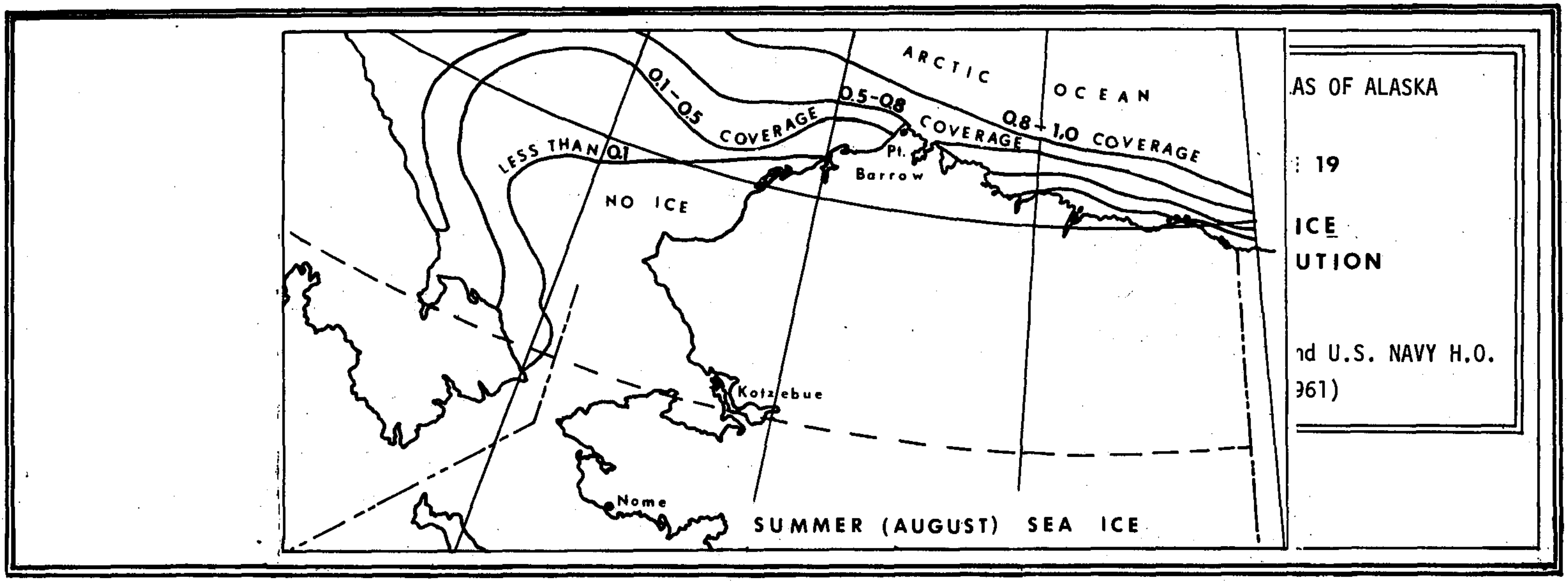
The presence of vast surfaces of annual and multi-year sea ice, in combination with open ocean floating ice masses and unpredictable meteorological conditions would not be conducive to year-round operation of LNG tankers both in coastal water approach routes and open ocean areas in Region 1.

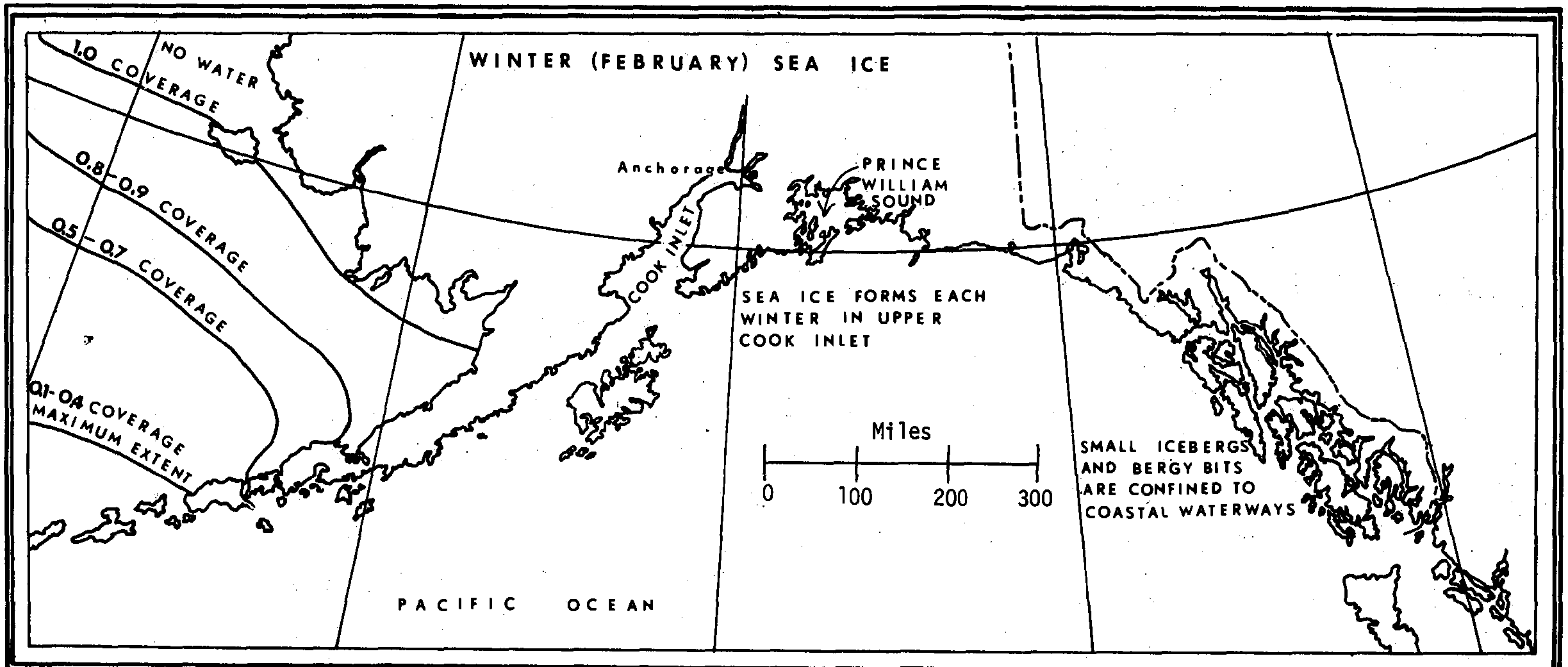
ii. Region 2

Physical Environment

The Chukchi Sea forms the oceanic boundary of Region 2 which extends from its northern limit at Cape Lisbon to the lower reaches of the Seward Peninsula. Meteorologically, the area exhibits many of the same characteristics as Region 1, and sea ice conditions are also similar. (See Figure 76 .)

Ice formation commences in late August, and by late November, the Bering Strait and adjacent areas are usually closed to navigation except for shallow draft vessels which use near-shore leads. The ice begins to break up in June, and is usually accompanied by heavy drifts. The receeding ice pack generally moves offshore in a northerly direction, and although the ice mass may be a considerable distance from land, sudden and violent wind changes may move the ice back to shore in a few hours. During the summer thaw periods, heavily massed floe ice frequently moves in and out of the area.





FROM: U.S. COAST AND GEODETIC SURVEY, 1966

Figure 76. Sea Ice Distribution

Evaluation

The presence of heavily massed sea ice during winter and moving ice floes in summer coupled with unpredictable and harsh meteorological conditions make Region 2 unsuitable for year-round tanker operations.

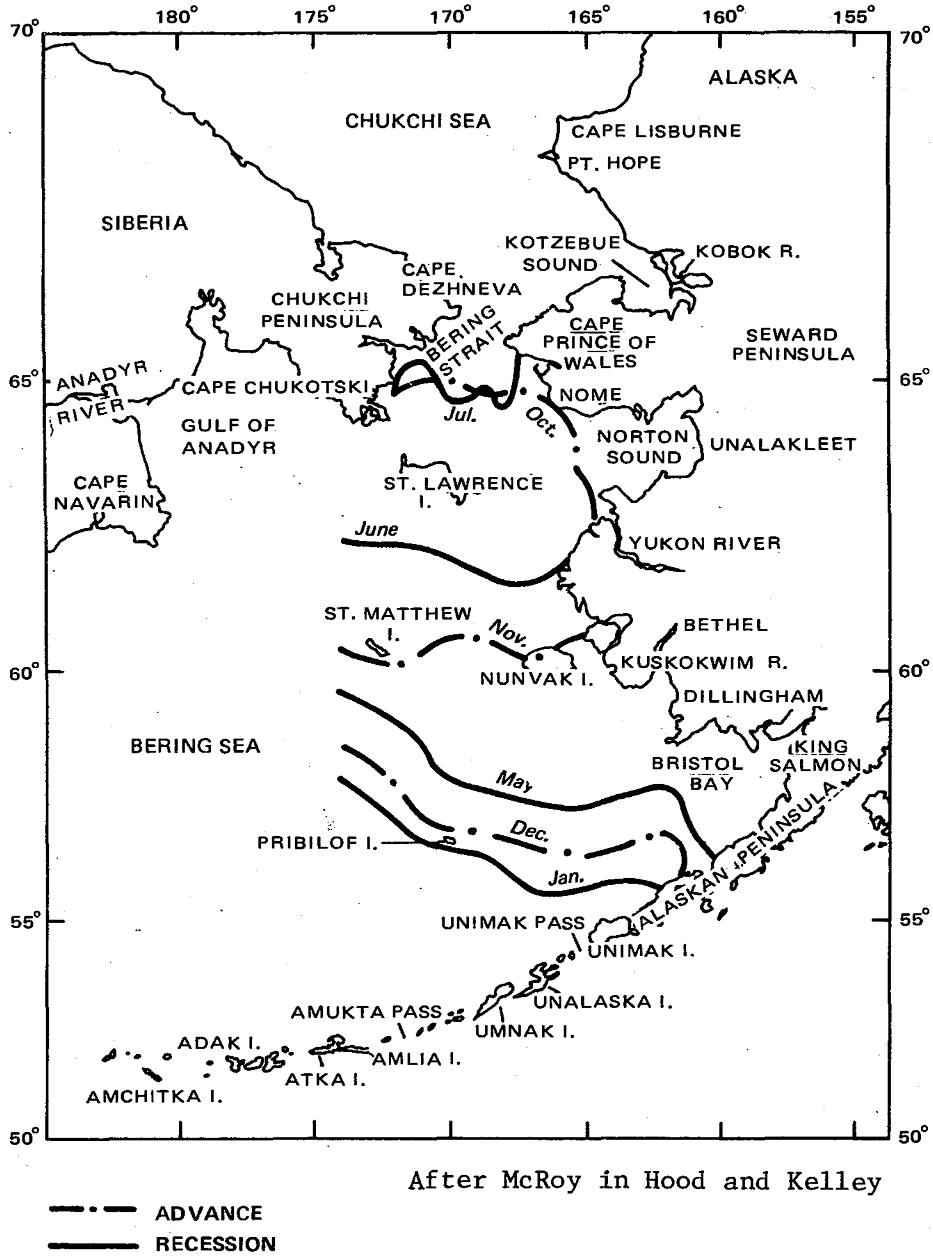
iii. Region 3

Physical Environment

Region 3 encompasses the area extending south from Norton Sound to the Aleutian Chain, and borders entirely on the Bering Sea. Meteorological conditions can be classified as maritime in the summer when much of the sea is ice-free, and continental in the winter when coastal waters are blanketed with ice masses.

Foul weather is most prevalent throughout the Bering Sea and along its coasts. The sea is frequented by winds, most of which blow at 22 to 44 knots, although higher winds blow periodically. Gale winds, 28 knots and above, are most common in the fall. In late spring and summer, the winds are usually accompanied by fog and rain which often restricts visibility. Fog occurs in every month of the year along the coast, and blowing snow conditions during the winter reduce the periods of good visibility along the coast. Ice fog is also a frequent occurrence along the Bering Sea coast, and when combined with light winds may be quite persistent.

Sea ice is characteristic of both the Bering Sea and its coastal areas. As in the regions previously discussed, the extent and nature of the ice varies considerably and results in generally unpredictable conditions. Ice formation usually begins in October, and by December the ice encompasses the entire region from Norton Sound to the Alaska Peninsula. (See Figure 77.) The ice is constant until the breakup begins in early June, and by late June the ice generally recedes to beyond Point Hope. By July, the ice retreats to the southern boundary of the Bering Strait.



After McRoy in Hood and Kelley

FIGURE 77-SEA ICE

Source: DOI Alaska Natural Gas Transportation System Draft Environmental Impact Statement, Part VI, Alternatives, Volume 2 of 2, p.VI-735; June 1975.

Ice breaking operations would be required to keep ports within the region open during winter months, and much of the area is considered generally hazardous to navigation throughout the year due to combinations of ice floes, sea ice, fog and rough seas.

Evaluation

The presence of extensive sea ice during winter periods in combination with frequently adverse and unpredictable weather conditions would not be conducive to safe year-round operation of LNG tankers in Region 3.

iv. Region 4

Physical Environment

Region 4 encompasses the south-central region of Alaska and extends from the Alaska Peninsula on the west to the Alaska-Canada border on the east. The region is bordered entirely on the south by the Gulf of Alaska.

The climate within the region can be classified as maritime and is strongly influenced by conditions in the Gulf of Alaska. Over the Gulf of Alaska winds are generally southwesterly to westerly during the summer and easterly for the rest of the year. Middleton Island, in the northern Gulf of Alaska has a maximum mean monthly wind speed of 15.2 knots in November, and during the summer months the mean monthly wind speed drops to about 7 to 9 knots. Wind speeds along the coast are generally more moderate than open ocean areas, due to the protection afforded by coastal mountains. Winds of 41 knots or more are reported 3 to 5 percent of the time in the ocean areas from October to February. Middleton Island reports winds of 41 knots or more about 1 percent of the time from October through March. High winds are rare during the summer. At protected coastal ports, such as Valdez, average wind speeds are less than open ocean areas, but funneling effects may greatly intensify winds.

Periods of restricted visibility (2 nautical miles or less) reach a peak in both winter and summer in the Gulf of Alaska. Restricted visibility occurs about 6.8 percent of the time in winter months, and in spring the frequency drops to 4.5 percent of the time. Peak summer months bring visibilities of 2 miles or less 6 to 12 percent of the time, and in the fall the frequency is reduced to 2 to 5 percent. Visibilities less than one-half nautical mile reach a peak of 6.7 percent in August and decrease to less than 1 percent in fall. Winter frequencies average about 2 percent.

Adverse navigational factors that would be encountered in the area include fogs, sudden wind and rain squalls, and snow storms. No sea ice forms within the region, with the exception of upper Cook Inlet. Marine ice conditions in Cook Inlet are a principal concern which must be considered in the design, construction, and operation of marine terminals and transport vessels. The ice varies in both nature and extent, and the intensity of the ice conditions is directly related to the severity of the winter season. The following excerpt (beginning on the following page) from a contract study of alternative sites in the Cook Inlet/Kenai Peninsula area prepared for the FPC by the Oceanographic Institute of Washington provides a description of marine ice conditions in Cook Inlet and their potential for constraining marine LNG operations.

Ice conditions within nearby Prince William Sound Subregion are vastly less prohibitive than those of Cook Inlet, and do not constitute a significant hazard to shipping operations. Ice is known to occur in the eastern region of the sound, but it is generally shore ice or "pan ice". This ice generally does not exceed 10 inches in thickness, and it has small areal extent. Ice is primarily found along the shallow shoreline waters and at points where freshwater flows into the sound. It has been reported that such ice has impeded small vessels in the Narrows, but does not pose a problem to large vessels.

EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON

4.3 Potential Oceanographic and Meteorological Constraints on Marine LNG Operations

4.3.1 The Cook Inlet Environment

4.3.1.1 Marine Ice Conditions

Ice is a major factor in the design of fixed structures in Cook Inlet. Ice is also a hazard to marine navigation and influences the design of vessels and location of facilities. The ice in Cook Inlet comes from four different sources. (F,8)

Sea Ice

This type is formed by sea water, first developing a thin crust on the surface and growing through the addition of ice on the bottom of the subsurface layer. Sea ice is predominant in Cook Inlet.

Beach Ice

The large tidal range in the Inlet accounts for the sudden appearance of a considerable amount of ice on the mud flats early in the winter. The ebbing tide exposes the mud to cold air, freezing the upper layer of mud. On the flood tide, the water adjacent to the frozen mud also freezes. Growth may be as much as an inch or more a day. Generally, however, a thickness no greater than about 20 inches is reached before the ice is pulled free of the mud. Some beach ice is lifted higher on the beach and some is carried out into the Inlet, where it grows much the same as sea ice.

Stamukhas

Observers have seen ice cakes greater than 20 feet thick on the mud flats. These result from beach ice which has broken free, been deposited higher on the mud flats, and frozen to the underlying mud. Ice floes floating toward the beach are caught on top of the higher piece of ice and, as the tide recedes, the overhanging pieces break off leaving a stack of layered ice with nearly straight sides. This process is repeated many times, being limited only by the height of the tides and the strength with which the original beach ice is frozen into the mud. On the high tide, occasional stamukhas of massive proportions are carried into the Inlet. Stamukhas 20 feet high, 30 feet wide and 60 feet long grounded on Middle Ground Shoal were observed by Pan American personnel in 1964.

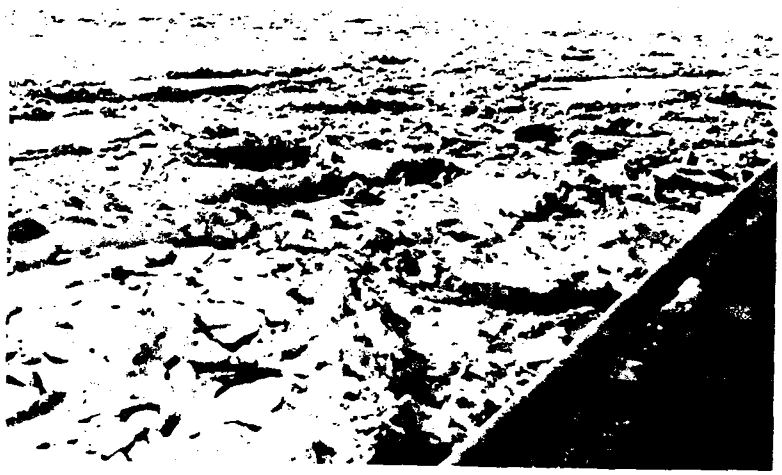
Estuary and River Ice

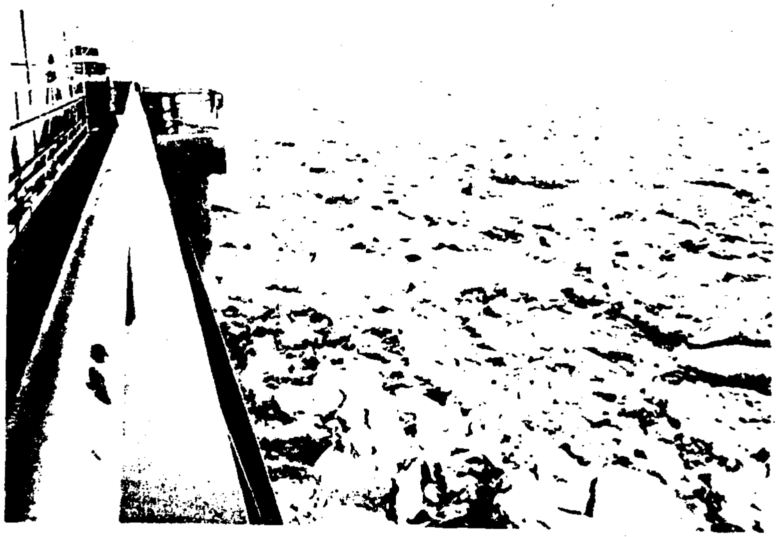
Fresh water ice forms during the winter

in estuaries and rivers around Cook Inlet. The estuary ice grows in the same manner as sea ice but is much harder. The river ice is unaffected by tidal actions and remains in the rivers until spring breakup. At that time, a considerable quantity of river ice with thicknesses up to 6 or 7 feet may be discharged into the Inlet.

The ice problem is most severe in Upper Cook Inlet (North of the Forelands). The port at Nikiski is somewhat protected from ice drifting down from the Upper Inlet by the constriction formed by East Foreland and by the winds which tend to blow the ice to the Drift River side of the Inlet. Nevertheless, Nikiski occasionally has ice problems which can be considered serious with regard to approaches, berthing, and loading operations. Figure 4-5 shows the ice conditions at a dock near Nikiski on March 24, 1972 (F,15). This situation may have occurred because of an onshore wind, which does not occur very often, but it does illustrate that the ice problem can be quite severe.

From January through April, 1972, there were ten ships damaged by ice in Cook Inlet, (F,5) (F,10) which was 7% of the 142 ocean going vessels that operated in the ice-stressed areas of Cook Inlet for that period. The ice casualty incidents are shown in Table 4-13 and Figure 4-6. It should





Dock near Nikiski, March 24, 1972,

Pictures Courtesy of Captain William L. Johnson, Alaska Marine Pilotage, Inc.

Figure 4.5

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TABLE 4-13

ICE CASUALTY INCIDENTS
COOK INLET
1971-1974

1-23-71	Anchorage Dock	Ice damage to tug rudder
2- 5-71	Between Anchor Point and Drift River	Tanker collided with ice
1-14-72	Drift River	Tanker emergency disconnect due to ice flow; spilled 1/2 bbl crude
1-25-72	Cook Inlet en route to Drift River	Tanker collided with ice
1-27-72	Cook Inlet off Kasilof	Tug collided with ice
1-27-72	Kachemak Bay	Vessel pushed ice through stern while mooring
2- 4-72	5 miles south Cape Ninilchik	Rig pusher and barge collided on ice
2-10-72	Anchorage Port	Vessel collided with dock
3- 7-72	Cook Inlet en route Homer to Drift River	Vessel collided with ice
2-16-72	Collier's Dock, Kenai	Barge collided with ice; caused by ice flow
3-21-72	Near Ninilchick	Tanker collided with ice
3-24-72	Near Platform "Baker"	Rig tender collided with ice and fixed object
4- 4-72	Collier Dock	Vessel collided with ice and dock
2-14-73	Drift River	Tanker emergency disconnect due to ice flow; spilled 10 bbls crude
3-23-73	Off Granite Point	Ice damaged vessel fuel tank; spilled 350-400 gal. diesel
3-10-74	Nikiski Dock	Tanker emergency disconnect due to ice flow; spilled 8-10 bbls crude

(From the files of Captain of the Port, U.S. Coast Guard, Anchorage)

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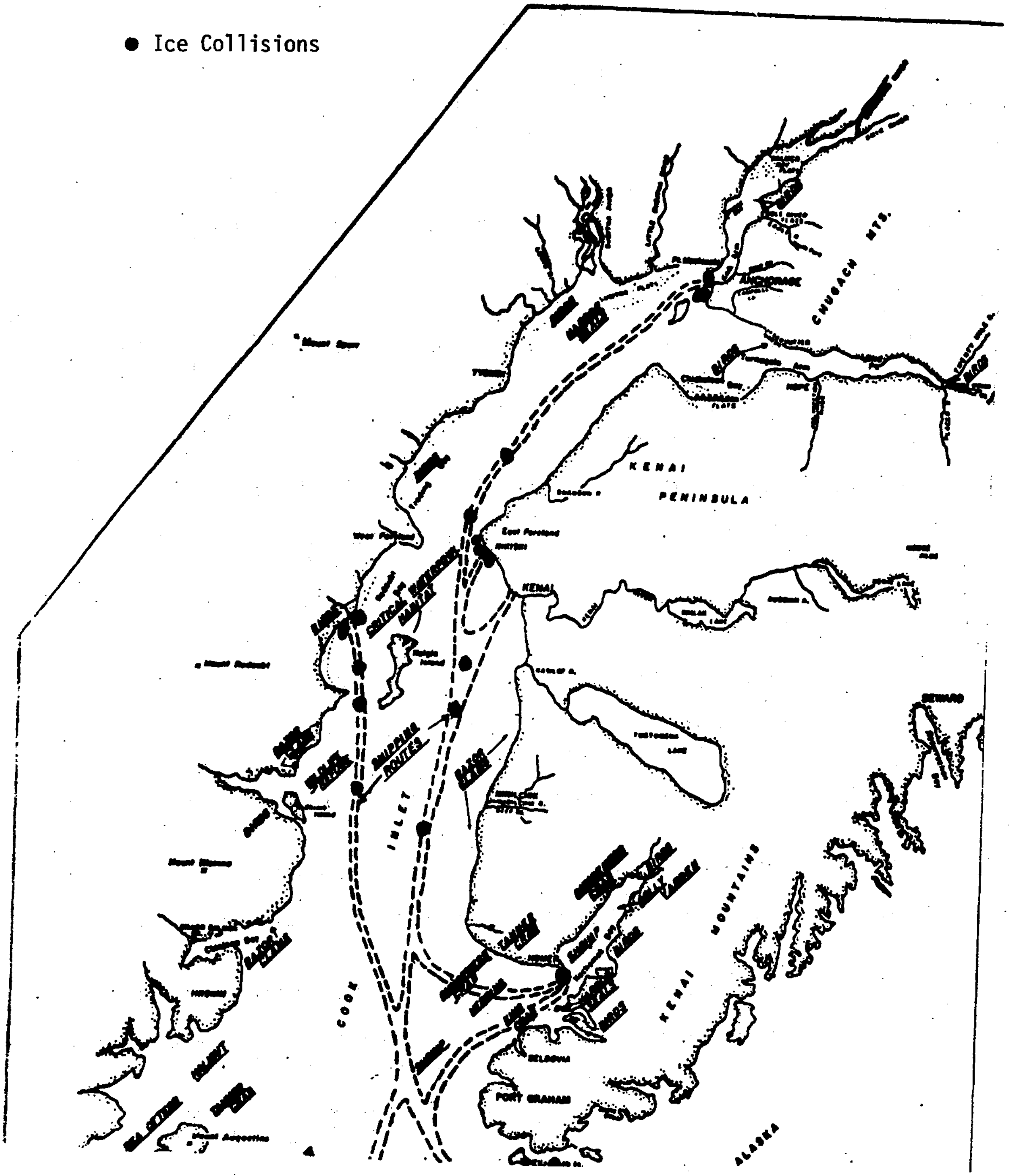

Figure 4-6 Ice Collisions, Cook Inlet

be noted (F,15) that the development of ice began slowly during the late fall of 1971, but persisted below normal temperatures during January, February, and March of 1972, resulting in a long and rough ice year.

By the 24th of January, 1972, very close pack ice existed from the Anchorage dock to Moose Point with close to very close pack south of Moose Point to Kalgin Island. From Kalgin Island south to Anchor Point and along the west side of the Inlet to southern Kamishak Bay, open to close pack had developed, with heaviest concentration along the edges of the Inlet.

By the end of the month of February close to very close pack persisted south to Cape Kasilof and and Chiskik Island. Variable amounts of floes and smaller ice chunks (brash) existed south to Anchor Point and Kamishak Bay.

During the latter part of March close to very close pack of brash and floes from 6 to 18 inches thick remained from Anchorage to southern Kalgin Island. From the southern part of Kalgin Island to Anchor Point on the east side of the Inlet and Chinitna Point on the west, open pack up to 6 inches thick existed.

The ice problem in Cook Inlet is quite variable and depends on the number of frost degree days. These days measure the departure of mean daily temperature from a standard of 32° F, one degree days for each degree of departure below the standard during the day. Figure 4-7 showing the cumulative degree days for the 1971-1972 winter, indicates a near normal accumulation of frost degree days during November and December, and a steady increase in the accumulated frost degree days through January, February, and March. The winter of 1970-1971 (F,14)was also a rough winter in terms of ice, with the number of frost degree days being similar to that of 1971-1972. Figure 4-8 illustrates the variability in the ice conditions as a function of the cumulative number of frost degree days.

The principal navigational hazard are the large "pans" (floes) which must be avoided. These ice floes can be a 1/2 mile wide with an average thickness of 4 to 5 feet. During the severe winter of 1964-1965, however, some ice floes were from 6 to 8 feet thick.

In spite of the obvious hazards and difficulties caused by the ice, the ports in Cook Inlet have been open year round for the past 10 years. It is reported that large vessels have no problem navigating in the ice, but this does not appear to be true for all the vessels. All reported accidents shown in Table 4-13 and Figure 4-6 occurred with older vessels which were not designed to withstand the ice conditions. No damage to date has been reported to newer vessels such as the LNG ships operating at Nikiski.

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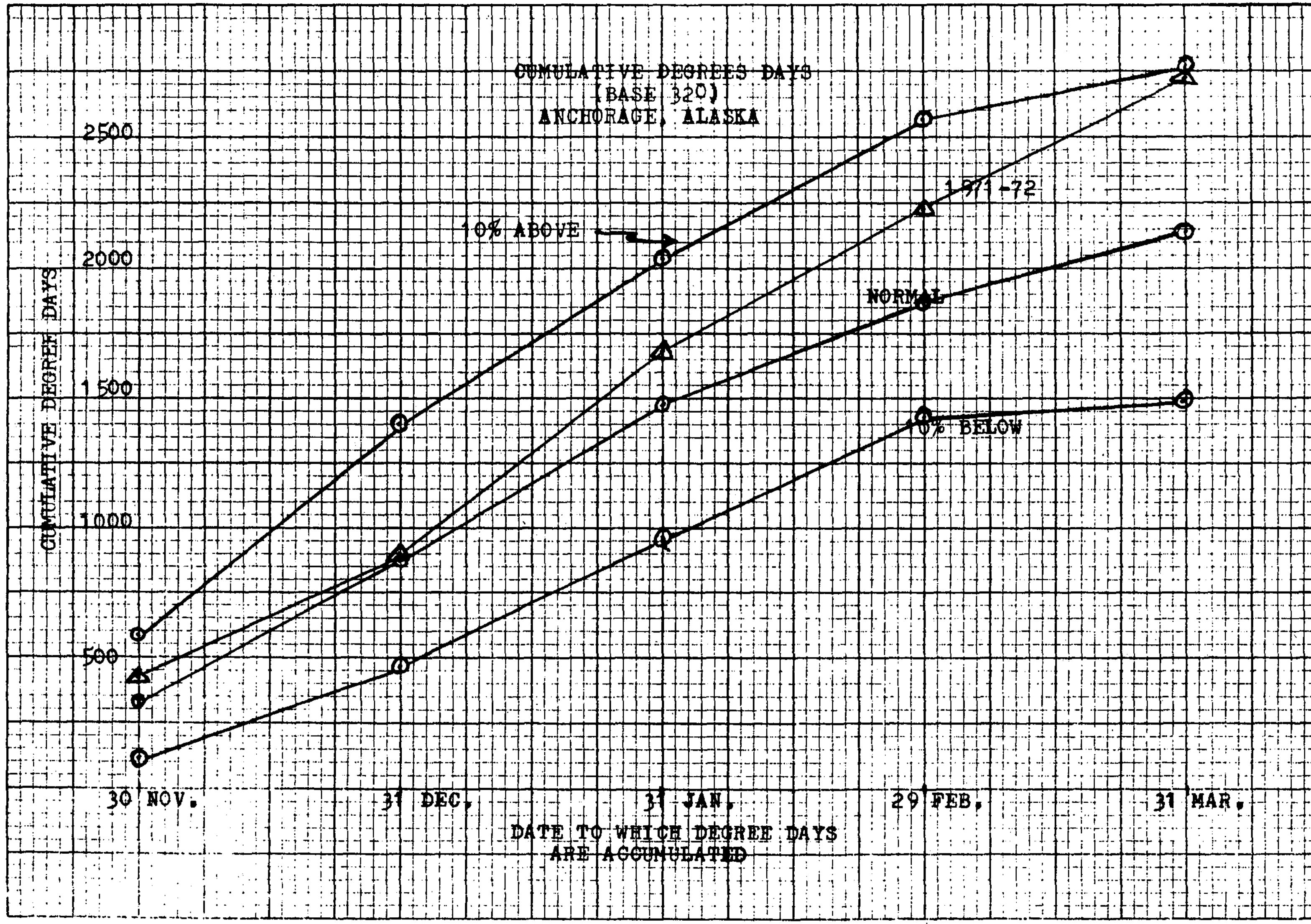

Figure 4-7

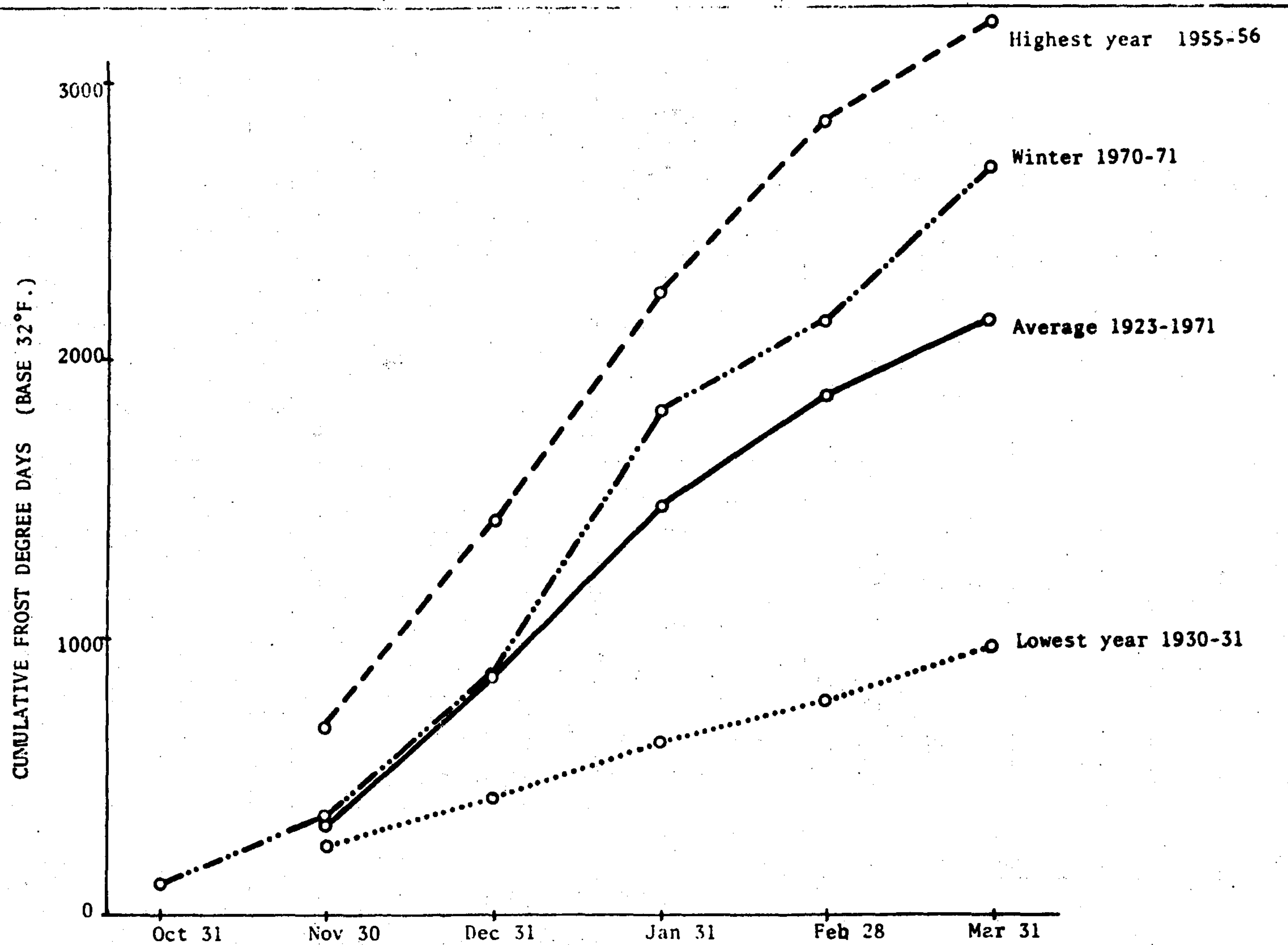

Figure 4-8 TOTAL FROST DEGREE DAYS TO DATE - ANCHORAGE ALASKA

EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON

The most serious ice problem for both petroleum and LNG vessels appears to occur during loading operations. It is worth noting that the location of 1/2 of the reported ice accidents reported from 1971-1974 were at docks. This is due to the fact that the ice tends to jam between the ship and the dock with the possibility of rupturing the loading arms. Mitigating measures for this problem have been incorporated at the present Phillips-Marathon facility at Nikiski. Fast release unloading arms are utilized, and the ship's engines are kept running under adverse conditions. If ice appears to be a problem, loading is interrupted. If the situation worsens, the loading arms are disconnected, and if necessary the ship gets underway. On one occasion during the winter of 1971-1972, five dockings during the course of a week were required to fill an LNG ship at the Phillips-Marathon dock at Nikiski. During normal operations, these ships require 15 hours to be filled. Such severe conditions are not the normal situation, and are dependent on the rare occurrence of an onshore wind. An abnormal situation such as this could result in a temporary queueing problem.

The ice problem decreases considerably in the southern part of the Inlet. Generally speaking, there is no ice, or very little ice, south of Anchor Point. This indicates that the Cape Starichkof site is relatively hazard free from ice conditions. It is stated

(F,13) that the Cape Starichkof site is ice free year-round. This statement is probably true for a normal winter, but some sea ice has appeared as far south as Anchor Point during severe winters.

There are conflicting opinions as to the relative seriousness of the ice conditions in Cook Inlet. There is little question that the ice is a hazard to navigational and loading operations. The problem resolves itself into the question of whether or not the risk level is acceptable. It is clear that in the Nikiski area companies such as Standard Oil Co., Tesoro Oil Co., Collier Carbon & Chemical Co., Phillip's-Marathon and Pacific-Alaska LNG Co. do not feel that the hazards are insurmountable. In addition, a petroleum facility with a sea island is in operation at Drift River, where the ice conditions are more hazardous than at Nikiski. Further, the more severe ice conditions north of the Forelands have not prevented year round marine traffic to Anchorage by other companies, including freight carriers such as Sea-Land and TOTE. Finally, permanent offshore wells are operating in areas where severe icing occurs.

In summary, although we have not attempted to define an acceptable level of risk in quantified terms for future LNG tanker operations in Cook Inlet, it is obvious that shipping companies, oil and gas companies, insurance companies, ports, governmental agencies (which issue permits), and others have accepted the present level of risk and are operating in this environment daily.

Evaluation

The general lack of large, solid masses of winter sea ice within the region allows for year-round operation of all ports within the region, and would not be restrictive to LNG tanker operation. Some periods of adverse conditions, such as storms and periods of reduced visibility would occur but would not unduly hinder tanker and terminal operation. Coastal water bodies offer some protection from adverse conditions, and appear to show favorable characteristics for terminal development. Two subregions, Prince William Sound and Cook Inlet, appear to be conducive for the location of terminal sites in that they offer considerable protection from adverse climatic conditions originating over the Gulf of Alaska. These two subregions also indicate a high potential for the discovery of suitable tracts of land from the standpoint of satisfactory topographic and geologic conditions, as they would relate to both terminal and connecting pipeline development, and satisfactory bathymetric conditions for marine terminal development.

v. Region 5

Physical Environment

Region 5 encompasses the southeastern portion of the state and extends from Icy Bay to the state boundary south of Ketchikan. The greatest portion of the region is bordered by the Pacific Ocean, with the exception of its northern reaches which border the Gulf of Alaska. The region lies well within the area of maritime influences which prevail over the entire coastal area of southeastern Alaska. The area is in the path of most storms that cross the Gulf of Alaska and consequently the region generally has moderate temperatures, little sunshine, and abundant precipitation. Maximum annual precipitation ranges from a low of 17.4 inches at Yakutat to a high of 202 inches at Ketchikan. Juneau, Haines and Sitka have intermediate average annual precipitation rates of 120 inches, 90.1 inches, and 140 inches, respectively. Prevailing winds at Haines are west and southeast, with Lynn Canal funneling the southeasterly winds. Strong winds may occur at any season. The strongest wind observed at Haines was in January 1952, with sustained speeds of 52 mph and gusts estimated at 65 mph. At Juneau, located to the southeast of Haines, the highest recorded wind speed of 58 mph occurred in November 1968. An estimated peak windgust of 130 mph occurred at Ketchikan during the same storm. Sea ice is not present in the region during any time of the year and ports remain open year-round.

Evaluation

The lack of winter sea ice within the region in combination with generally acceptable climatic conditions would permit year-round operation of LNG tankers and the associated marine terminal operation. The development of an LNG terminal within the region would require that a connecting pipeline be routed partly through Canadian lands, which could create both jurisdictional and political controversies. In a comparison between potential terminal sites in Cook Inlet (Redoubt Bay) and southeastern Alaska (Haines) contained in the United States Department of the Interior's (DOI) Final Environmental Impact Statement for the proposed Trans-Alaska Pipeline, 1972, they concluded that "Between the technically feasible pipeline route and terminal alternatives - Livengood to Redoubt Bay or Livengood to Haines - there appears to be no great environmental advantage in choosing one over the other." In view of this DOI conclusion, and the political implications that could arise from a Canadian connecting pipeline which are beyond the scope of this study, the staff has chosen not to analyze any specific sites within southeastern Alaska.

d) Site Specific Analysis - Prince William Sound Subregion

Within the Prince William Sound subregion, 11 potential terminal sites were analyzed and rated as to their suitability for LNG terminal development. Figure 78 shows the location of the sites. Each site was given a symbolic rating in each of 10 categories which represent the physical characteristics of each site as they relate to the developmental and/or operational requirements of the proposed project. (Detailed descriptions of each category have been presented in Section **H-2b)**. LNG Terminal Siting Criteria). The ratings assigned to each site are indicated in Figure 79.* Those sites which were rated as unsatisfactory in one or more categories were rejected from further consideration. Of the 11 sites that were studied, 8 were considered unacceptable in meeting the technical requirements of the project; the primary bases for their unacceptability are indicated in the following subsection. The three remaining sites were subjected to a more intensive analysis to determine which would be best suited for terminal development.

In addition to a symbolic rating corresponding to physical characteristics, each of the three remaining sites has also been rated as to its ecological and biological conditions and sensitivities. The ecological rating has been assigned on the basis of the relative sensitivities of existing ecosystems and the potential for adverse effects resulting from terminal construction and operation. The comparative ecological and biological conditions and sensitivities of each site were emphasized because other environmental aspects, such as air and noise quality sensitivities were considered similar for each of the three sites. It has therefore been assumed for the purpose of this portion of the study that the impacts on these other environmental conditions would be of similar magnitudes for each site.

* Figure 79 is located at the end of this section with other foldouts.

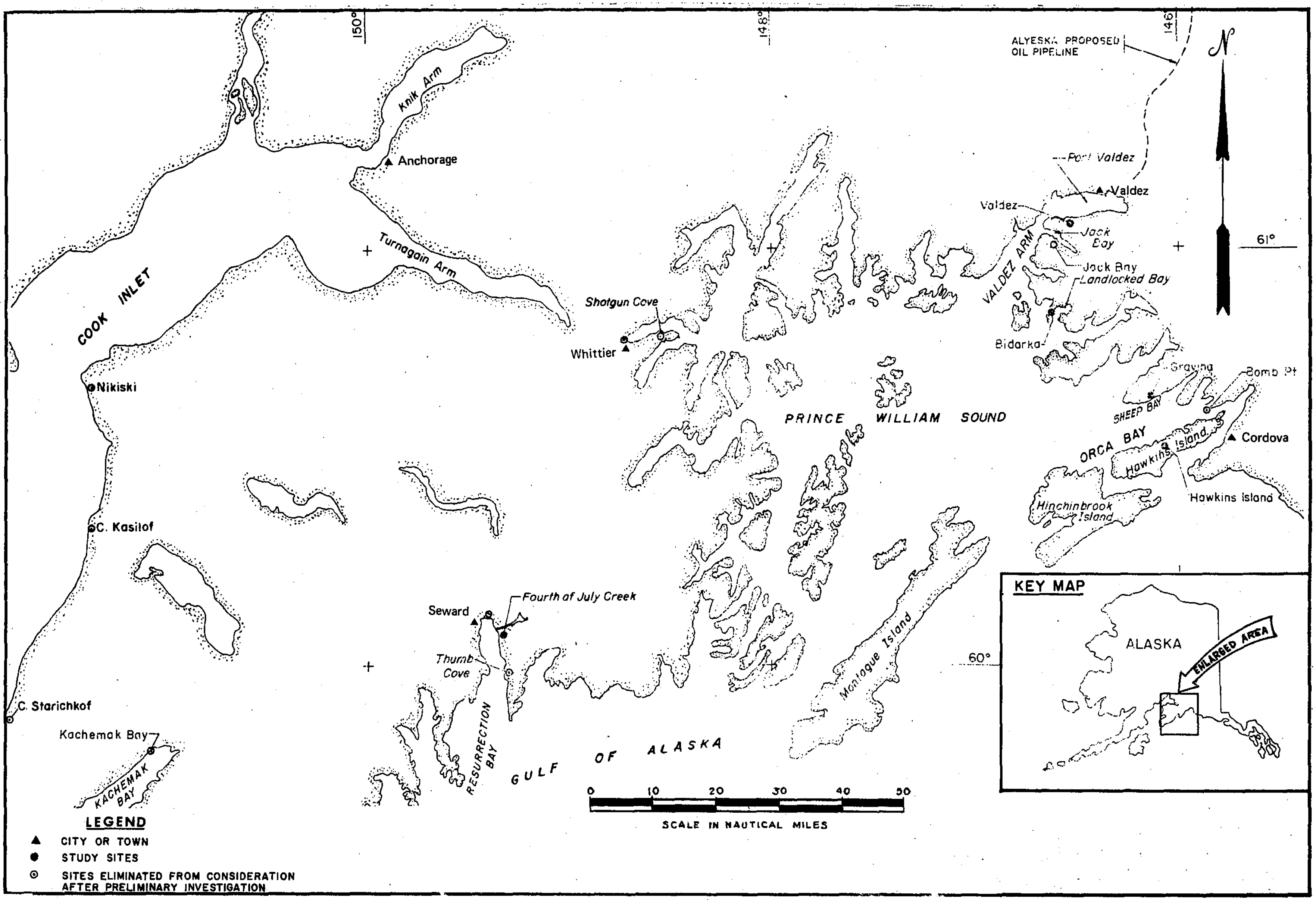

Figure 78. Prince William Sound Sites

REFERENCES: U.S.C. and GS. Map No. 8502

I. Sites Rejected From Further Study

Bomb Point

The Bomb Point site is located in the southeastern region of Prince William Sound on the northern shore of the Narrows, an area between Orca Bay and Orca Inlet. Most of the land at the tip of Bomb Point is below the 100-foot elevation contour and would not afford adequate protection for the plant in the event that seismic sea waves were generated during an earthquake (minor shoreline damage was sustained at Bomb Point during the 1964 earthquake). 1/ Toward the east on Bomb Point, steep slopes are present that would require extensive site preparation, so the site was rejected from further consideration.

Valdez

The Valdez site is located on the southern shore of Port Valdez and is bordered by Anderson Bay to the west and Jackson Point to the east. The site is located on relatively steep sloping land. The land would require extensive site preparation before it would be suitable for construction. 2/ Excavation required for tank foundations would result in large quantities of material that would probably have to be hauled to spoil disposal areas.

The 1964 Alaskan earthquake initiated highly destructive waves within the Port Valdez area which caused considerable shoreline damage. The distribution of damage within Port Valdez indicates that the highest waves probably originated at the sites of large submarine slides of segments of the Shoup Glacier end moraine, which is located across Port Valdez from the potential terminal site. Maximum wave runups at the plant site reached 78 feet at its western end near Anderson Bay and about 37 feet near Jackson Point. A past history of repeated submarine slides in Port Valdez is suggested by breaks of submarine telegraph cables and fish kills during at least five earthquakes in 70 years. Breakage of two submarine cables during the earthquake of 1908 between

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1/ USGS Prof. Paper 542-E, Plate 2

2/ El Paso Alaska Company, Docket No. CP75-96 _et al_.

Shoup Bay and Anderson Bay is strongly suggestive of previous sliding in the same general area. 1/ Figure 80 shows the extent of wave damage at the site and the location of major subaqueous slides and submarine cable breaks.

The rugged topographic conditions at the site, which would require extensive site preparation and the disposal of large quantities of spoil material, and the possibility of seismic damage resulting from slide-induced waves do not make the site suitable for terminal construction or operation.

Jack Bay

Jack Bay is located near the northern end of Valdez Arm just south of Valdez Narrows. The site itself is located on the southern shore of Jack Bay between the lower reaches of Gregarieff and Levshakoff Creeks. Although the contour of the land is not too steep, the presence of a small, unnamed creek within the site would complicate the preparation and use of the site. High winds funneled southward through the mountains on either side of Valdez Narrows could strike an LNG ship broadside as it turned to enter the narrow mouth of Jack Bay. Other winds and waves sweeping the length of Jack Bay would affect docking maneuvers. The site was therefore rejected from further consideration because of navigational unsuitability.

Seward

A potential site at the head of Resurrection Bay just northeast of the town of Seward was rejected on the basis of geologic instability. The potential site is located on a floodplain which has formed at the convergence of the Resurrection River and its major tributaries. The site is comprised of approximately 75 feet of unconsolidated floodplain deposits consisting of coarse sand and fine to medium gravel. These deposits overlie approximately 100 feet of marine sand and silt, which in turn overlie several hundred feet of unconsolidated glacial deposits.

During the 1964 earthquake, the alluvial deposits which underlie the site were greatly fractured, and their submarine extension beneath the bay underwent sliding during dynamic conditions of continued seismic shock. It can be anticipated that future seismic activity would produce additional sliding and fracturing.

1/ USGS Prof. Paper 542-C

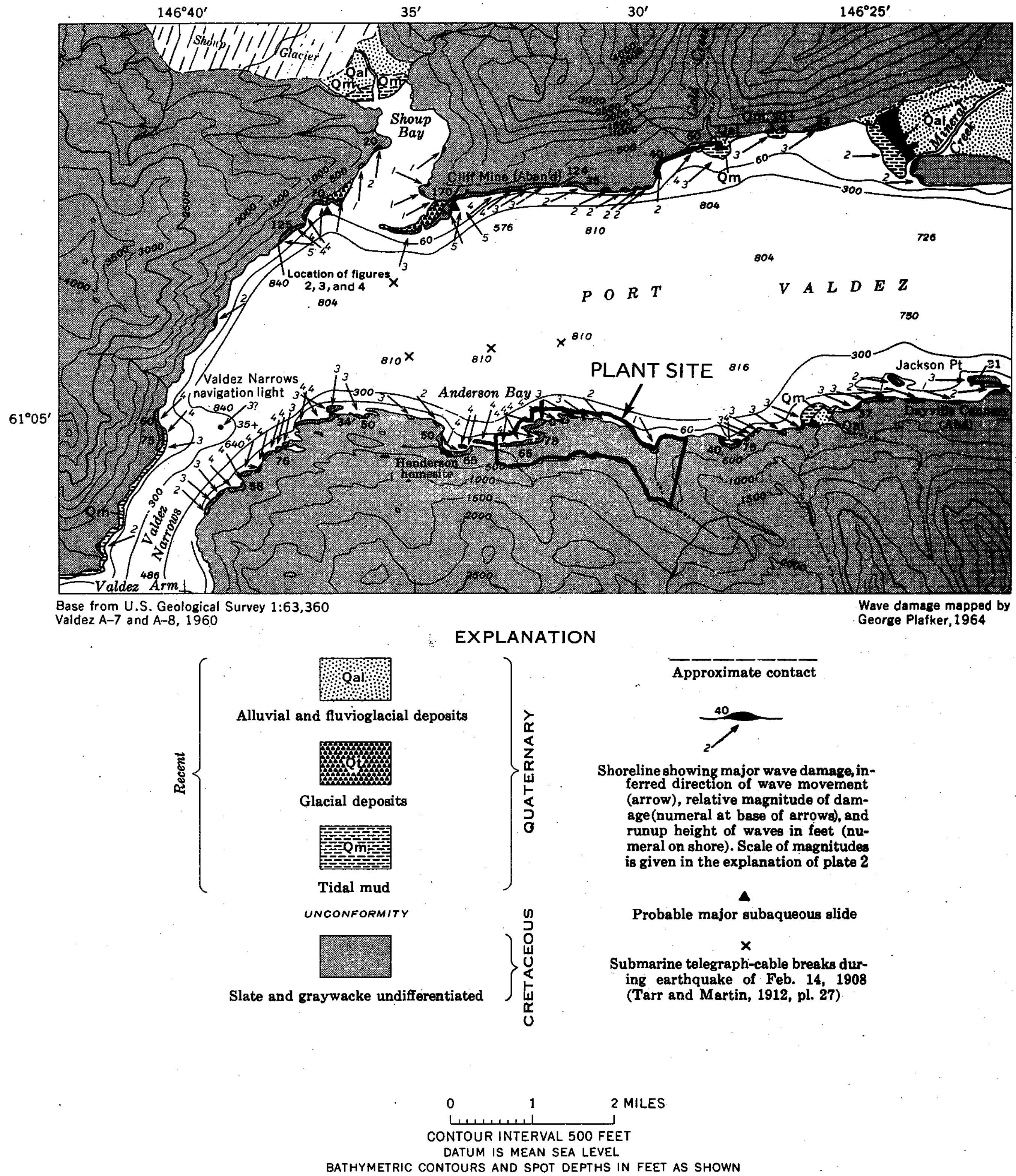


Figure 80. Map Showing Distribution and Intensity of Wave Damage in the Western Part of Port Valdez.

The potential Seward site was also subjected to the effects of earthquake-induced sea waves which were generated both locally and from distant areas of land or sea floor movement. Local waves developed from subaqueous sliding and seiche action within Resurrection Bay, and resulted in large runup heights both on the site property and adjacent areas throughout the Bay. (See Figure 81.)

The unstable nature of the unconsolidated sediments which underlie the potential site coupled with the possibility of future ground movement and inundation during seismic events makes the site unsuitable for terminal development.

Fourth of July Creek

The Fourth of July Creek site is located on the east side of Resurrection Bay, approximately 3 miles southeast of Seward on the fan-delta formed by the creek. The fan-delta presents a triangular-shaped surface which is approximately 2½ miles long and 1½ miles wide along its distal edge, and is bounded by steep-sided uplands comprised of glacial deposits and exposed bedrock. The fan-delta itself is composed of loose sand and gravel at the bay and grades to cobbles and boulders toward its head. The thickness of these deposits probably exceeds several hundred feet.

The fan-delta at Fourth of July Creek is geologically equivalent to the deltaic material present at the northwest corner of the bay which failed catastrophically during the 1964 earthquake and caused the near total destruction of the Seward area through ground failure and slide-induced waves. During the quake, the Fourth of July Creek fan-delta similarly underwent submarine sliding, although there was no apparent surface extension of the slides on the land surface. The fan-delta was subjected to approximately 3½ feet of tectonic subsidence accompanied by tsunami runups over 100 feet.

The development of the terminal at the Fourth of July Creek site would require that the facilities be placed a considerable distance inland, toward the head of the fan-delta, where the structural integrity of the facility would be more secure in the event of a future seismic disturbance. At the head of the fan, the amount of flat, construction-suitable terrain is limited, and the construction of the facilities would encroach upon the steep, bordering upland areas and result in extensive grading of these land forms. The length of the loading trestle and cryogenic transfer line connecting the tanks to the LNG carriers would be of the order of 2½ miles long, which approaches the limit of desired technical feasibility. Even toward its head, the stability of the deltaic material during future seismic events is questionable. Therefore the site was eliminated from further consideration.

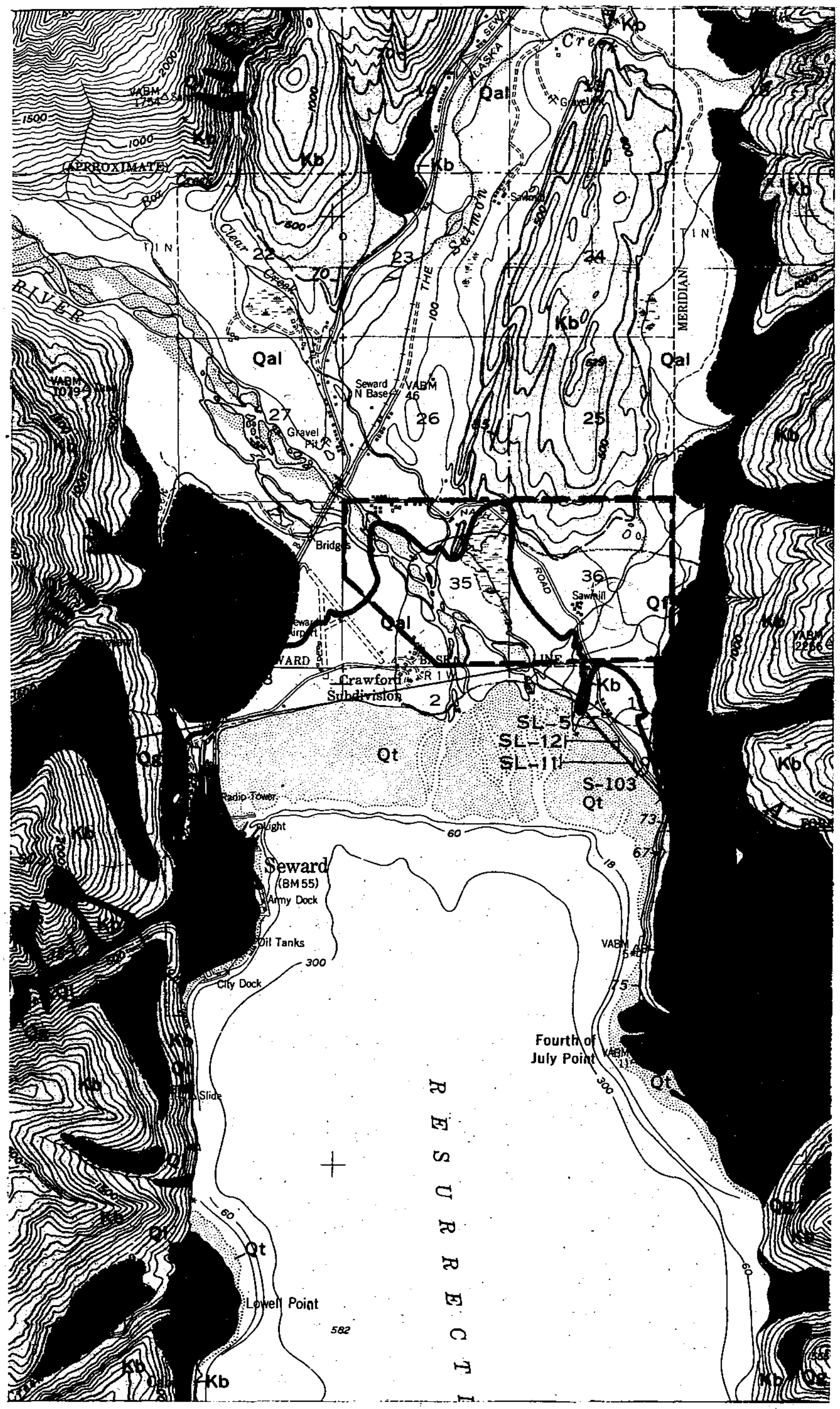


Figure 81. Seward Site

Thumb Cove

The Thumb Cove site is located on the eastern shore of Resurrection Bay approximately 8 miles south of the city of Seward. The location of the site at the head of the cove offers only a minimum amount of land which does not require considerable excavation from the sides of mountains. Excavated material not suitable for use as construction or diking material would have to be hauled away and disposed of as spoil. Thumb Cove offers a minimal amount of space for LNG carrier maneuvering, and during certain periods Resurrection Bay and the site areas are subjected to adverse atmospheric and oceanic conditions which would further hamper LNG carrier operations. Anchorages in Resurrection Bay are few and are subject to strong winds. Heavy seas are carried into the bay with strong southerly winds, and winter gales strike with sudden force. The prevailing winds are from the south from April to September and north during the rest of the year. At Seward, navigation difficulties are experienced during southerly winds, as the heavy seas and wind velocities affect docking maneuvers. 1/ The sheltered nature of Thumb Cove would offer some protection from adverse meteorological conditions, but its limited size in combination with adverse conditions could prove to be hazardous and therefore this site has been eliminated from further consideration.

Whittier

The Whittier site is located at the head of Passage Canal just west of the town of Whittier. The site lies on a delta which is comprised of unconsolidated coarse, subangular to subrounded gravel in a matrix of coarse sand. The depth of this deposit is unknown, but is estimated to be at least 44 feet. This unconsolidated material dips steeply into Passage Canal, forming unstable submarine slopes that approach angles of at least 20 to 25°. During the 1964 earthquake, the submarine slopes underwent sliding which generated waves of a highly destructive nature. All offshore docking facilities and nearly all near-shore structures were severely damaged or destroyed both at the town of Whittier and at the head of Passage Canal.

Because the submarine slopes in Passage Canal were not significantly decreased by the landsliding during the earthquake, another earthquake of comparable magnitude would probably trigger more submarine landslides, and destructive waves would inevitably follow. (Kachadoorian, 1965). If an LNG terminal were to be developed in the Whittier area, the marine terminal, docking facilities, and LNG transport vessels would be in serious jeopardy of being destroyed by waves and slope failure during a future large-

1/ USDI Final Environmental Impact Statement, Proposed Trans-Alaska Pipeline, Volume 5, 1972.

scale seismic event. Therefore, the site has been eliminated from further consideration.

Shotgun Cove

The Shotgun Cove site is located approximately 4½ miles east of the town of Whittier on the southern shore of the Passage Canal. The site displays favorable oceanographic and meteorological conditions, but the area around Shotgun Cove is under consideration for development as a sport fishing and recreational boating harbor, therefore land use conflicts and safety problems would arise from terminal development. The cove also provides limited maneuvering room and an alternative to the conventional marginal pier configuration would be required. 1/ As a result of maneuvering and land use conflicts, this site has been eliminated from further consideration.

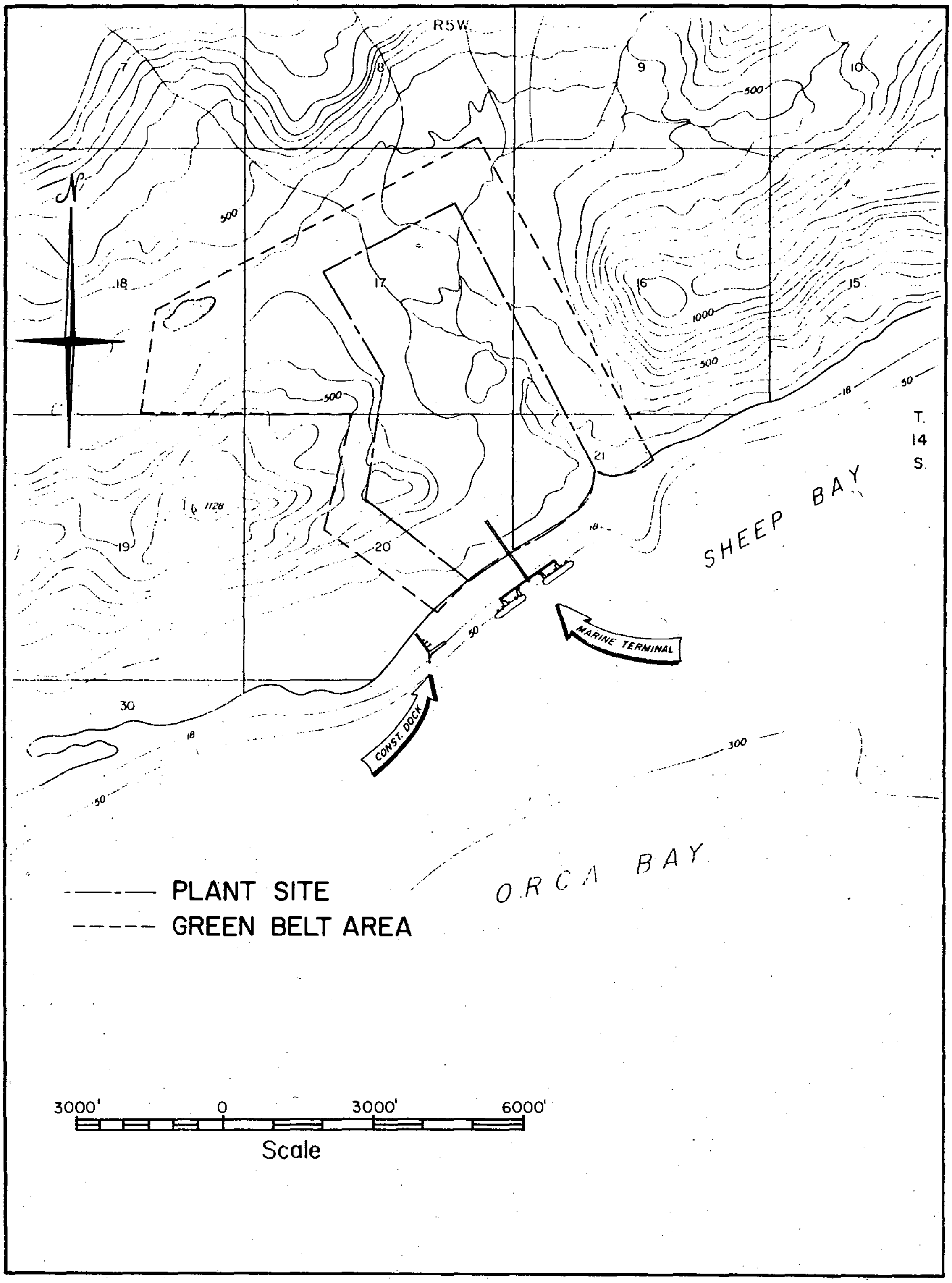
ii. Site Assessments - Prince William Sound

The three sites within the Prince William Sound subregion that were considered most acceptable according to the criteria prescribed in the initial rating system were the Gravina, Hawkins Island, and Bidarka sites. The locations of the sites are illustrated in Figures 82, 83, and 84. Each site has been subjected to an in-depth analysis which involves the tabulation of the pertinent physical characteristics of each site and an assessment as to which site most closely correlates with the physical requirements of the project and the established criteria. Each site has also been subjected to a detailed environmental analysis in an effort to determine the diversity and sensitivity of ecosystems and populations within the site area, and the relative magnitudes of impacts that could result from project development at each of the three sites. Table 37 compares the physical characteristics of each site, a summary of which is included below, and the results of the environmental analysis are included in Table 38 along with a narrative summary. Tables 37* and 38* also include a comparison with an alternative site in the Cook Inlet area. (See later sections for the analysis of how this additional site was selected).

Many of the physical characteristics of the three sites are similar, due to their proximity to each other within the Prince William Sound area. Despite the similarity in many of the physical traits of the site, the characteristics of the Gravina site correspond most closely to the requirements established in the LNG terminal siting criteria. The principal problem at the Gravina site is that it is poorly drained and may require additional site preparation. The site also lies within the confines of the Chugach

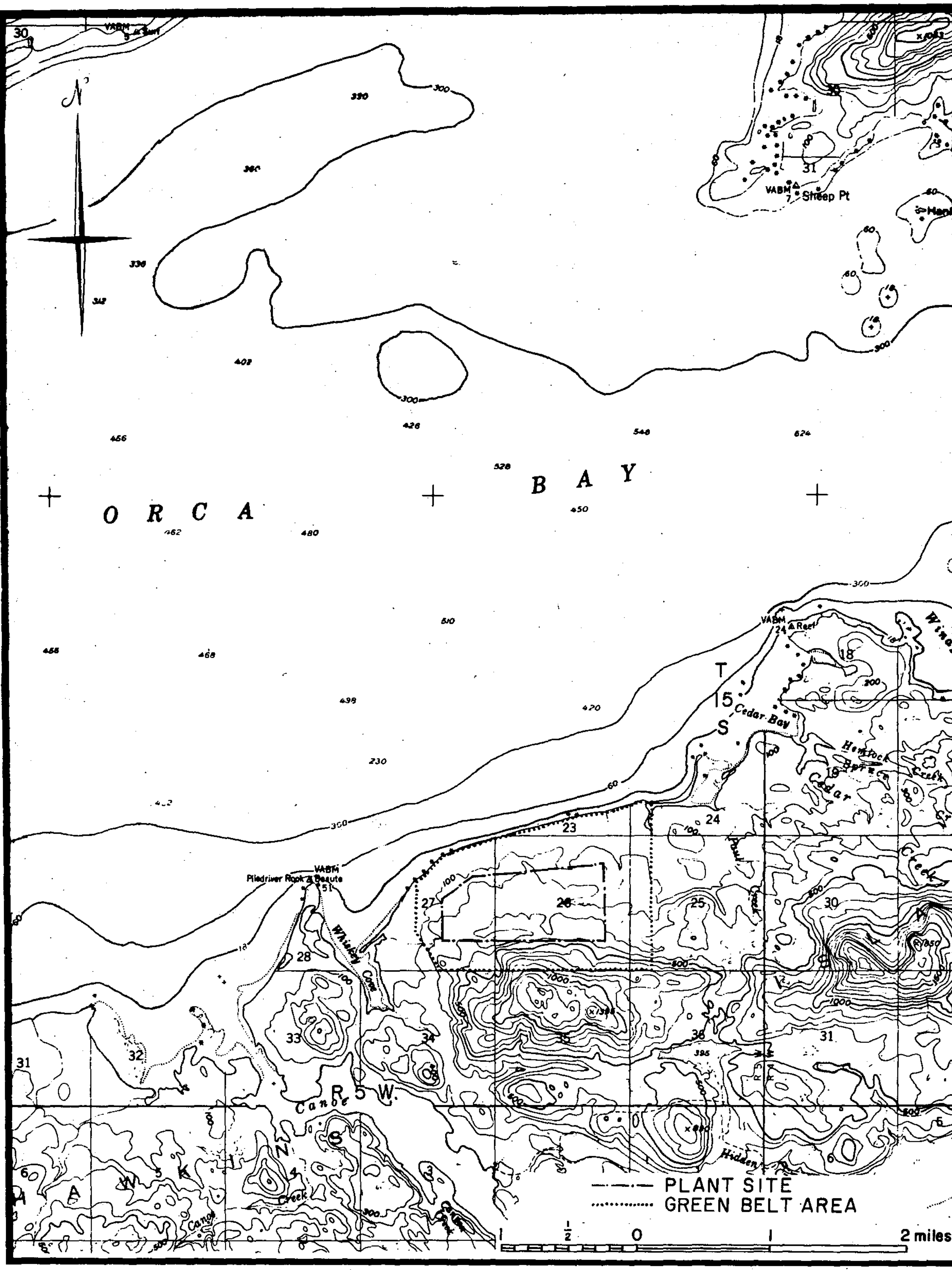
1/ El Paso Alaska Company, Docket No. CP75-96 et al.

*Tables 37 and 38 are located at the end of this section with other foldouts.



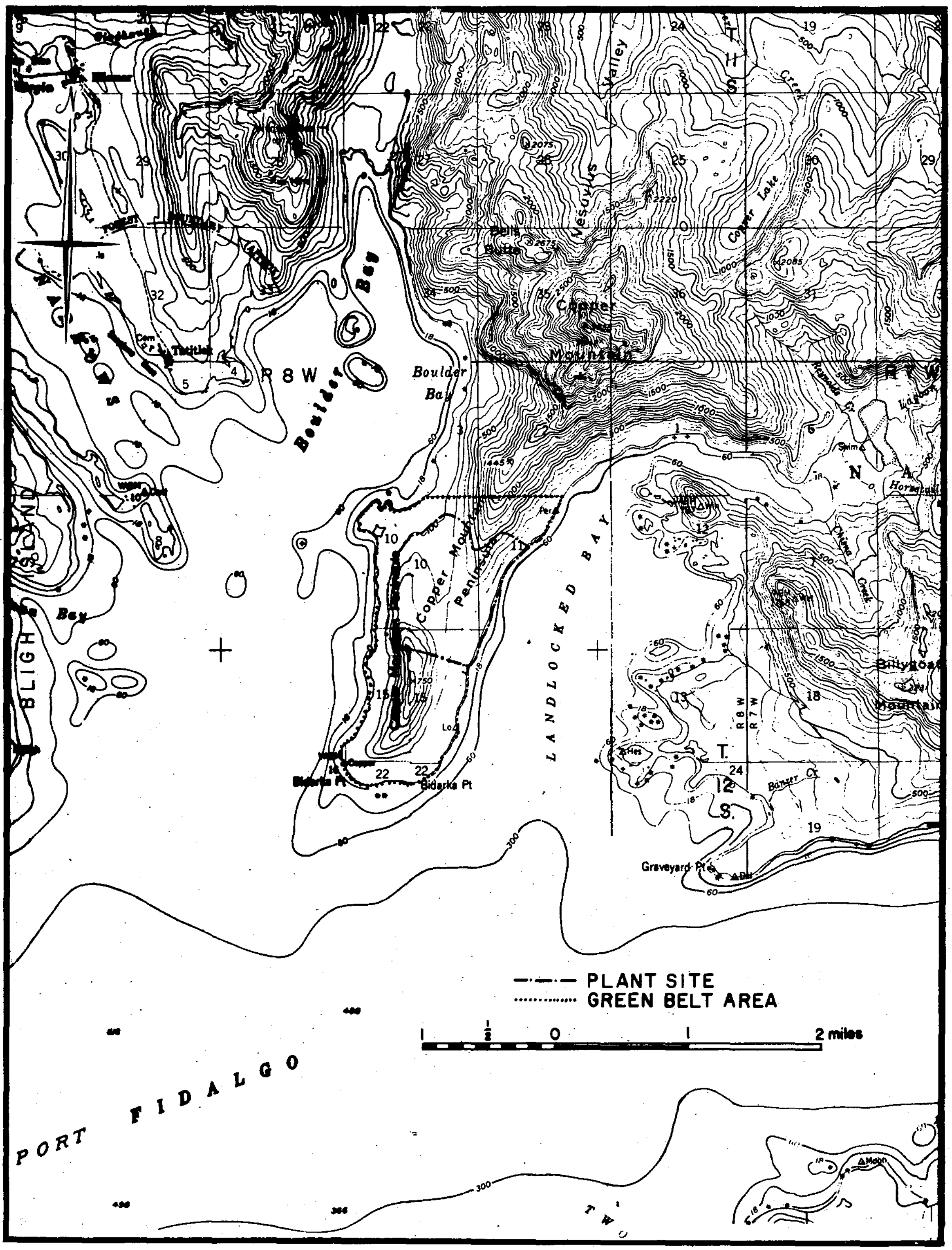
REFERENCE: U.S.G.S. Map - Cordova (C-6)

Figure 82. Gravina Site, Prince William Sound



REFERENCE: U.S.G.S. Map-Cordova (C-6)

Figure 83. Hawkins Island Site, Prince William Sound



REFERENCE: U.S.G.S. Map - Cordova (D-7) (D-8)

Figure 84. Bidarka Site, Prince William Sound

National Forest, and some land use conflicts could arise depending on the Chugach National Forest plans and the attitude of the public in protecting wilderness characteristics. (See Environmental Analysis Section for further discussion.) It should be noted, however, that the boundaries of the Chugach National Forest encompass nearly all of Prince William Sound, and any site located in this area would lie within national forest properties.

The Hawkins Island site displays drainage characteristics somewhat similar to those of the Gravina site, the only difference being that the Hawkins Island site displays a higher degree of drainage at upper elevations. Drainage at the lower elevations is poor and would probably also require additional preconstruction site preparation. Development of the site would require the construction of a submarine pipeline across the Narrows (a stretch of water between Orca Bay and Orca Inlet) which would be approximately 1 mile long and reach a maximum depth of 240 feet. Although construction of such a pipeline would not be beyond the limits of technical feasibility, the submarine pipeline would require the mobilization of additional equipment and increase costs. 1/

The emplacement of a natural gas connecting pipeline to the Bidarka site could be both difficult and costly. The terrain to the north and west of the site through which the pipeline would pass is extremely rugged and would not be conducive to pipeline construction.

iii. Biological and Socioeconomic Analysis - Prince William Sound

The construction and operation of an LNG terminal at Gravina, Hawkins Island, or Bidarka would have direct impacts on the biological and socioeconomic environments of Prince William Sound. Among the biota most sensitive to impact would be eagles, salmon, deer, bear, and sea otters.

One of the highest concentrations of bald eagles in Prince William Sound occurs at Gravina Point; 16 active eagle nests were found within 5 miles of the proposed site in 1973. One nest was found near the shore within the site. Because bald eagles are often intolerant of human activities, the construction and operation of an LNG facility near their nests would probably drive them away. Since acceptable nesting trees are generally at a premium, especially where the eagle population is large, the affected bald eagles would probably be lost from the breeding population for the life of the project.

1/ El Paso Alaska Company, Docket No. CP75-96 et al.

The operation of the proposed LNG plant's cooling system could have noticeable impacts on the marine biota. See section C-6, Impacts on Aquatic Biota, for a detailed analysis of marine impacts expected at the Gravina site.

The Gravina site would occupy some critical wintering grounds for deer and an intensive use area for concentrations of both black bears and brown/grizzly bears. A large concentration of sea otters occurs just offshore from the site, and a critical mountain goat range lies immediately to the north of the site. Winter habitats, such as those of the Sitka black-tailed deer, are particularly important because they are limited in area and are often utilized to the maximum extent possible. If deer were excluded from a portion of their winter range, the forage in the remaining part of the range would not support the whole population, and starvation would affect an even greater number of deer than those displaced by the LNG facilities. The deer might well damage their remaining winter range by overgrazing, compounding the plant's impact and increasing that impact's duration. Concentration and intensive use areas, although not as sensitive as winter habitats, are important because of the numbers of individuals that can be affected and because such areas are of prime importance to the species for food, reproductive activities, or other factors.

Commercial fishing for king and tanner crabs also takes place near the Gravina site. The presence of adult crabs, especially in an estuarine environment like Orca Bay, may indicate that the area of the site is used as a spawning and rearing area by these species. Kachemak Bay, a similar bay in lower Cook Inlet, is extensively used in this way. A major seabird breeding colony and a harbor seal rookery are located about 5 miles to the east of the Gravina site in the mouth of Sheep Bay, and a molting area for dungeness crabs is found farther up the same bay.

From a biological standpoint, the general remoteness of the Gravina site weighs heavily against its use for the construction of an LNG facility because such an area is relatively undisturbed and is of value to more species than is a disturbed area. The fact that the site is isolated means that the pipeline route must impact undisturbed areas.

Since no existing roads connect Gravina to Cordova, the nearest town, some plant personnel would have to commute to work from Cordova by boat or airplane. This and other factors would undoubtedly result in pressure being brought to bear for the construction of a road through the Chugach Forest to connect Cordova with the site. In the event of major injury at the proposed facilities, the distance to the nearest medical facility (Cordova) would become a vital factor. Finally, a plant built at the Gravina site would have to rely almost completely on its own resources to cope with any large-scale disaster and/or emergency.

One corollary to the problem of the remoteness of the Gravina site is the socioeconomic impact of the proposed project upon the town of Cordova. Cordova has a small population (1,164 in 1970), the majority of whose residents participate in some way with the fishing industry. Nearly all construction and plant personnel would have to be recruited from outside Cordova, and most would have to come from outside the Prince William Sound area. The limited existing medical, housing, utility, educational, and recreational facilities of a town with fewer than 1,500 people would have to absorb the impacts attributable to the influx of the families accompanying up to 5,600 construction workers. Since Cordova is inaccessible by road from the rest of the state, the ferries and airlines servicing Cordova would be severely strained. The population expansion and influx of construction materials would give added impetus towards the construction of the Copper River Highway, a project which has been proposed to connect Cordova with the rest of the Alaskan highway system and which faces stiff opposition by environmental groups. Undoubtedly the Cordova area would suffer from the familiar "boom" syndrome during the construction phase of the LNG facilities, and the notorious "bust" syndrome after the construction.

Hawkins Island

The Hawkins Island site lacks the eagle nesting concentrations found at Gravina Point, but the area along the shore is heavily used by waterfowl. There are 10 creeks and sloughs with runs of pink and chum salmon within 5 miles of this site. Two streams with pink salmon runs are found at the site itself. The impact of the seawater cooling system on these migrating fish and the young salmon leaving the two streams could be particularly significant.

The Hawkins Island site lies within a critical winter habitat for deer and an intensive use area for black bear.

Sea otters congregate just offshore. There is a commercial fishery for salmon and tanner crabs near the site, as well as a recreational fishery that includes clam digging. Hook points for salmon nets are found along the shore at the site. There is a major seabird colony 4 miles from the site and a Vancouver goose rearing area 5 miles away. Steller sea lions inhabit a rookery 5 miles from the site, and brown/grizzly bears are known to den in an area 6 miles away.

The Hawkins Island site, although closer to Cordova than the Gravina Point site, is also isolated. The trip by air to the site from Cordova is fairly short, but most commuters leaving Cordova for work at the Hawkins Island site would have a lengthy boat ride around half the circumference of the island. Socioeconomic impacts to Cordova because of the LNG plant's construction and operation would be similar to those described for the Gravina location. The proposed pipeline route to the Hawkins Island site would be longer than any route suggested for the east side of Prince William Sound, with the exception of the Copper River alternate route to Hawkins Island. The latter route, besides being lengthy, would impact the tremendously productive and sensitive environment of the Copper River Valley.

Bidarka

The Bidarka site is near a major bald eagle concentration in Port Fidalgo, although the nearest known active nest is found 3 miles north of the site on Boulder Bay. Three chum and pink salmon streams enter the estuary within 5 miles of the site, although the nearest lies across Landlocked Bay from the site. A large concentration of sea otters can be found offshore. Some recreational fishing takes place locally, and a commercial fishery for king and tanner crabs is conducted near the site. The Bidarka site is within a major commercial salmon fishing area, and hook points for salmon nets are present along the shore. Herring spawn along both sides and on the tip of the peninsula at Bidarka and are the subject of an intensive fishery. The thermal effluent from an LNG plant at the Bidarka site might pose serious environmental problems because of the small size of Landlocked Bay. The confinement of the heated discharge waters in this small space could increase its impact considerably, possibly even blocking fish migrations through the bay.

The Bidarka site is rather isolated and thus would encounter the same problems already mentioned for the Gravina and Hawkins Island sites. The small town of Valdez (population 1,890 in 1970) would probably bear most of the socioeconomic impacts of placing an LNG facility at Bidarka, as well as the impacts of the Alyeska oil terminal already under construction. The native village of Tatiklek is only 3 miles from this site and could conceivably suffer impacts to any subsistance lifestyles practiced by the villagers in direct proportion to the impacts of facilities on the local wildlife. Access to the site, both by the gas pipeline and by construction and LNG plant personnel, would be extremely difficult. The terrain between the Alyeska oil pipeline corridor near Valdez and the site at Bidarka is much better suited for its present use as a mountain goat habitat than for pipeline construction. The distance from Valdez to the site is 23 miles by air and much longer by boat, making the hazard and inconvenience to the people commuting to the site even greater than at the Gravina Point and Hawkins Island sites. Constructing a road for these people from Valdez to Bidarka would be even more difficult than laying the pipeline and have considerable effect on the environment.

e) Site Specific Analysis

Cook Inlet Subregion

In response to an FPC contract, the Oceanographic Institute of Washington conducted a study of alternative sites in the Cook Inlet/Kenai Peninsula area. The study involved an investigation of the Cook Inlet coastal areas for potential LNG sites, and was accomplished on both a subregional and a site specific level. The following excerpt from the study as submitted to the Commission describes the general procedures that were conducted in the site selection process:

1.4.2 Process of Elimination, Location and Evaluation of Impacts

There are a number of environmental factors that influence the accessibility, the effective placement, and the operations of an LNG facility. There is the impact of the facility and its subordinate operations on the environment and conversely the effects of the environment on the facility operations. Table 1-3 indicates the major parameters and their relationship to the operational modes of an LNG facility.

These major parameters and the extensive list of subparametric relationships were used in both the elimination and location iterative processes for determining viable plant sites. Appendix 4.1 provides both a detailed description of the parameters considered and the methodology used in the study. Fig. 1-6 is a schematic of the site selection and ranking process.

The initial phase was a gross elimination process based on facility site and marine terminal requirements. The Cook Inlet region was subdivided into 11 sub-regions (see Figure 1-7 and Table 1-4). Unfavorable land uses and status, excessively long distances to main pipelines, close proximity of volcanos and other detrimental geological features, unsafe approaches for maneuvering and docking of transport vessels, and adverse meteorological and marine conditions were all considered factors important in eliminating areas as unsuited for LNG terminal placement. This broad screen elimination rejected sub-regions 1,5,6 (see Table 1-5). Sub-region 9 was eliminated in the second iteration of the process on the basis of biotic community impacts.

TABLE 1-3 SITE CHARACTERISTICS VS. OPERATIONAL MODES OF LNG FACILITY

SITE CHARACTERISTICS \ OPERATIONAL MODES	(ROUTES)	(FACILITY SITE)		(MARINE TERMINAL)	(NAVIGATIONAL ROUTES)
	PIPELINE	LIQUEFACTION	STORAGE	TRANSFER	TRANSPORT
SAFETY OF APPROACH				Major	Major
TOPOGRAPHY	Major	Major	Major	Minor	Minor (APPROACH)
SOILS ANALYSIS	Major	Major	Major		
GEOLOGY	Major	Major	Major		
METEOROLOGY				Major	Major
PHYSICAL OCEANOGRAPHY				Major	Major
BIOLOGICAL IMPACTS	Major	Major	Minor	Major	Major
POPULATION CHARACTERISTICS	Major	Major	Major	Major	Minor
PRESENT LAND USES	Major	Major	Major	Minor	

This table shows major site characteristics and the operational modes within which each is a factor of consideration. Solid and hatched lines indicate whether a particular characteristic is a major or minor factor of consideration in each mode.

(solid line) -- major factor of consideration
(hatched line) -- minor factor of consideration

EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON

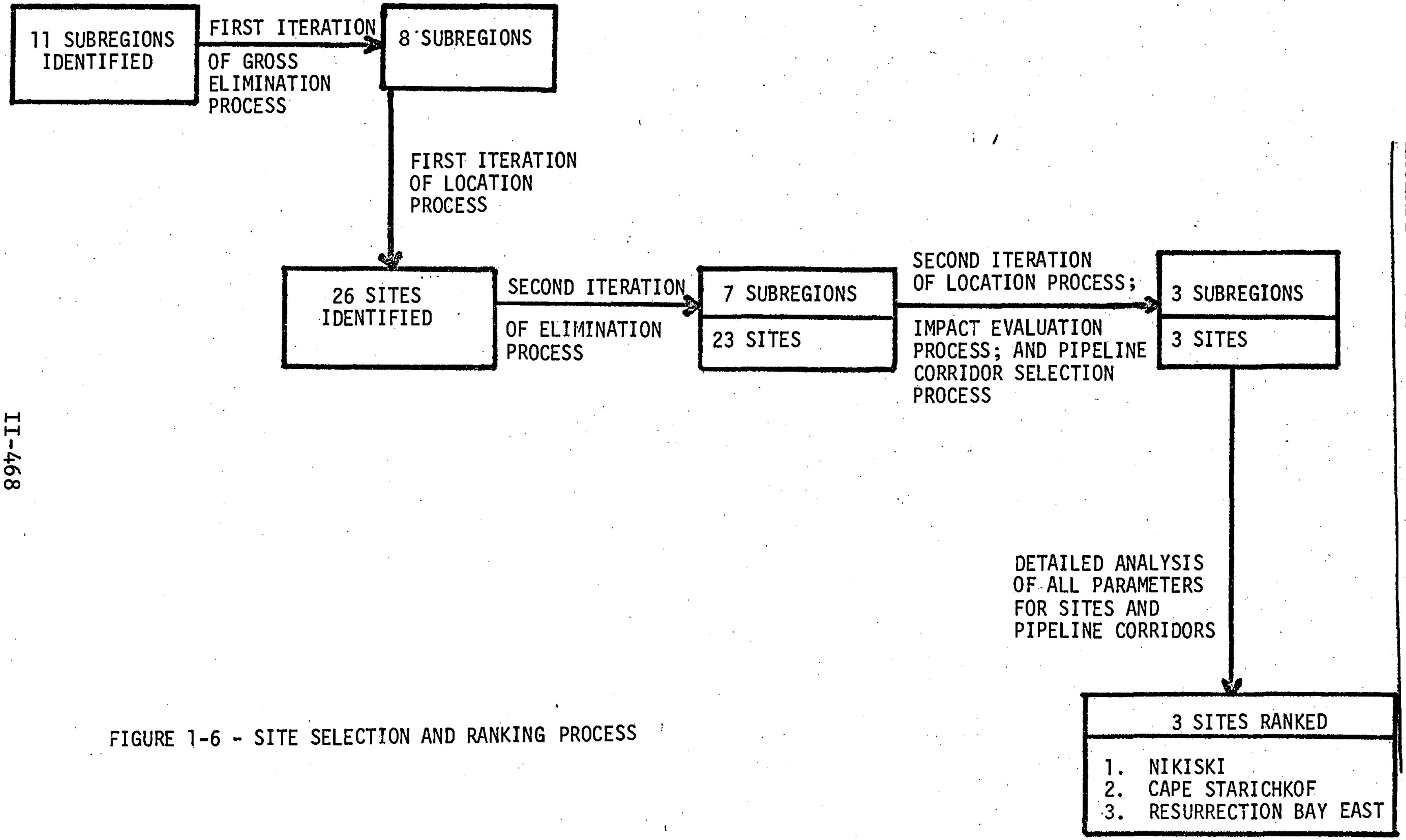


FIGURE 1-6 - SITE SELECTION AND RANKING PROCESS

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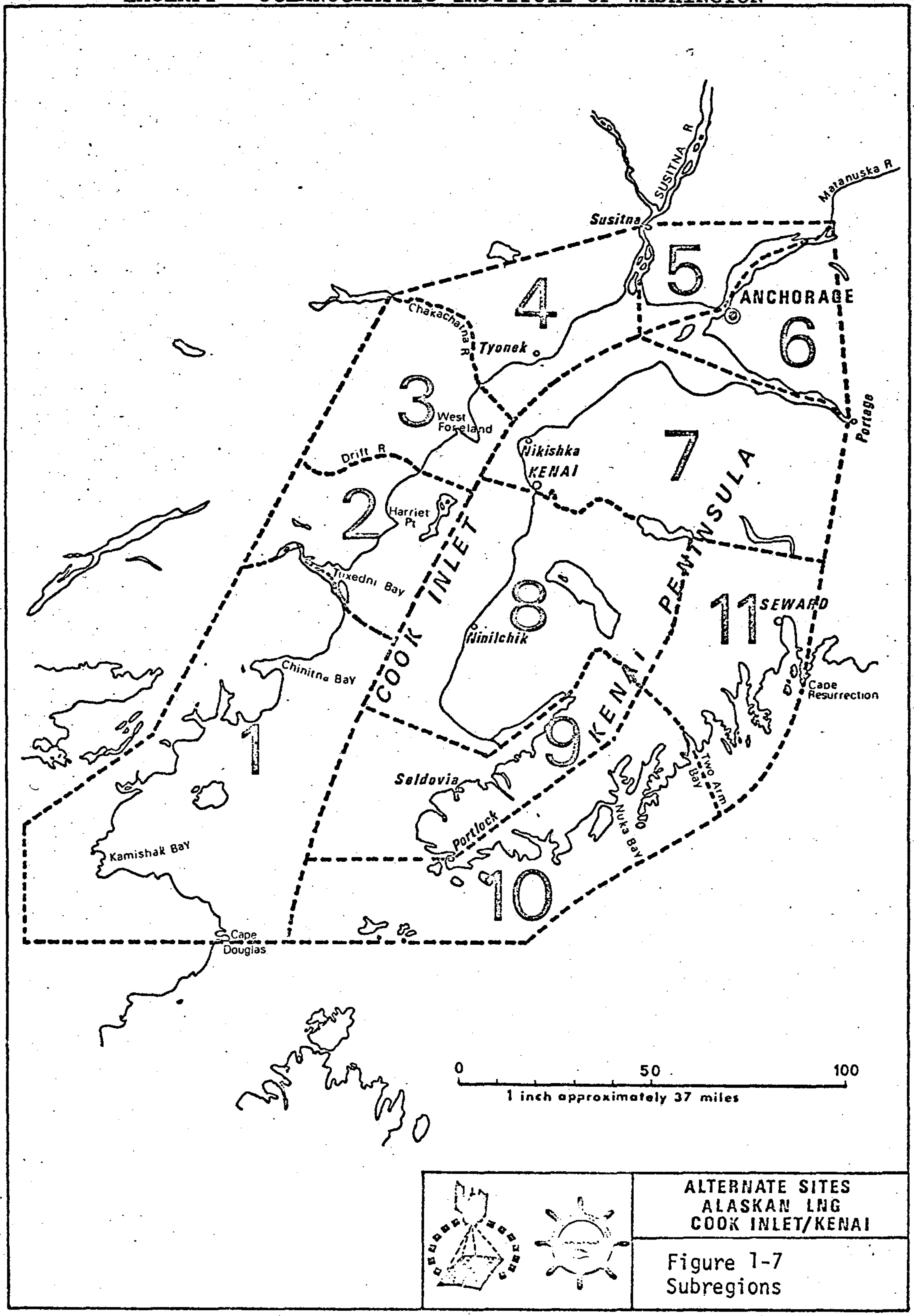
EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON



ALTERNATE SITES
ALASKAN LNG
COOK INLET/KENAI

Figure 1-7
Subregions

EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON

TABLE 1-4

SUB-REGION DESCRIPTIONS

Number	Name Used in this Report	Boundary
		Cape Douglas
1.	Chinitna-Kamishak	
		Tuxedni Bay
2.	Harriet Point	
		Drift River
3.	West Foreland	
		Chakachatna
4.	Tyonek-Beluga	
		Susitna River
5.	Susitna Delta	
		Knik Arm
6.	Anchorage Plain	
		Turnagain Arm
7.	East Foreland	
		Kenai River
8.	Starichkof-Homer	
		Fox River
9.	Seldovia	
		Port Chatham
10.	Nuka Bay - West Arm	
		Aialik Bay
11.	Seward	
		Cape Resurrection

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TABLE 1-5

Land Subregions Eliminated and Accepted by the Broadscreen Elimination Process.

Eliminated from Consideration		Accepted for Further Study	
Subregion 1:	Chinitna-Kamishak	Subregion 2:	Harriet Point
Subregion 5:	Susitna Delta	Subregion 3:	West Foreland
Subregion 6:	Anchorage Plain	Subregion 4:	Tyonek-Beluga
Subregion 9:	Seldovia	Subregion 7:	East Foreland
		Subregion 8:	Starichkof-Homer
		Subregion 10:	Nuka Bay-West Arm
		Subregion 11:	Seward

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Land areas not eliminated by this initial screening were subject to closer examination for particular locations which met facility and pipeline site requirements (location process). Analysis of sites to determine their suitability for accommodating an LNG terminal facility or the pipeline leading to it, included additional information on topography and physiography, soil analysis and subsurface conditions, geology and seismic history and the meteorological and marine conditions of the area. Only those sites which compared favorably with these aspects of the site requirements for the facility and the pipeline were chosen for further consideration.

A number of prospective sites were further eliminated on the basis of possible local adverse impact on ecosystems and biotic communities, human populations and present land status. The criteria for the evaluation of impacts were established and applied by the respective disciplines (impact process). From this type of study approach a number of alternate sites were chosen which possessed suitable physical requirements. These sites would cause minimal environmental damage in accommodating the LNG facility and the pipeline leading to it with its accompanying structures. Thus, the process of selection followed a logical sequence which enabled identification of specific sets of rationale for accepting certain locations over others.

Twenty-six sites or areas were chosen by the location process and investigated for their adverse impacts and further elimination. Figure 1-8 illustrates their location in Cook Inlet and Resurrection Bay.

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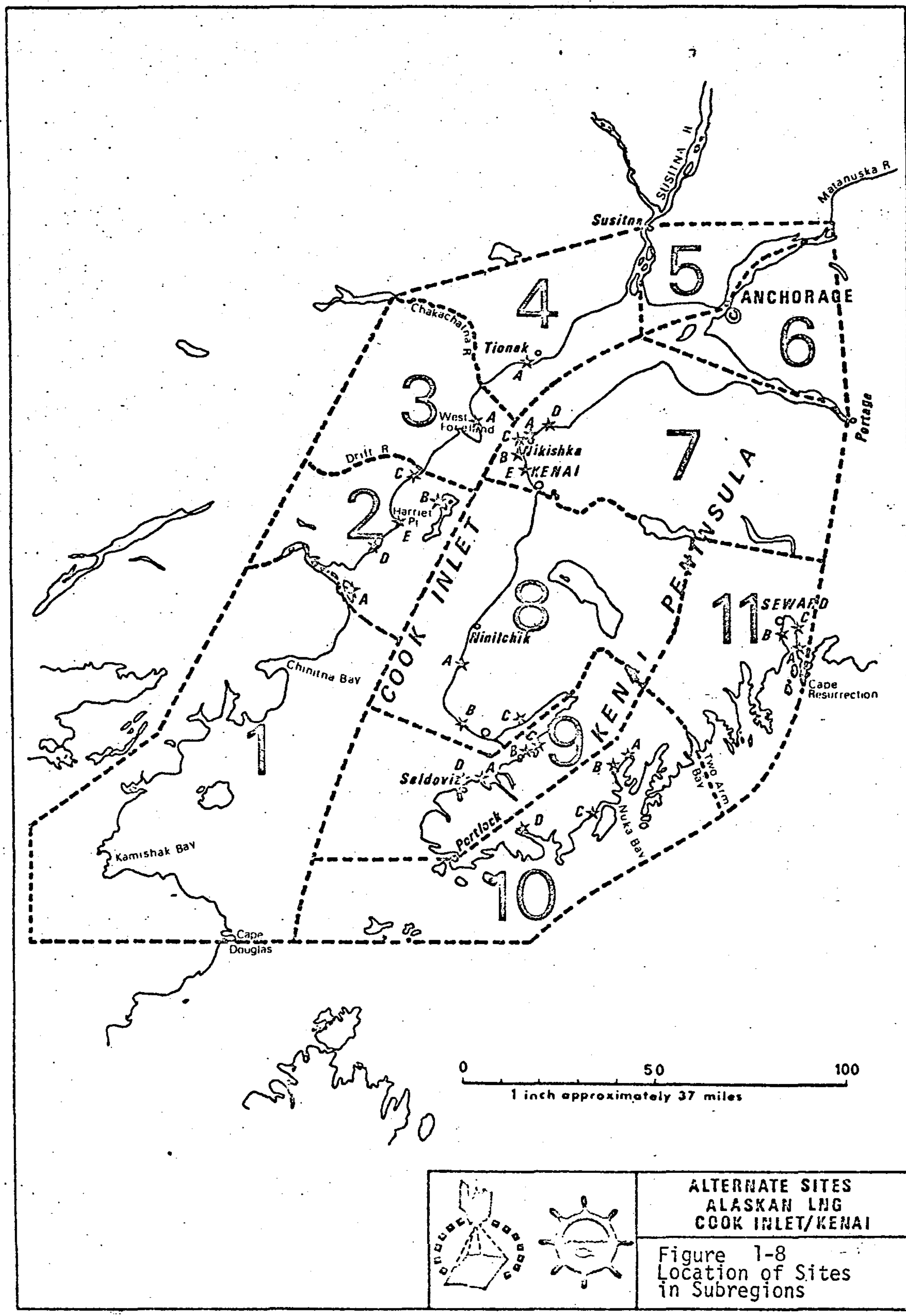

ALTERNATE SITES
ALASKAN LNG
COOK INLET/KENAI

Figure 1-8
Location of Sites in Subregions

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A list of the parameters used for evaluation and location of plant sites, marine terminals, and navigable water ways is shown in Table 1-6.

The twenty-six sites were evaluated using both quantitative and qualitative analyses.

In Cook Inlet a synthesis of seven parameters was done by considering tradeoffs and establishing a zone of indifference shown in Figure 1-9.

The major parameters used for assessing the sites or areas, the measures of discrimination used in the evaluation process, and the results of the analysis are summarized in Table 1-7.

Three sites were selected by this process; Nikiski, Cape Starichkof, and Resurrection Bay East (see Figure 1-10, 1-11, & 1-12).

The final impact perturbations to the environment by the placement of the LNG plant and marine terminal at the 3 sites were evaluated. The principal concerns were the impact on the human population, the physical conditions of the surrounding area, the adverse effects on the biotic communities, and the marine conditions that prevailed.

The impacts were projected on two sets of scales:

1) time scale of impact: measuring short range and long range changes; and
2) geographic scales of impact measuring the changes in the immediate vicinity of the site and that on the regional surroundings.

Finally, the analyses resulted in a ranking of the three sites;

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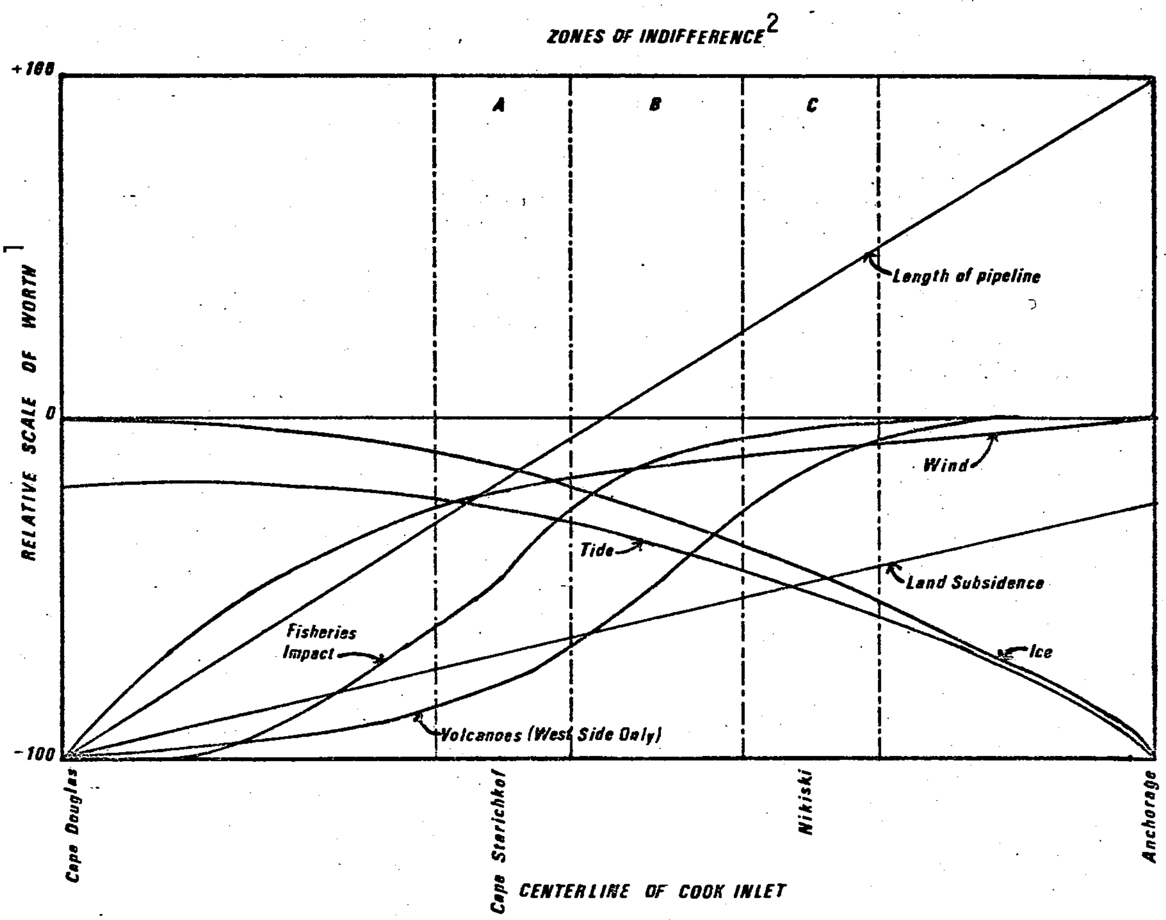
TABLE 1-6

PARAMETERS	CONSTRAINTS
Land Area Available	Gradable 400 acres, perimeter 100 acres, greenbelt 700 acres, totaling 1200 acres.
Topography	Graded area, should be $<$ 10% slope, perimeter should not be $>$ 40% slope, greenbelt should be free of slides.
Distance from Plant to Terminal	Maximum distance of 2.5 miles.
Soil Characteristics	Bedrock is desirable, however, dense glacial sill is good for foundation support, well drained gravelly material has low potential against soil liguefaction and frost action.
Distance from Terminal to Shore	Maximum distance of 4100 feet.
Proximity of Faults	No active faults should be near the site.
Proximity of Nearest Community	Preferably, beyond self-ignited worst-case plume from a 4 tank spill (i.e. two million gallons), proximity of not less than 5.7 miles. Preferably, beyond self-ignited plume from vessel spill at marine terminal (i.e. 165,000 cu. meters), proximity of not less than 4.2 miles.
Pipeline Accessibility	Grades $<$ 40°, stable well drained soils, outside of human settlements, the utility corridors where existant.
Water Depth at Berth	Minimum depth of 50-60 feet at MLLW.
Marine Terminal Exposure	Minimal occurrence of winds over 30 MPH, Minimal occurrence of waves over 6 feet. Minimal occurrence of tidal currents over 4 knots.
Maneuvering Area Required	Minimal channel width of 450 feet, Minimum turning diameter of 2000 feet is required.
Size & Depth of Channel	Minimum water depth of 50-60 feet at MLLW, Minimum channel width of 450 feet.

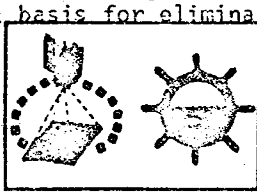
TABLE 1-6 (Cont.)

PARAMETERS	CONSTRAINTS
Hydrological & Geological Hazards	Possible flood plains due to glacier or volcanic activities should be avoided for the sites.
Channel contours and Constraints	No sharp turns in channel, no large boulders or other obstructions to navigation.
Vessel Traffic Patterns	Minimal traffic moving in well defined patterns is desirable, but not a critical factor in locating potential sites.
Aids to Navigation	Sufficient aids to navigation should be present in Cook Inlet and Resurrection Bay site areas to handle projected vessel traffic increases.
Anchorage Areas	Maximum anchoring depth of 200 feet.
Ice Conditions	Minimal occurrence of adverse floe and pack ice thickness: unresolved. See discussion of ice conditions in Appendix 4.3.
Environmental Impact Comment	Outside of wildlife and fish concentration, outside of aquifer recharge areas for human settlements, not visible in major scenic views.



Notes: 1. Relative Scale of Worth-for all parameters the highest positive value is +100 and the lowest negative value is -100. Neutrality is 0 on the scale.

2. Zones of Indifference-A,B and C are the three zones in which the investigators could accept sites with an attitude of indifference. In these zones the negative worth or impact was not considered to be a basis for elimination.



ALTERNATE SITES
ALASKAN LNG
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Figure 1-9
Parametric Tradeoffs

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Table 1-7 Location for LNG Plant and Marine Terminal Using Parametric Analysis

Sub-region	Location	Description	Parameters[1]						
			Biotic Communities[2]	Navigation[3]	Pipeline[4]	Land Status[5]	Land Use & Population[6]	Topography[7]	Geology[8]
2	A	Chisik Island	No	Q	No	No	Refuge	Ok	No
2	B	Kalgin Island-West S.	No	Q	No	No	Recre-ation	Ok	Ok
2	C	Drift River	No	No	No	Ok	Oil	Ok	No
2	D	Redoubt Point	Q	No	No	Ok	Forest	Ok	Ok
2	E	Harriet Point	Q	No	No	Ok	Forest	Ok	Ok
3	A	West Foreland	Ok	No	No	Ok	Forest	Ok	Ok
4	A	North Foreland-Tyonek	Ok	No	No	No	Village	Ok	No
7	A	Nikishka	Ok	No	Ok	Ok	Industry	Ok	Ok
7	B	Nikiski	Ok	Ok	Ok	Ok	Industry	Ok	Ok
7	C	East Foreland	Ok	Q	Ok	No	Light	Ok	Ok
7	D	Boulder Point	Ok	No	Ok	Ok	Industry	Ok	Ok
7	E	Salamatof	Ok	No	Ok	Ok	Village	Ok	Ok
8	A	Cape Starichkof	Q	Ok	Ok	Ok	Radio	Ok	Ok
8	B	Bluff Point	Q	No	Ok	Ok	Rural	Ok	Ok
8	C	Kachemak	No	No	Ok	Ok	Rural	Ok	Ok
9	A	Kasitna Bay	No	Q	Ok	Ok	Village	No	Ok
9	B	Peterson Bay	No	Q	Ok	Ok	Village	Ok	Ok
9	C	Halibut Cove	No	Q	Ok	Ok	Village	Ok	No

Table .1-7 (cont'd)

			Parameters[1]						
Sub-region	Location	Description	Biotic Communities[2]	Navigation[3]	Pipeline[4]	Land Status[5]	Land Use & Population[6]	Topography[7]	Geology[8]
9	D	Barabara Point	No	No	Ok	Ok	Forest	Ok	Ok
10	A	Nuka Bay-North Arm	Q	Q	No	Ok	Forest	No	No
10	B	Nuka Bay-Beauty Bay	Q	Q	No	Ok	Forest	Ok	No
10	C	Nuka Passage	Q	Q	No	Ok	Forest	Ok	Ok
10	D	Port Dick-West Arm	No	No	Ok	Ok	Forest	No	No
11	A	Thumb Cove	Ok	Ok	Ok	Ok	Forest	No	Ok
11	B	Lowell Point	Ok	Q	Ok	Ok	Forest	No	No
11	C	Resurrection Bay East	Q	Q	Ok	Ok	Forest	Ok	Ok

Notes:
1. OK = Acceptable; NO = Eliminated.
2. Severe impact was judged to be the case for all "No" answers.
3. Bathymetry and anchoring criteria were used.
4. Pipeline was answered "No" if the route was hazardous or difficult.
5. Land status was marked "No" if the land was in a specific claim for wildlife refuge, village core township, recreation patents, or similar dedication.
6. Land Use and Population is descriptive by words used.
7. Topography that did not provide a gradable site of 400 acres was marked "No".
8. Geological hazards were judged to exist for all "No" answers.

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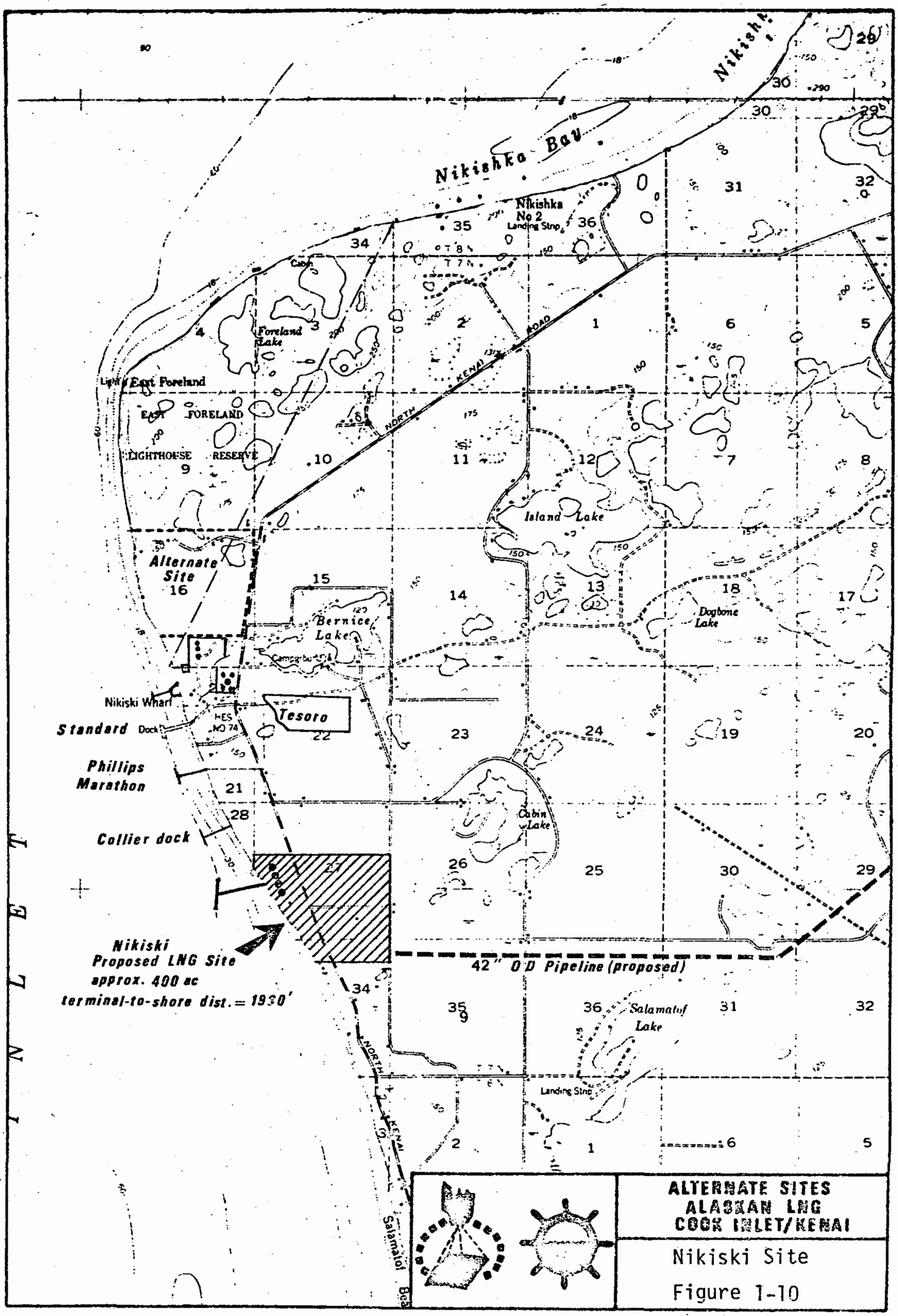
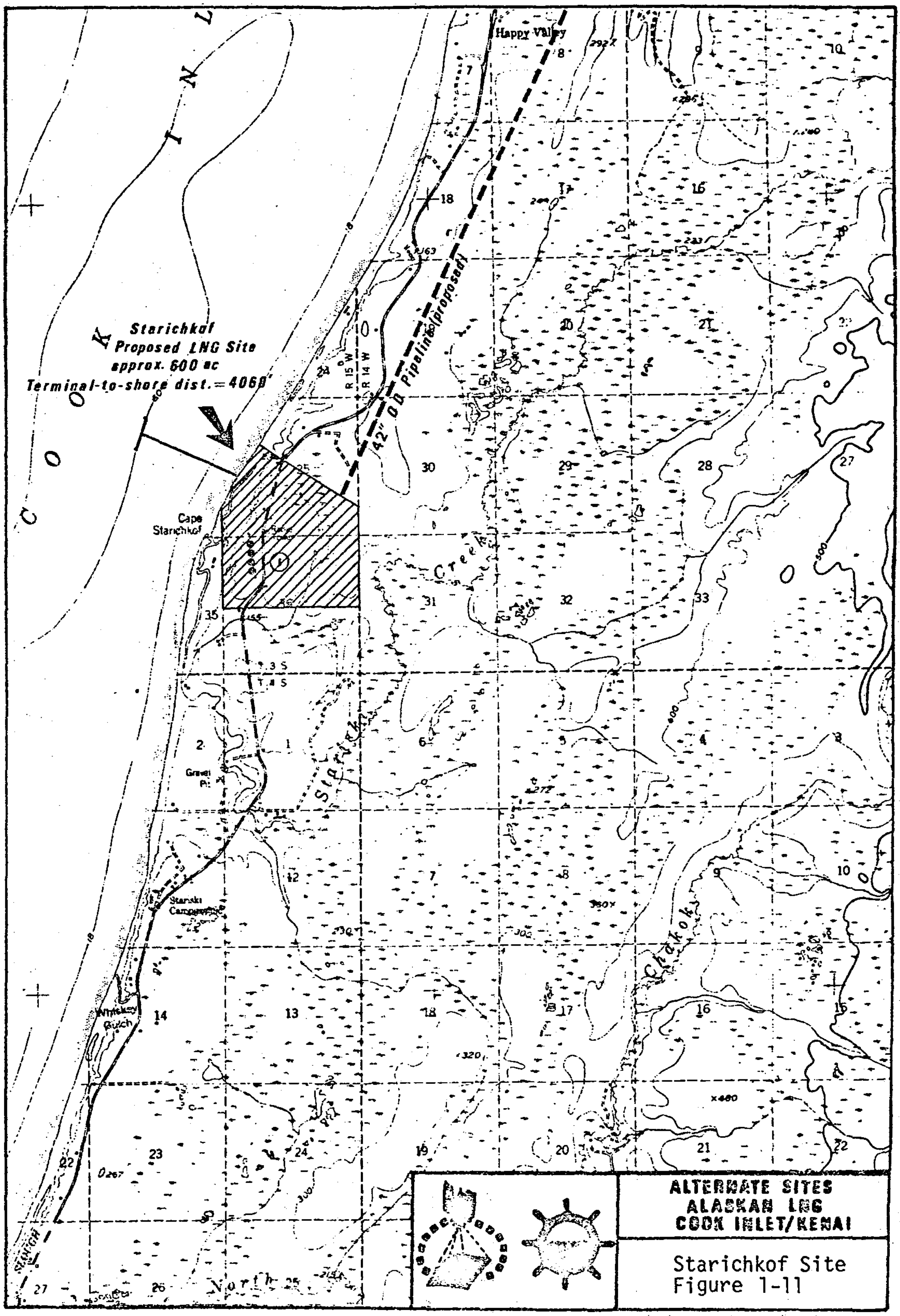
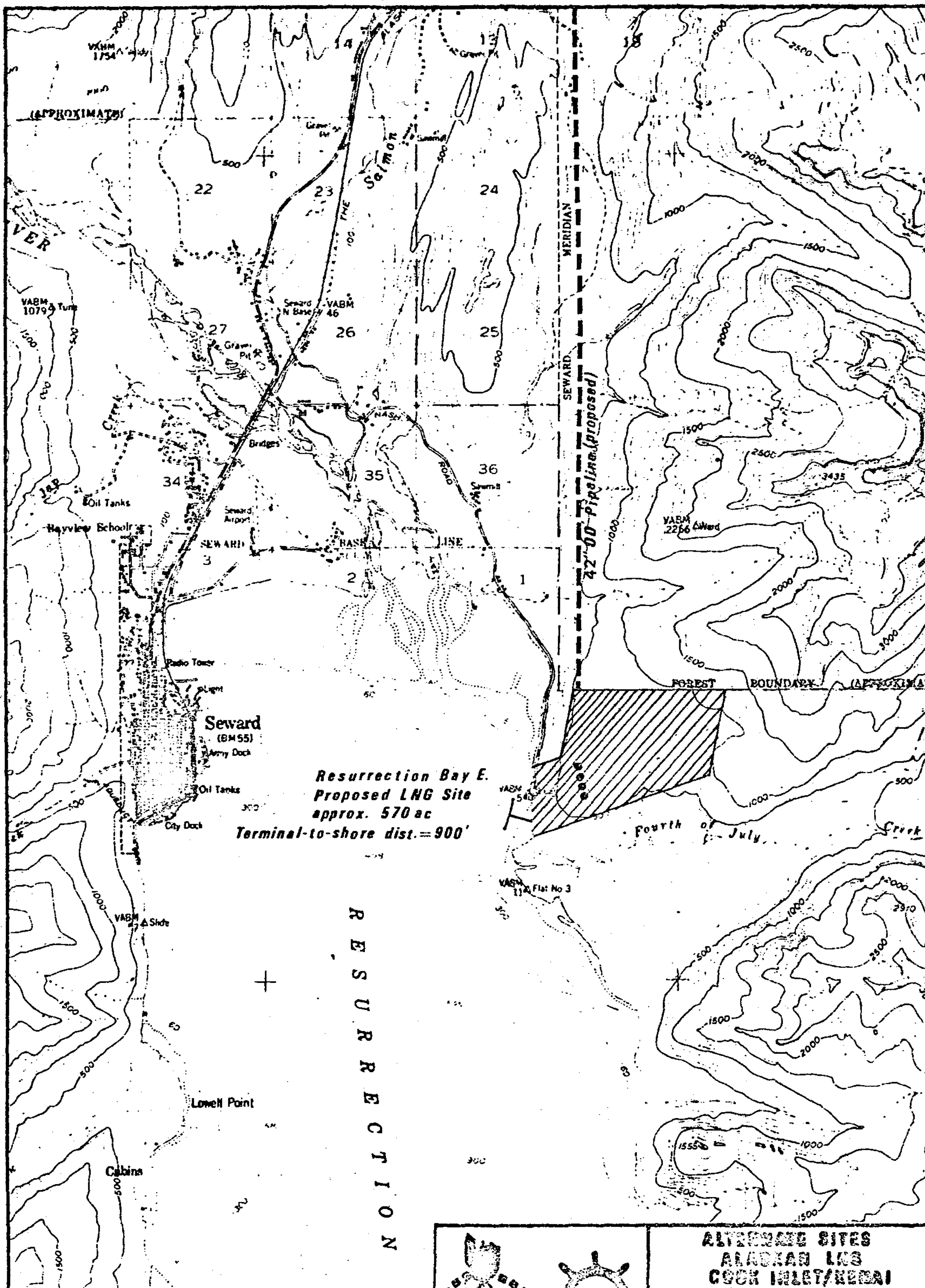




Starichkof Site
Figure 1-11



ALTERNATE SITES
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Resurrection B.E. Site
Figure 1-12

and an ordinate scale was used.

Site	Rank*
Nikiski	1st
Cape Starichkof	2nd
Resurrection Bay East	3rd

The staff's analysis of alternative sites in the Cook Inlet area consists of the presentation of 11 1/ of the 14 sites that were not eliminated from further study by Oceanographic Institute on the basis of navigational unsuitability in their initial gross elimination site selection process. The locations of the sites are shown in Figure 85. The same method of analysis used for the Prince William Sound sites has been used for the sites in the Cook Inlet area. The symbolic ratings, which represent the physical characteristics of each site as they relate to the developmental and/or operational requirements of the proposed project, are shown in Figure 86*.

Of the 11 sites that were studied, 10 were considered unacceptable for the technical requirements of the project and were rejected from further study. The principal reasons why these sites were rejected are explained in the following subsection.

1/ The staff's own analysis of potential sites within the Prince William Sound subregion included the three sites, Thumb Cove, Fourth of July Creek, and the Seward vicinity. The staff's analysis of the Resurrection Bay area concluded that the area would not be suitable for terminal development (see discussions on rejection of Thumb Cove, Fourth of July Creek, and Seward sites, Pages II-448 to II-452) based on overall geologic, climatic and oceanographic conditions characteristic of the Resurrection Bay area. It is the staff's conclusion that the last three sites identified by Oceanographic Institute in its Table 1-7 would not be suitable for terminal development.

* Figure 86 is located at the end of this section along with other foldouts.

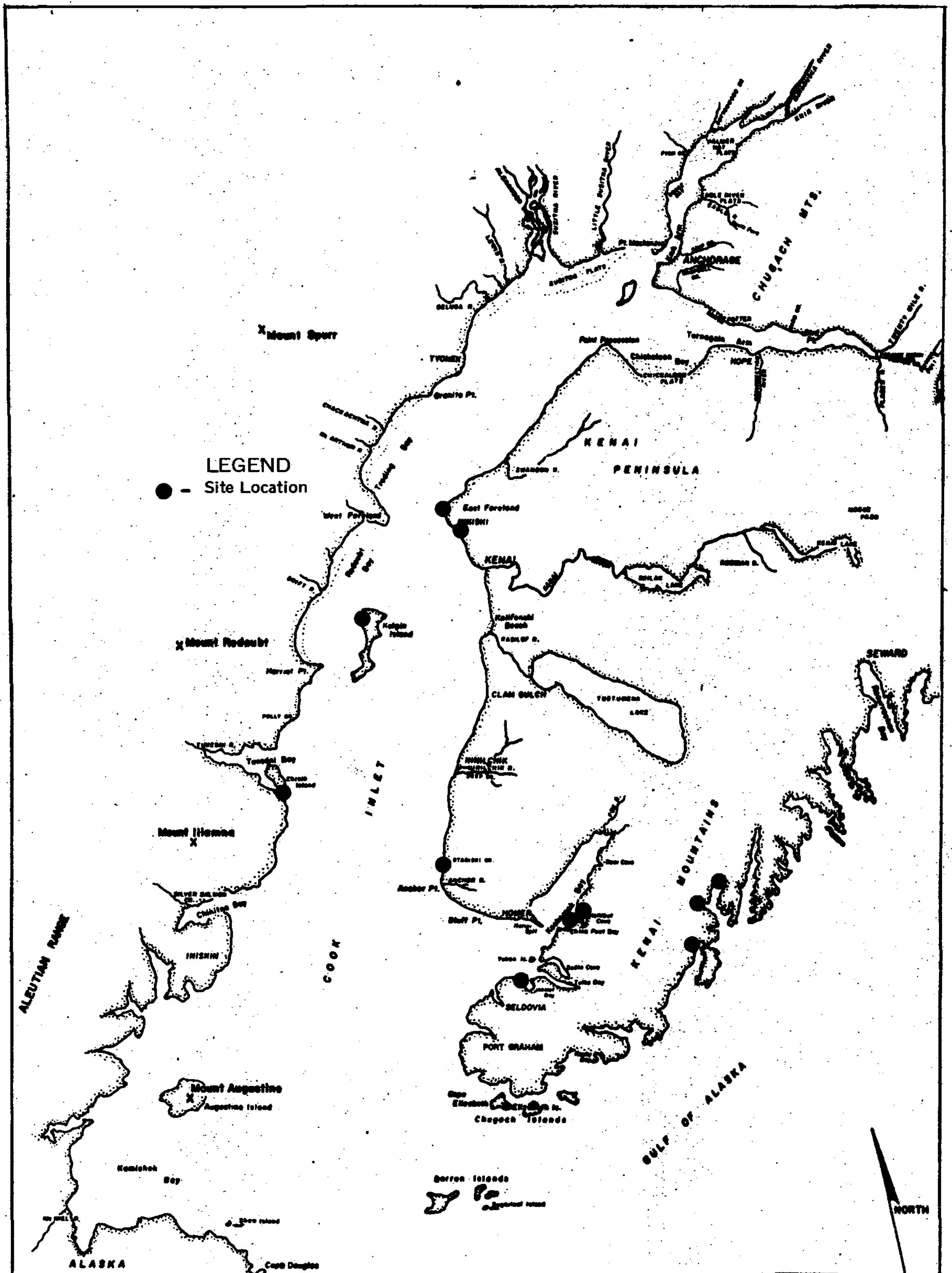


Figure 85. Location of sites analysed in Cook Inlet

i. Sites Rejected From Further Study

East Foreland

The East Foreland site is located approximately 60 miles north of Anchor Point and about 56 miles from Anchorage. The site consists of a nearly level wooded headland with a 276-foot bluff at the water's edge. East Foreland is presently classified as a lighthouse reserve, so LNG terminal development could involve land use conflicts between the existing conservation-oriented land use and newly introduced, industrially oriented uses. The site also lies above the constriction in Cook Inlet formed by the Forelands and would be subject to severe winter ice conditions which could adversely affect the operation of the marine terminal associated with the proposed project.

Nuka Bay - North Arm, Nuka Bay - Beauty Bay, Nuka Passage

Three sites within the Nuka Bay - Nuka Passage area, on the south coast of the Kenai Peninsula were considered as potential sites for terminal development. Each of the three sites is situated on deltaic deposits developed from the disposition of fluvial material transported by streams and creeks traversing the area. River deltas are characteristically susceptible to soil liquefaction, and historic earthquake occurrences have indicated that such deposits also display a high potential for tsunami inundation and subaqueous landsliding during periods of dynamic stress. These geologic considerations, in combination with evidence as to the frequent occurrence of high-speed Venturi winds (williwaws), which could adversely influence safe LNG tanker navigation, would not be conducive to LNG terminal development at either of the three Nuka Bay - Nuka Passage sites.

Kasitna Bay

The Kasitna Bay site is located on the south shore of Kachemak Bay between Nubble Point and Herring Inlets. The primary drawback of the site is that it would require extensive preconstruction site preparation to compensate for the uneven topography, resulting in excessive amounts of spoil material as well as increased costs from these massive cutting and filling operations. For this reason, the site was rejected from further consideration as a potential site.

Halibut Cove

The Halibut Cove site is located in Kachemak Bay on the east shore of Halibut Cove. The site presents two disadvantages which resulted in its removal from further consideration as a potential terminal site. The rugged topography of the site would require extensive preconstruction site preparation consisting of massive cutting and filling operations which could both increase costs as well as expand land disruptions resulting from the disposal and/or hauling of spoil material. The site is also located within the floodplain of Grewingk Glacier and could be subject to outburst flooding or other adverse effects associated with glacial activities.

Peterson Bay

The Peterson Bay site is located on the south shore of Kachemak Bay just west of the Halibut Cove site. Unlike the Halibut Cove site, Peterson Bay would not be subject to adverse effects from Grewingk Glacier, but its uneven topography would similarly require extensive grading and preconstruction site preparation. The Peterson Bay site was therefore discounted from further consideration as a potential site for terminal development.

Kalgin Island - West Side

The Kalgin Island site is located on the northwest side of Kalgin Island. Maneuvering might be restricted in some directions but the area is sufficient. Much of the site is wet and marshy which might create problems during preconstruction site preparation and might hinder facility foundation stability. The extensive marshlands on the island are used extensively as a waterfowl habitat and present land use of the area is directed toward conservation and ecological preservation. The development of an industrial facility on Kalgin Island would not be consistent with the existing natural conditions of the area and would result in the removal or disruption of a critical waterfowl habitat.

Snug Harbor - Chisik Island

The Snug Harbor site, on Chisik Island, is at the mouth of Tuxedni Channel on the west side of Cook Inlet. The topographic configuration of the site, which would require massive cutting and filling operations prior to emplacement of the facilities, in combination with the existing status of Chisik Island as a natural wildlife refuge, would create land use problems and conflicts for industrial development of the magnitude proposed at the site.

Nikiski

Nikiski is located 9 miles northwest of Kenai, Alaska, and 65 miles southwest of Anchorage, Alaska. Two sites in this general area were considered for the proposed LNG facilities. (See Figure 87.)

Although all other factors appear favorable for the use of the Nikiski sites, sea ice in conjunction with extreme tidal currents create serious problems for the navigation, docking, and loading of LNG vessels at Nikiski. OIW commented on these problems, but concluded that since docking has generally been possible year-round at the three existing Nikiski terminal facilities (Standard Oil Company Refinery, Collier Carbon and Chemical Plant, and Phillips-Marathon Liquefaction Plant), the hazards of ice action could be overcome. In the course of investigating the severity with which ice problems occur, the environmental staff contacted the 17th Coast Guard District in Juneau, Alaska with a request for information. 1/ It was learned that in the Coast Guard's opinion, "the siting of any additional LNG terminals in the Nikiski area poses a significant hazard to the safety of life, property, and the environment". 2/ The port of Nikiski has apparently been developed to the extent that additional vessels would be hampered by ice and currents, and would run a very real risk of colliding with docks or other ships if they were torn away from their own docks or forced to initiate emergency disconnect procedures.

Table 39 lists recent ice-and current-related incidents involving the operations of LNG tankers in the Nikiski area and updates the OIW list. (See Page II-439 of this section.) In view of the U.S. Coast Guard determination that any additional LNG terminals in the Nikiski area would pose significant hazard to the safety of life, property, and the environment, both sites in the area have been eliminated from further consideration.

1/ FPC Letter to U.S. Coast Guard, dated October 10, 1975. (See Appendix E.)

2/ U.S. Coast Guard Letter to Federal Power Commission, dated November 14, 1975. (See Appendix F.)

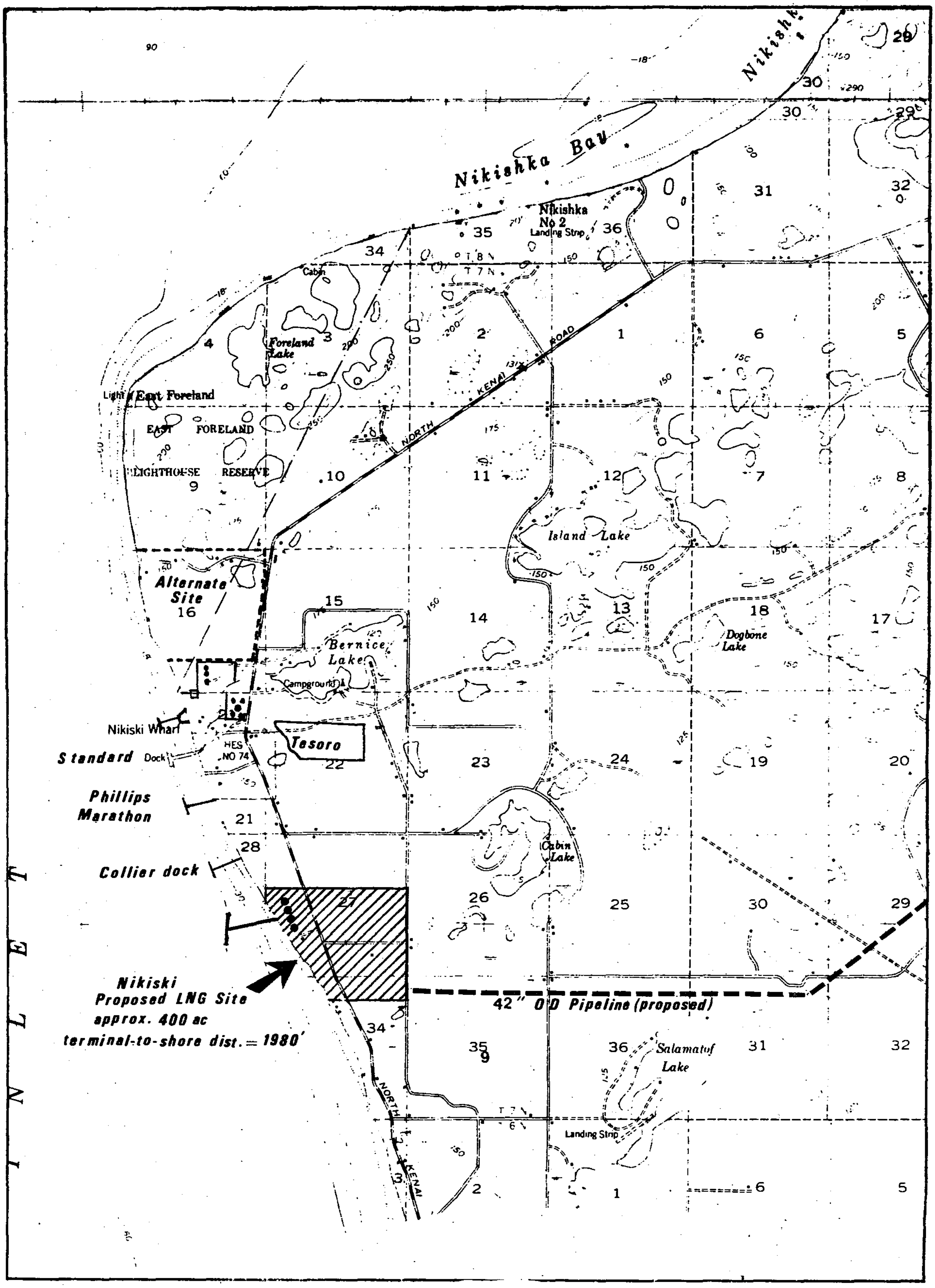


Figure 87 Nikiski Site, Cook Inlet

TABLE 39

ICE- AND CURRENT-RELATED INCIDENTS
FOR THE PORT OF NIKISKI AND THE OPERATION
OF LNG SHIPS IN COOK INLET
1971-1975

Date	Location	Description
1-12-71, 1-13-71	Phillips-Marathon Terminal	Loading of LNG ship slowed or stopped for a total of 5 hours due to ice. One mooring line broken during docking.
2-2-71	Near Kasilof	LNG ship approaching Nikiski forced to turn back when ice plugged main condenser.
2-23-71	Phillips-Marathon Terminal	Saltwater system of LNG ship plugged repeatedly by ice while loading at dock. Some pressure exerted on ship by ice wedged between shore and ship.
3-14-72	Phillips-Marathon Terminal	Ice wedged between shore and LNG ship, breaking two mooring lines and forcing pilot to abandon docking.
3-15-72	Phillips-Marathon Terminal	Mooring line of LNG ship broken due to ice pressure and winch problem. Extreme ice conditions coupled with 27.8-foot tide caused delay in loading LNG.
3-16-72	Phillips-Marathon Terminal	Repeated ice problems occurred while LNG ship was attempting to load LNG. Mooring line broken, then emergency disconnect required, after which ship could not dock again until the tide changed.
3-16-72	Collier Carbon and Chemical Terminal	Barge collided with ice; caused by ice flow.
3-18-72	Phillips-Marathon Terminal	Extreme ice conditions halted loading of LNG and later required emergency unmooring.
3-27-72	Phillips-Marathon Terminal	Loading of LNG delayed twice due to ice conditions.
4-4-72	Collier Carbon and Chemical Terminal	Vessel damaged by collision with ice and dock.
2-19-73	Collier Carbon and Chemical Terminal	Vessel attempting to load broke away from dock due to ice conditions. LNG ship advised to delay approaching Nikiski as a result.
2-20-74	Phillips-Marathon Terminal	Loading of fuel oil aboard LNG vessel delayed because of severe ice conditions.
3-10-74	Nikiski Dock	Oil tanker required emergency disconnect due to ice conditions, 8 to 10 bbls. crude oil spilled.
1-8-75	Standard Oil Terminal	Oil tanker broke loose from dock, narrowly missing collision with LNG ship moored at Phillips-Marathon Terminal.
3-25-75	Standard Oil Terminal	Oil tanker was unable to dock during ebb tide because of strong currents. LNG vessel crew at Phillips-Marathon Terminal placed on standby in case oil tanker drifted toward the LNG vessel.

Source: J.B. Hayes, Rear Admiral, U.S. Coast Guard, Letter to the Federal Power Commission dated November 14, 1975, and U.S. Army Corps of Engineers, Alaska District, FEIS on Offshore Oil and Gas Development in Cook Inlet, Alaska (Anchorage, 1974), p.30.

ii. Site Assessment - Cook Inlet

The only site not eliminated in the foregoing site selection process was the Cape Starichkof site. This site lies on the eastern shore of Cook Inlet some 13 miles south of Ninilchik. (See Figure 88.) The site at Cape Starichkof would cover an area of approximately 600 acres and would be connected to a marine terminal with a pier projecting 4,060 feet into the waters of Cook Inlet. The pertinent physical characteristics of the site were tabulated in a manner similar to that undertaken for the Prince William Sound sites, and are presented in Table 37. The results of the overall ecological and biological comparison are indicated in Table 38.

The climate at Cape Starichkof resembles that at Homer, the nearest source of meteorological data. The average wind speed is 5.7 knots, with wind speeds in excess of 21.7 knots occurring about 1 percent of the time. Visibility less than 6 miles occurs 5.7 percent of the time.

Much of the site is nearly level and lies at an elevation of over 200 feet. The northwestern portion of the site, between the Sterling Highway and the shore of Cook Inlet, slopes rapidly towards the beach in a series of heavily vegetated ravines. Other more gradual slopes may be found along a small stream flowing southward through the site and along the southern and eastern borders of the site.

Bedrock at Cape Starichkof is more than 60 feet beneath the surface and no bedrock exposures are found in the immediate area. There are no active faults on or near the site, and maximum earthquake magnitudes at the site are not expected to exceed 7.5 on the Richter scale. The 1964 Alaskan earthquake resulted in a subsidence of approximately 4 feet at Cape Starichkof and produced 20-foot high waves at Seldovia and Halibut Cove, about 30 miles south and southeast, respectively, from the site. The site's elevation should be sufficient to protect the LNG plant from tsunamis. There are no known landslides or other mass movement phenomena at the site, and the potential for soil liquefaction is low. The soils consists of peat and various silt-loams overlying 3-5 feet of silt and 40-50 feet of dense, gravelly materials. Drainage is generally fair, although a poorly-drained marshy area can be found in the northeastern portion of the site. Some care would be required to protect surrounding wetlands.

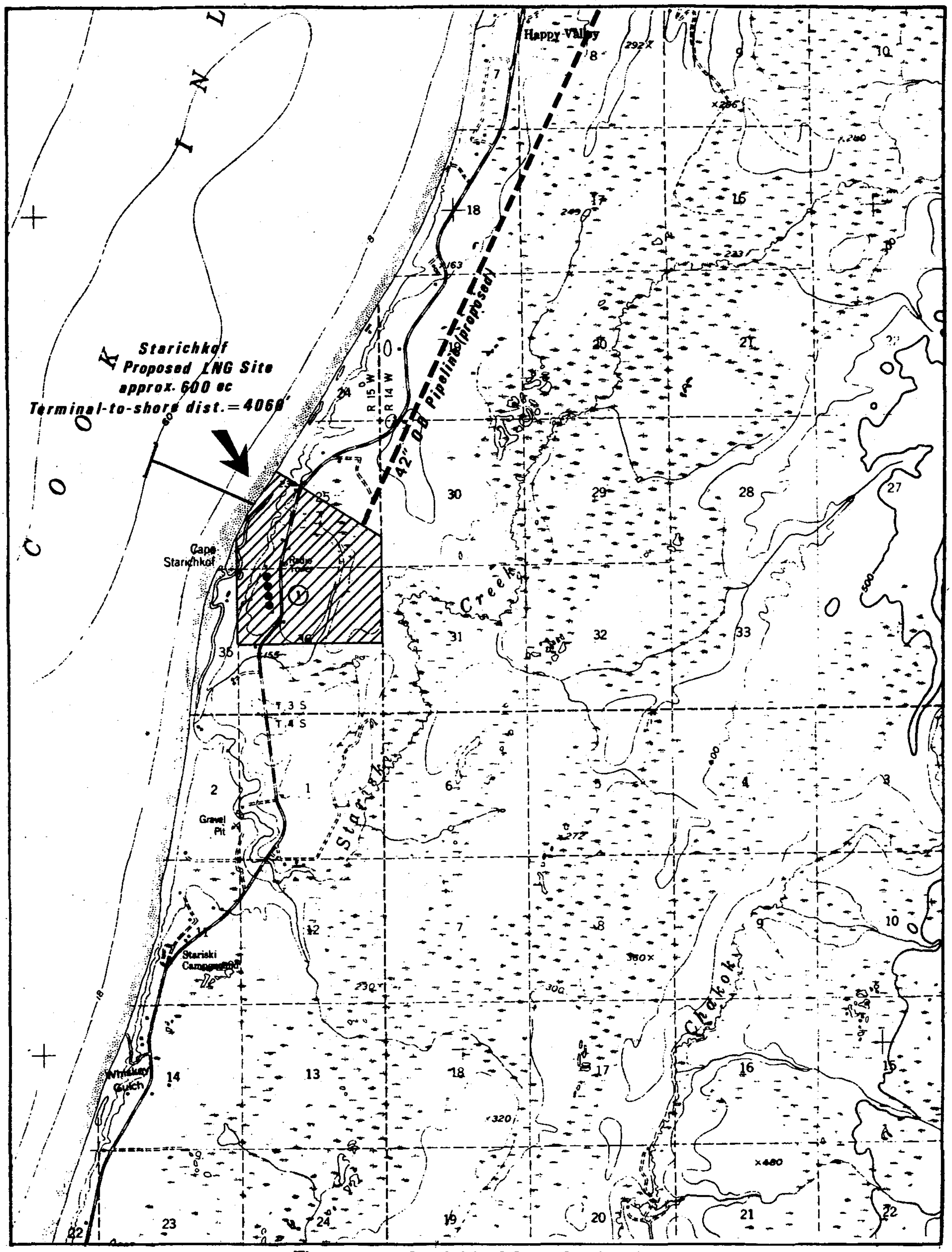


Figure 88 Starichkof Site, Cook Inlet

The site is surrounded on three sides by Stariski Creek, and an unnamed stream flowing through the site empties into this creek. The water table lies about 10 feet beneath the ground surface. Surface waters are generally confined to marshes and streams.West of the site the waters of Cook Inlet deepen gradually to where the 60-foot depth contour lies less than 0.8 miles offshore. A shoal area with depths less than 60 feet lies 1.5 to 2.3 miles offshore (Figure 88), but it appears that LNG tanker access to the terminal area would not be hindered by this shoal. No dredging would be required to provide access to a marine terminal constructed at the end of the 4,060-foot trestle proposed by OIW, and two navigational lights marking the route to and from the terminal would probably be sufficient to aid docking vessels.

The diurnal tidal range at Ninilchik, 13 miles north of the site, is 19.1 feet. Average currents at Cape Starichkof are 2.2 knots at floodtide with a maximum of 3.5 knots; ebb currents are less strong. Maximum wave heights of 10 to 12 feet generally occur about three times a year. The offshore area is generally ice-free, although 10 to 20 percent of the surface may be covered by ice during severe winters. The U.S. Coast Guard is unable, for lack of sufficient data, to assess the ice hazards at Cape Starichkof in detail, but states that regarding both the amount of ice present and the length of the ice season, ice conditions are probably less severe at Cape Starichkof than at Nikiski. Based on all information received at this time, the environmental staff is of the opinion that ice conditions would not constitute a significant navigational or loading hazard.

Most sediment movements in this area of Cook Inlet are confined to shifts of the bottom materials. A northerly transport of bottom sediments takes place along the coast. The sands and gravels making up the bottom would be conducive to ship anchoring and channel dredging, but the sediment mobility would create a need for repeated maintenance dredging. Suspended sediment concentrations in this part of the inlet are generally less than 20 parts per million (ppm), although the outflow from the nearby mouth of Stariski Creek may add more suspended sediments to the local regime during periods of high runoff. Due to the distance from developed communities and industries, the waters off Cape Starichkof are probably relatively free from sewage and other contaminants.

iii. Biological and Socioeconomic Analysis - Cook Inlet

The construction of an LNG facility at the Cape Starichkof site would have a substantial effect on the biological and socioeconomic environment of the Cook Inlet area. Moose, bears, anadromous fish, clams, swans, and caribou are among the species that might be affected.

No concentrations of eagles, bears, sea otters, sea birds, or other warm-blooded animals occur near the Cape Starichkof site. The moose, which is the major grazing animal on the Kenai Peninsula, is present in the site area, but does not occur in large numbers and has no critical habitats in the site's vicinity. Black bears are numerous but, like the moose, are generally not found in concentrations.

Stariski Creek is the only anadromous fish stream within 5 miles of the Cape Starishkof site. A small tributary of this stream flows through the site. Stariski Creek is known for its runs of chinook salmon, cohoe salmon, and steelhead. Both this stream and the area offshore from its mouth received attention from recreational fisherman. Hook points for salmon nets are found along the shore at the site, and a major commercial salmon fishery is present in Cook Inlet nearby. There is no commercial crab fishery in the area, and only a limited herring fishery is conducted in this part of Cook Inlet. Beds of razor and red-necked clams can be found along the shoreline and on sandbars offshore.

The Cape Starichkof site, transected by the Sterling Highway is readily accessable from the major towns and cities on the Kenai Peninsula, yet is not too near any major population centers. The nearest towns are Happy Valley, which is 5 miles north of the site, and Anchor Point, which is 8 miles south. These two communities would share LNG facility-related socioeconomic impacts with a number of population centers in the Kenai-Cook Inlet area, which had a total population of 4,487 people in 1974, and with the Anchorage area, which boasted a population 10 times that figure in 1970. The environment is not as pristine as much as the Prince William Sound area due to the existence of scattered residences, roads, and light construction in the area. Transportation of construction and plant operation personnel to this site would be cheaper and more convenient than to the Prince William Sound sites, and temporary housing in the form of mobile homes could be brought by road directly to the site. One drawback to the Cape Starichkof site is the existence of seven residences and a radio tower within the site boundaries.

The length of the pipeline to the Cape Starichkof site may be the biggest drawback of this alternative. This pipeline route would be longer than the route to Gravina Point and would require 16 miles of marine pipeline. More of the environment would therefore be subject to impact if this alternative were chosen.

f) Comparative Analysis - Cape Starichkof vs. Gravina

Based upon the information presented in the preceeding analysis of potential LNG terminal sites in Alaska, the staff is of the opinion that both the Cape Starichkof site within Cook Inlet and the Gravina site within Prince William Sound might be suitable locations for the development of the LNG terminal facilities proposed by El Paso Alaska Company. The site selection study submitted to the FPC by El Paso concludes that the Gravina site would constitute the most acceptable location on the basis of the criteria established in the study. A noticeable difference exists between the methodology used by the staff and by the applicant in the respective site selection analyses. In the staff's study, considerable attention has been directed toward determining the existing environmental conditions and sensitivities of the potential sites, as well as evaluating the potential for adverse environmental impacts that could be incurred by project development at the sites. As stated in the "Introduction and Methodology" section of the staff's report, Page II-420, in order for a site to be considered suitable for development, it must satisfactorily comply with the basic requirements necessary for the success of the project and it must exhibit a degree of environmental and ecological stability such that the project could be implemented with a minimal amount of environmental disruptions.

The site selection study submitted by the applicant is comprised of the selection and subsequent evaluation of potential sites "based upon criteria which define an idealized site in terms of the physical characteristics and properties which such a site should exhibit. These physical characteristics and properties are determined by requirements of the LNG plant, the marine terminal, and the LNG carrier fleet.

"From a realistic point of view, it was recognized that the ideal site would be difficult if not impossible to locate. The overall objective of the study was to locate a site which approached the ideal as closely as possible.

"The criteria are utilized as guidelines during an initial site survey of the general region. Basic requirements concerning the amount of land available, the location of deep water relative to shore, the maneuvering room available in the offshore areas and the proximity of areas with a high population density are generally sufficient to determine if a specific location warrants further consideration as a potential site.

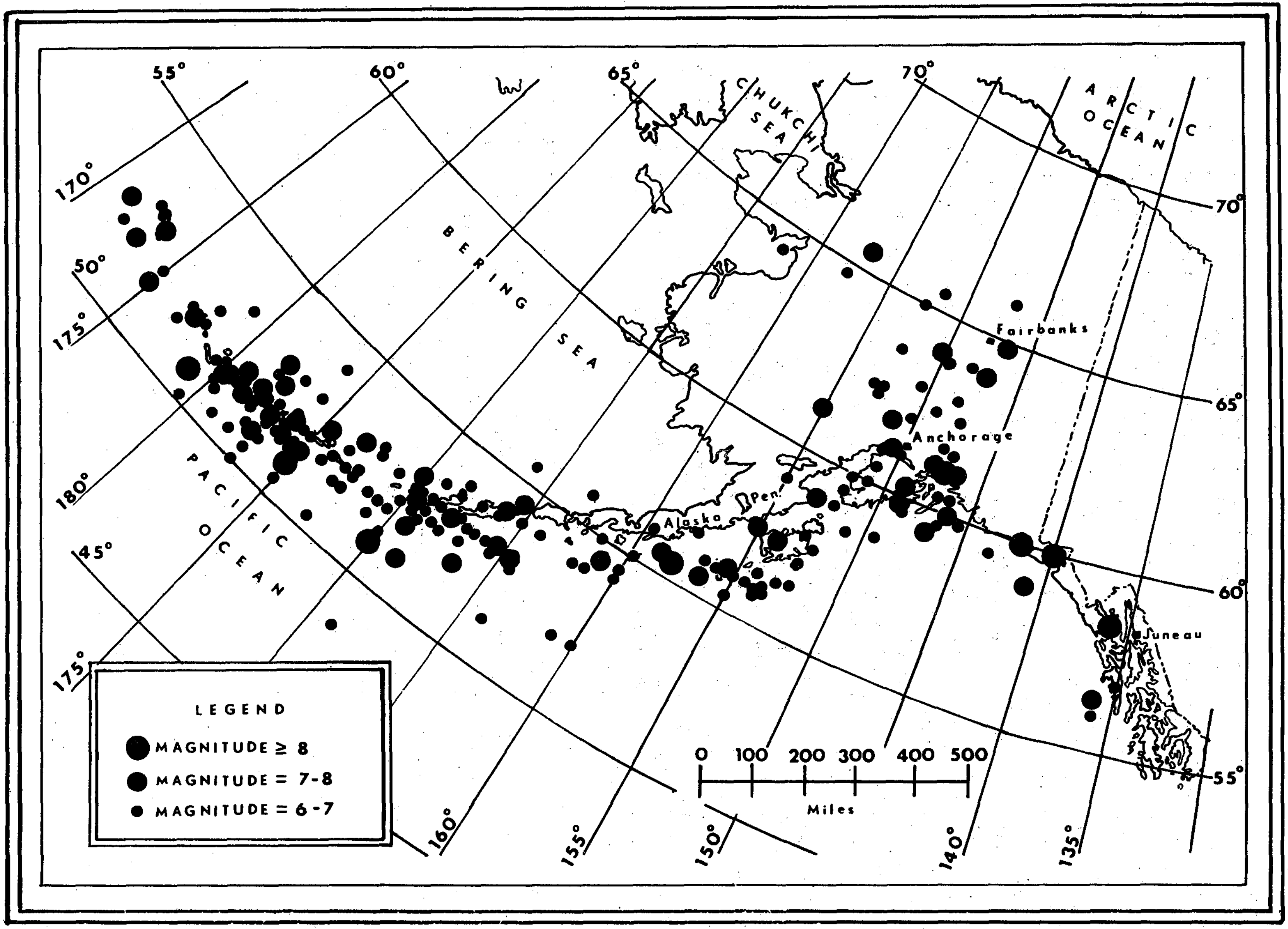
"Locations that merited further consideration were subjected to additional studies to ascertain the extent to which each location complied with the requirements set forth in the criteria. These studies were concerned with a detailed evaluation of the physical conditions which exist in three major areas of each location: the area which would be utilized as the location of the plant, the area in which the marine terminal would be located and the bodies of water which would be utilized by the LNG carriers. A specific location was considered to be a viable site if it possessed characteristics equal or similar to those defined in the criteria, which are discussed in more detail in the subsequent sections." 1/

The staff is in agreement with the applicant that of the sites that were considered in Prince William Sound, the Gravina site is probably the most viable location on the basis of compliance with the technical requirements of the proposed project. The staff, however, disagrees with El Paso's premise that the Cape Starichkof site is not a viable alternative, since it, too, complies with the technical requirements of the project, and also has the advantage of exhibiting fewer environmental sensitivities and less potential for adverse environmental impacts than the Gravina site.

During the process of reviewing the information contained in the filings submitted by the applicant, the contract study prepared by the Oceanographic Institute of Washington, and numerous additional sources of information, the staff has become aware of the potential adversities that could be encountered in the Cook Inlet area, most notably the potential for the disruption of shipping or docking maneuvers through the interaction of winds and masses of sea ice. The Cape Starichkof site apparently lies outside the area of disruption.

Based on the historical record, the Gravina - Prince William Sound area appears to exhibit a higher susceptibility to large magnitude seismic events than does the Cape Starichkof - Cook Inlet area. As is indicated in Figure 89, a greater number of earthquakes ranging in magnitudes from 7 to 8 have occurred in the vicinity of Prince William Sound, than in the Cook Inlet area. During the 1964 earthquake, Gravina Peninsula was subjected to 4.5 feet of vertical displacement upward, and 30 feet of horizontal displacement. The Cape Starichkof area, located within the area of subsidence that resulted from the earthquake, was subjected to no more than 1 foot of subsidence.

1/ Trans-Alaskan Gas Pipeline Project, Site Selection Report.



FROM: U.S. COAST AND GEODETIC SURVEY, 1966

Figure 89. Earthquakes in Alaska. Magnitude ≥ 6, 1899-1964

The Cape Starichkof site lies in close proximity to the active Aleutian volcanic arc, and would exhibit a potential for sustaining adverse effects from the eruption of the nearest volcanoes within the arc. The active volcanoes closest to the site are Redoubt and Mount Augustine, located 60 and 65 miles, respectively, from Cape Starichkof. The principal effect of a volcanic eruption as related to the integrity of an LNG terminal facility would be the generation of sea waves. The eruption of Mt. Katmai in 1912, located approximately 150 miles southwest of the site, was accompanied by earthquakes with magnitudes of 6.4 and 7, as well as many lesser foreshocks and aftershocks. The largest reported tsunami in Cook Inlet was a 25 to 29-foot wave at Graham on English Bay (50 miles south of Cape Starichkof), and was associated with the eruption of Mount Augustine in 1883. The following table excerpted from the OIW study indicates the eruptive history of volcanoes within the Cook Inlet area prior to 1972. Mount Augustine exhibited major activity on January 23 and February 6, 1976. Two major explosions occurred on each date. The January 23 events were accompanied by a plume of gas and ash extending to an altitude of about 40,000 feet, microseisms up to about magnitude 3.5, and superheated gas and mudflows expelled on the north side of the island. Approximately one-sixteenth inch of ash fell in Anchorage, and perhaps one-eighth inch fell on Kenai. No tsunami was reported. It was known as early as the middle of October 1975 that volvanic activity was imminent. The current activity could last several months. (Dr. Juergen Kienle, personal communication.)

Columbia Glacier, located approximately 40 miles northeast of Gravina, is the only glacier in Alaska that has not initiated a precipitous retreat of its ice front in the past century. The other tidal glaciers in the state are already retreating to land or have done so already. The continued stability of Columbia Glacier depends upon the ice margin remaining on the shoal upon which it presently ends, but evidence indicates that the glacier would probably retreat within the next 20 years, but not in the next 5. The problem that would arise, as it would affect LNG shipment in Prince William Sound, would be the dramatic increase in the number of icebergs calved by the glacier during a rapid retreat. It could calve icebergs at a rate amounting to 1 cubic mile of ice per year. Icebergs from other tidal glaciers in Alaska have massed up to 800 million tons of ice each. Icebergs from Columbia Glacier reaching Prince William Sound, however, could be limited in size by the water depth over the existing shoal, although a considerable number of large icebergs could bulldoze their way through the shoal.

EXCERPT - OCEANOGRAPHIC INSTITUTE OF WASHINGTON

AUGUSTINE

1812: active
1883: violent eruption with ash and mud-flows-hunters driven off island by eruption: large waves arrived at English Bay and Port Graham-hazard to boats and coastal villages
1885: steaming shore to summit
1895: crater steaming
1935: lava eruption
1963: active
1964: active, July 5th and August 19th: Coast and Geodetic Service navigation station operator on island endangered by eruptive activity-eruptive clouds a hazard to aircraft
Present State: Lava dome moving upward, and continually degassing-recurrent microearthquake activity

ILIAMNA

1741: quiet
1768: smoke
1778: resumed actively
1779: active
1786: smoke
1867: ash eruption
1876: smoke
1933: smoke
1947: smoke
1952-3: smoke
Present State: Continuing fumarolic activity near summit

SPURR

1953: ash eruption-ash fall-out on Anchorage-costly clean up and damage to equipment-ash cloud hazard to aircraft
1954: ash eruption
Present State: Continuing fumarolic activity near summit

REDOUBT

1778: active
1819: smoke
1902: active
1933: smoke
1966-68: recurrent explosions and turbulent clouds to elevations over 40,000 feet-two flash floods resulting from rapid snow melting occurred in the Drift River Valley endangered seismic survey crew-rescue required
Present State: Small lava dome extruded at head of fissure vent in 1967-68-dome is degassing-microearthquake activity level presently unknown

*AUGUSTINE IS THE GREATEST VOLCANIC RISK OF THE FOUR, FOR THE FOLLOWING REASONS:

(1) It is seismically active; (2) the lava dome has grown about 245 feet in elevation since 1958; (3) the dome is continually degassing; (4) it has a history of explosive eruptions; (5) it is in a marine setting; a requirement for phreatic or Krakatoan type eruptions; (6) large waves (tsunami or splash induced) could be generated by Augustine eruptive activity, and such waves could threaten coastal installations, dwellings, sea lanes and fisheries; (7) explosive eruptive clouds are a potential hazard for airline traffic.

No evidence exists to indicate that an Augustine eruption is imminent. Scientists do believe, however, that the volcano is capable of erupting and that it is possible to recognize pre-eruptive trends early enough to alert all communities prior to a major eruption; if if instrumentation is increased as proposed by the University of Alaska Geophysical Institute.

TABLE 2-2 Eruptive History of Volcanoes in the Cook Inlet Basin Alaska

The development of transmission pipeline routes connecting the natural gas reserves at Prudhoe Bay with either the Cape Starichkof or Gravina potential LNG terminal sites would be within the limits of technical feasibility, and have been discussed in detail in the body of the environmental impact statement. The following table is presented to provide a comparison between the lengths of the pipeline routes that would issue to the Cape Starichkof and Gravina sites. 1/

Comparison of Pipeline Length for Alternate Sites

	Distance from MP 389.5 in Utility Corridor (miles)		
Sites	Actual	Weighted*	Marine Crossing**
Gravina Point	419	419	0
Cape Starichkof	425	473	16

* The weighted distance was calculated as follows: (actual distance - marine crossing) + 4(marine crossing) = weighted distance.

** There are several other considerations that would be used in a full cost comparison including tunnelling, stream crossings, river crossings, aerial crossings, wetland construction, steepness of grade, lack of road or railroad access, utility corridor, etc.

g) Conclusions - LNG Plant Site

After conducting an extensive study of the Alaskan coastline, the staff identified four potentially acceptable sites (Cape Starichkof, Bidarka, Hawkins Island, and Gravina) in the Cook Inlet and Prince William Sound areas. The staff found Cape Starichkof to be the best site in Cook Inlet, and agreed with El Paso that Gravina was the best site in Prince William Sound.

Gravina's major drawback was found to be its potential for biological and socioeconomic impact. This site's strength was its acceptability from a navigational standpoint. Cape Starichkof's major drawback was the additional pipeline and marine pipeline crossing required to reach the site, but biological and socioeconomic problems at the site would not be as significant as similar problems at Gravina. The Cook Inlet area is also somewhat more satisfactory from a seismic standpoint. In addition, due to the high topographic relief at the Gravina site it is expected that significant amounts of cut and fill would be required versus what is expected to be minor cut and fill requirements at the Cape Starichkof site. In other categories little differences between the sites existed, or one category canceled out another. For example, Gravina is exposed to possible glacial retreat activity, but Cape Starichkof was nearer areas of historic volcanic activity.

1/ Oceanographic Institute of Washington, 1975.

Close scrutiny revealed that Prince William Sound might not be entirely free of ice conditions during the life of the project, while the ice conditions in Cook Inlet, though chronic in upper Cook Inlet, were not found to be significantly hazardous to the operation of LNG vessels in the vicinity of Cape Starichkof. Other issues of public safety were analyzed and it was concluded that while a major LNG accident must be recognized as possible and the consequences of such an accident must be taken into consideration, it is held to be highly unlikely and, therefore, the risks inherent with an LNG operation at either Cape Starichkof or Gravina are concluded to be of an acceptable nature to the public. Although the safety analysis presented in Section C-15 and other safety studies were considered, this conclusion is primary based upon an independent study conducted by the staff responsible for the overall assessment of LNG site alternatives. This study arrived at conclusion similar to those previously discussed and is found as Appendix A in Volume I.

The staff concludes that when the suitability of the two sites to comply with technical requirements of the proposed project is considered in combination with their relative susceptibilities to adverse environmental impacts, the Cape Starichkof site is better than the Gravina Point site. However, one other project should be identified to give a full perspective of the volumes of gas to be imported to California and the possible need for one or more LNG liquefaction, storage, and export terminals within the State of Alaska.

In addition to the El Paso project, Pacific Alaska LNG Company (Pacific Alaska) has proposed in Docket No. CP75-140 to transport from a proposed site at Nikiski, approximately 400 million cubic feet of natural gas per day to a proposed LNG facility in California. In view of the U.S. Coast Guard's determination that "the siting of any additional LNG terminals in the Nikiski area poses a significant hazard to the safety of life, property, and the environment", the Nikiski site is not suitable for the proposed Pacific Alaska LNG terminal. Therefore, it is the environmental staff's further conclusion that a joint LNG terminal would be more advantageous to construct and operate at Cape Starichkof for the two volumes of gas associated with the aforementioned projects and that the proposed volumes of gas associated with the Pacific Alaska project be transported to Cape Starichkof by maximum utilization of the pipeline which would carry Prudhoe Bay gas to Cape Starichkof. Modifications to the alternative El Paso pipeline may be warranted depending on the volumes of gas El Paso proposes to transport. 1/ Such a terminal and pipeline system could be built and operated in a safe and efficient manner without posing a significant hazard to the general populace. In comparison to Gravina Point, this latter alternative, i.e., a joint terminal, is concluded to be far superior to two new LNG terminals within the Cook Inlet area.

1/ On December 19, 1975, El Paso testified on a possible alternative to their proposal showing the receipt of 2.367 billion cubic feet of gas per day at Prudhoe Bay instead of 3.189 billion cubic feet of gas per day as originally proposed.

3. No Action or Postpone Action

The actions that are available are to grant the El Paso Alaska System the certificates that are sought, to deny them, or to postpone action pending further study. If action is postponed, this decision will ultimately lead to one of the other two.

The alternative of "no action" means the denial of the certificates necessary for the functioning of any part of the integrated El Paso Alaska System. Denial of a certificate for the El Paso Alaska portion of the integrated system would, in effect, be no action on the entire system.

The alternatives to "no action" on the integrated El Paso Alaska System are: (1) the alternative transportation modes, (2) the alternative energy sources, or (3) no Artic Gas System as these are fully described in USDI's Alaska Natural Gas Transportation System EIS.

Denial of the Point Conception terminal and its associated pipelines could result in: (1) no action on the El Paso Alaska System, or (2) action on an equivalent alternative site with other associated pipeline construction.

Table 36

Major Wildlife Impacted Along the Pipeline Corridor North Terminus to Lane Creek Junction

Species	Miles and Habitat Usage	Relative Habitat
Moose	96 miles; general presence	medium
	85 miles; concentrated fall and winter range	high-limiting habitat
Caribou, Nelchina Herd	88 miles; general presence	medium
	50 miles; winter range	high
Dall Sheep	20 miles; general presence	medium
Black Bear	225 miles; general presence	low to medium
Brown-Grizzly Bear	125 miles; general presence, rare north of Alaska Range	low to medium
Waterfowl	45 miles; nesting concentration, river flats	high - key North American breeding area

Source: Alaska Department of Fish and Game, 1973.

Figure 79. Symbolic Ratings - Prince William Sound Sub Region

	Topographic Conditions	Foundation Stability	Seismic Considerations	Atmospheric Conditions	Oceanographic Conditions	Distance to Deep Water	Navigational Suitability	Anchorage Suitability	Ice Formation	Land Use Conflicts
Gravina	◐	○	◐	○	○	○	○	◐	○	◐
Hawkins Island	◐	○	◐	○	○	○	○	◐	○	◐
Bidarka	◐	○	◐	○	○	○	◐	◐	○	◐
Bomb Point	●	○	◐	○	○	○	○	◐	○	◐
Valdez	●	○	●	◐	○	○	◐	●	○	◐
Jack Bay	◐	○	◐	◐	○	○	●	○	○	◐
Seward	○	●	●	◐	◐	●	◐	●	○	◐
Fourth-of-July Creek	●	●	●	◐	◐	●	◐	●	○	◐
Thumb Cove	●	○	◐	◐	○	○	●	○	○	○
Whittier	◐	●	●	◐	◐	○	◐	◐	○	●
Shotgun Cove	◐	○	◐	○	○	○	◐	◐	○	●

LEGEND

○ - Favorable condition.

◐ - Sub-Favorable condition that could be mitigated with appropriate measures.

● - Unfavorable condition that could not be mitigated or which would present a serious problem or hazard.

Table 37. Physical Comparison of Five Potential Sites

NAVIGATIONAL FEATURES

Site	Dimensions of Approach Channel	Depth of Channel	Dredging	Navigational Obstructions	Estimated Vessel Traffic
Gravina	Narrowest width is 6 miles (211.2 times beam of ship).	Avg. depth greater than 300 ft.	No dredging required.	All turns are gradual.	Moderate ship traffic travels N-S in Prince William Sound. Light traffic moves E-W near site.
Hawkins Island	Narrowest width is 6 miles (211.2 times beam of ship).	Avg. depth greater than 300 ft.	No dredging required.	All turns are gradual.	Moderate ship traffic travels N-S in Prince William Sound. Light traffic moves E-W near site.
Bidarka	Narrowest width is 0.8 miles (Landlocked Bay) (38.1 times beam of ship).	Avg. depth is 600 ft.	No dredging required.	All turns are gradual.	Moderate ship traffic travels N-S in Prince William Sound. Minimal traffic near site.
Cape Starichkof	Greater than 450 feet.	Sufficient depth along channel.	No dredging required.	All turns are gradual.	657 tanker sorties in Cook Inlet in 1973.

Table 37. Physical Comparison of Five Potential Sites (Continued)

NAVIGATIONAL FEATURES (Cont'd)

Site	Established Traffic Patterns	Traffic Safety System	Navigation Aids	Suitability of Anchorage Area	Depth at Anchorage Area	Dimensions of Anchorage Area
Gravina	N-S in Prince William Sound E-W near site.	USCG safety system does not include area near site. No safety lanes.	Light at Gravina Pt. (Fl 15 Sec. 27 ft. 10m) Light at Johnson Pt. (Fl 6 Sec. 57 ft. 13m) Horn at Cape Hinchinbrook (Fl 5 Sec. 235 ft. 22m R Bn 292).	Fair	Avg. depth is 150 ft.	Sufficient maneuvering room.
Hawkins Island	N-S in Prince William Sound E-W near site.	No traffic safety systems in Prince William Sound. No safety lanes in Orca Bay.	Light on N. shore of Orca Bay. Buoy marking Middle Ground Shoal. (R"2" Fl 6 Sec. Bell) Johnstone Point (Fl 6 Sec. 57 ft. 13m) Cape Hinchinbrook, horn (Fl 5 Sec. 235 ft. 22m R Bn 292)	Fair	Greater than 120 ft.	Sufficient maneuvering room.
Bidarka	N-S in Prince William Sound.	No traffic safety systems in Prince William Sound. No safety lanes in Port Fidalgo.	Goose Island (lighthouse) Fl 6 Sec. 41 ft. 12m Bligh Reef (lighted buoy) Fl 6 Sec. Ra Ref R "z".	Fair	Greater than 120 ft.	Limited maneuvering room.
Cape Starichkof	N-S near site	No safety lanes in Cook Inlet at present.	Marker lights on 15 offshore oil platforms in Cook Inlet. Anchor Point Fl 6 Sec. 41 ft. 16m	Fair to good	Less than 200 feet.	Sufficient maneuvering room.

Table 37. Physical Comparison of Five Potential Sites (Continued)

LAND STATUS

Sites	Existing Zoning Stipulations	Present Use of Site	Status of Surrounding Area	Parks Forests and Recreation Areas	Historical Sites	Archaeological Sites	Transportation and Utility Corridors
Gravina	U.S. Forest Service Land	No development	National Forest	Site is within confines of Chugach National Forest (4,800,000 acres in size)	Valdez Trail. Alukag (Gravina Bay People)- Historic Native Place.	—	None
Hawkins Island	U.S. Forest Service Land	No development	National Forest	Site is within confines of Chugach National Forest.	Rip Rock vicinity, Hawkins Island. Palugvik site, 3.75 mi. east of Rip Rock (10 mi. from site).	—	None
Bidarka	U.S. Forest Service Land	No development	National Forest	Site is within confines of Chugach National Forest.	Tatitlek-Historic Native Place 3 miles NNW of site.	—	None
Cape Starichkof	—	Subdivision is being cleared and surveyed on site. School patent borders the site on the south. Radio tower within site. Seven residences on site and greenbelt.	Land is dedicated to state.	None	None on site.	—	Powerline borders site on the east. Small service roads present. Sterling Hwy bisects site.

Table 37. Physical Comparison of Five Potential Sites (Continued)

	TOPOGRAPHY			SOILS		
Site	Elevations of Site	Slope of Site	Topographic Irregularities	Description	Degree of Drainage	Soil Depth
Gravina	Minimum elevation of 100 ft. above MSL. Maximum elevation of approx. 500 ft.	Overall slope of 1:25. Facility area slope varies from 1:3 to 1:10.	None	Organic silts and peat.	Much of site is poorly drained. Standing pools of water common.	Organic soils vary from 5-10 ft. thick.
Hawkins Island	Minimum elevation of 100 ft. Maximum elevation of about 500 ft.	Overall slope of 1:10. Facility area slope est. to be same as overall slope.	Numerous terraces resulting in non-uniform slope.	Organic silt and peat overlying gravel.	Much of site is poorly drained.	Soils vary from 0-30 feet thick.
Bidarka	Minimum elevation of 100 ft. Maximum elevation of 500 ft.	Overall slope is 1:10. Facility area slope est. to be 1:5 to 1:10.	None	Local patches of organic silt over layer of granular soils.	Plant site is well drained.	Soils vary from 20-30 ft. thick.
Cape Starichkof	Minimum elevation of just less than 100 ft. Maximum elevation of 200+ ft.	Overall slope is 1:25. Facility area is nearly level.	Small ridge-like structure across western edge of site.	3-5 feet of silt over 40-50 feet of dense gravelly materials.	Drainage is gen. fair. Depth to water table is 10 feet. Some poorly drained areas within site boundaries.	40-50 feet.

Table 37. Physical Comparison of Five Potential Sites (Continued)

GEOLOGY

Site	Bedrock Description	Depth to Bedrock	Max. Expected Earthquake Magnitude	Active Faults on or Near Site	Recorded Horizontal and Vertical Displacements	Liquefaction Potential	Max. Expected Tsunami Runup and Wave Heights	Landslides, Mass Movement Subsidence	Mineral Resources and Exploration
Gravina	Sedimentary rocks of the Orca Group. Slightly metamorphosed and complexly folded marine sandstone and dark-grey to black or reddish brown hard siltstone and argillite interbedded in slate and greywacke.	10-40 feet	8.5	Possible faults of unknown activity within 2 mi. of site.	+4.5 ft. vert. 30 ft. Horiz.	Low	Runup-estimated at 34 ft. Wave heights-20 to 30 ft.	No occurrences	No production or exploration.
Hawkins Island	Interbedded slate and greywacke, steeply-dipping. Includes minor amounts of sandstone, limestone and cherty rocks.	0-30 feet	8.5	None on site.	Up to 6 ft. in Orca Inlet area. No data for Hawkins Island.	Low	Max. expected runup estimated at less than 100 ft.	None on site. Small rock slides present along cliffs. Cause unknown.	No production or exploration.
Bidarka	No bedrock exposed on penninsula. Unconsolidated deposits (stream & lake deposits, alluvium, glacial marines and outwash gravels) over interbedded slate and greywacke.	20-30 ft. (thins on higher slopes)	8.5	None	+4 ft. vertical horizontal movement.	Low	Max. expected runup estimated at less than 100 ft.	None on site. Numerous landslides on east side of Copper Mountain Penninsula.	Abandoned mining operation on northeastern side of peninsula. No ongoing production or exploration.
Cape Starichkof	No exposed bedrock on or near site.	Greater than 60 feet.	7.5	None	No more than 1 ft. of tectonic subsidence.	Low	20 foot high waves at Seldovia and Halibut Cove generated during 1964 earthquake.	None on site.	No production or exploration.

Table 37. Physical Comparison of Five Potential Sites (Continued)

SOCIOECONOMICS

Site	Distance to Nearest Residence	Distance to Nearest Population Center	Population Trends
Gravina	13 miles (Cordova)	Cordova - pop. 1513 13 mi. SE of site.	Cordova- 1970 pop. = 1164 1977 pop. 2500 30% increase 1970-1977 Cordova McCarthy Census Division 1970 pop. - 1857 1977 pop. 2500 35% increase 1970-1977
Hawkins Island	10 miles (Cordova)	Cordova - pop. 1513 13 mi. SE of site.	Cordova - 1970 pop. = 1164 1977 pop. 2500 30% increase 1970-1977 Cordova McCarthy Census Division 1970 pop. - 1857 1977 pop. 2500 35% increase 1970-1977
Bidarka	3 miles to Indian village of Tatitlek.	Valdez - 22 miles NE of site.	Valdez Chitina Whittier Census Division (south of Chugach Range) 1970 pop. 1890 1977 pop. 7000
Cape Starichkof	Nearest residence on site.	Anchor Point 8 mi. pop. 102 Homer - 20 mi. pop. 1,083	Kenai-Cook Inlet Population Division Year — Population 1970 — 4414 1972 — 3822 1973 — 4049 1974 — 4487

Table 37. Physical Comparison of Five Potential Sites (Continued)

TERMINAL EXPOSURE

Site	Wind Characteristics	Reduced Visibility	Wave Characteristics	Current Velocities	Ice Formation
Gravina	Avg. Speed is less than 13 mph. Wind speed / % Freq. 10-20 Kn 39.8 20-30 15.2 30-40 5.2 40-50 1.7 50-60 0.5 60-70 0.1	Less than 5 miles (Duration/% of occurrence) 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12-24 hr. 39% 29% 17% 9% 5% Less than 1 mile 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12-24 hr. 64% 22% 10% 4% -	Calm seas 67% of time Wave ht. / % freq. Winter 4 ft. 28.5 6 ft. 6.5 Summer 4 ft. 9.0 6 ft. 1.2	Avg. current speed is 1.2Kn.	No ice
Hawkins Island	Average wind speed is 7-9 mph.	less than 5 miles (Duration/% of occurrence) 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12-24 hr. 39% 29% 17% 9% 5% less than 1 mile 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12-24 hr. 64% 22% 10% 4% --	Calm seas 91.8% of time Wave ht. / % freq. 1-3 ft. 7.4 3-6 ft. 0.7 6-10 ft. 0.1	Avg. current speed is 1.2Kn.	No ice
Bidarka	Average wind speed is 8 mph. Site may be subject to "williwaws" (gusts to 75 mph.)	less than 5 miles (Duration/% of occurrence) 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12 hr. 39% 29% 17% 9% 6% less than 1 mile 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12 hr. 64% 22% 10% 4% -- less than 1/2 mile 1 hr. 1-3 hr. 3-6 hr. 6-12 hr. 12 hr. 80% 14% 6% - --	Calm seas 96% of time	Avg. current speed is 1 Kn.	Thin ice may occur at head of bay and on beach.
Cape Starichkof	Avg. wind speed is 5.7 knots. 35 mph in May 1971. Wind speeds greater than 25 mph occur about 1% of the time.	Visibility less than 6 miles occurs 5.7 percent of time.	Extreme wave heights of 4-12 ft. can occur. Wave heights of 10-12 ft. occur about three times per year.	Avg. current speed is 2.2 Kn. at flood tide; ebb currents less strong.	Ice present only during severe winters, when ice may cover 10-20 percent of surface

Table 38. Biological Comparison of Five Potential Sites

Site	Mountain Goat	Caribou	Anadromous Fish Streams	Commercial Crab Species	Existing Habitat Disturbance	Herring Fishery	Salmon Fishery	Sports Fishery	Clam Digging	Pipeline Route
Gravina	Critical range immediately north of the site.	None	Four streams on Orca and Sheep Bays within 5 miles of the site. Lake in northwest corner of site is in headwaters of pink salmon spawning stream, Pass Creek.	King and tanner crabs taken off-shore. Dungeness crab molting area 10 miles northeast of site in upper end of Sheep Bay.	Little	Not a regular important fishing area, although any local schooling of herring can bring intensive fishing effort if noticed.	Salmon taken offshore. Hook points for salmon nets located along the shore at the site.	Orca Bay used by sports fishermen.	None	810 miles Portion from Lowe River to site has prime or critical mountain goat habitat, bear denning and concentration areas, some swan and eagle nesting, submarine crossing of Comfort Cove.
Hawkins Island	None	None	Ten streams and spawning sloughs within 5 miles of site. Pink salmon spawn in West Lagoon on site's eastern boundary, and in unnamed stream within site. Pink and chum salmon in other streams.	Tanner crabs taken offshore.	Little	Not a regular fishing area, although the fishermen may take advantage of any large schools noticed.	Salmon taken offshore. Hook points for salmon nets located along the shore at the site.	Orca Bay used by sports fishermen.	Butter clams along Canoe Passage 2 miles west of site.	869 miles Copper River Valley route impacts high density waterfowl habitat, bear, moose, and deer habitats, and major salmon habitat, submarine crossing to Hawkins Island.
Bidarka	Habitat on mainland on Copper and Billy Goat Mts. 5 to 10 miles north and east of site.	None	Three chum and pink salmon streams within five mi. of site.	King and tanner crabs taken in Port Fidalgo near the site.	Little	Herring spawn along all sides of Bidarka Point peninsula. Associated commercial fishery in area.	Major salmon fishing area. Hook points for salmon nets located along the shore at the site.	Sports fishermen in the area.	None	Approx. 795 miles Portions from Lowe River to site in prime mountain goat habitat, some bear habitat.
Cape Starichkof	None	None	One stream just south and east of site. Stariski Creek has king and silver salmon and steelhead spawning.	None	Considerable; roads, houses, radio tower.	Limited gill net fishery in area.	Major salmon fishing area. Hook points for salmon nets along the shore at the site.	Sports fishermen in the area, generally concentrating at the mouths of streams, especially Deep Creek.	Razor and red neck clams dug in area	815 miles Portions from Point Possession to site in low to medium density waterfowl habitat, bear, moose, and caribou habitats. Submarine crossing of Cook Inlet.

Table 38. Biological Comparison of Five Potential Sites (Continued)

Site	Waterfowl Shorebirds Seabirds	Bird Migration Route	Bald Eagle Nesting	Trumpeter Swan Nesting	Marine Mammals	Black Bear	Brown/Grizzly Bear	Moose	Sitka Deer
Gravina	Waterfowl winter offshore. Major seabird breeding colony at Gravina Rocks, 5 miles east of the site.	None	One of highest concentrations in Prince William Sound. One active nest within site boundaries. Sixteen active nests within 5 miles of the site in 1973.	None	Sea otter concentration offshore. Harbor seal rookery 5 miles east of site.	Intensive use area.	Intensive use area.	None	Within critical wintering grounds. Less abundant here than on Hawkins and Hinchinbrook Islands.
Hawkins Island	Waterfowl winter offshore. Waterfowl habitat on land along the shore at the site. Vancouver geese rearing area 5 miles west of site. Major seabird colony 4 miles west of site.	One of Alaskan coastal routes passes about 10 miles to the southwest.	Within general nesting range.	None	Sea otter concentration offshore. Steller sea lion rookery 5 miles east of site.	Intensive use area, although seldom seen on Hawkins Island.	Denning area 6 miles west of site.	None	Within critical wintering grounds. Relatively abundant on the island.
Bidarka	Waterfowl winter offshore. Waterfowl habitat and scoter rookery 2 miles east of site across Landlocked Bay.	An inland route passes about 10 miles to the north.	Large concentration in Port Fidelgo area. Closest known active nest 3 miles north of site on Boulder Bay.	None	Harbor seal concentration in Port Fidalgo 10 miles east of site.	Present, but not numerous.	Present, but not numerous.	None	None
Cape Starichkof	Waterfowl habitat throughout much of inland area, especially in northern portion of site. Low density waterfowl concentration.	None	Within general nesting range.	Nesting may occur, but no lakes or ponds which provide usual habitat are nearby.	Both harbor seal and beluga whale may occur but are not common.	Present, but not concentrated.	Few present	Large numbers present, but not concentrated because habitat is widespread.	None

Figure 86. Symbolic Ratings - Cook Inlet Sub Region

	Topographic Conditions	Geologic or Foundation Stability	Seismic Considerations	Atmospheric Conditions	Oceanographic Conditions	Distance to Deep Water	Navigational Suitability	Anchorage Suitability	Ice Formation	Land Use Conflicts
Cape Starichkoff	◐	○	◐	○	◐	○	○	○	○	◐
Nikiski	○	○	◐	○	◐	○	●	○	●	○
East Foreland	◐	○	◐	◐	◐	○	○	○	●	●
Nuka Bay (North Arm)	●	●	●	◐	◐	○	○	○	○	○
Nuka Bay (Beauty Bay)	●	●	●	◐	◐	○	○	◐	○	○
Nuka Passage	●	●	●	◐	◐	○	○	○	○	○
Kasitna Bay	●	○	◐	○	○	○	◐	○	○	○
Peterson Bay	●	○	◐	○	○	○	◐	◐	○	○
Halibut Cove	●	●	◐	○	○	○	○	○	○	○
Kalgin Is. (West Side)	◐	○	◐	○	○	○	◐	○	◐	●
Chisik Is. (Snug Harbor)	●	●	◐	○	○	○	◐	○	○	●

LEGEND

○ - Favorable condition.

◐ - Sub-Favorable condition that could be mitigated with appropriate measures.

● - Unfavorable condition that could not be mitigated or which would present a serious problem or hazard.

I. RECOMMENDATIONS

The recommendations referenced with a footnote one (1/) apply only to the El Paso Alaska proposal as described in Section A, Volume II of the FEIS. All other recommendations are applicable regardless of the final route and site selection.

1) Applicant should utilize a 48-inch pipeline design to permit future expansion of the pipeline system with a minimal amount of new pipeline construction or show cause why this design is not feasible.

2) The Yukon River should be crossed utilizing the existing Yukon River Bridge. (See Section D.1.)

3) Borrow pits should not be located at areas of topographic prominence or at other highly visible sites.

4) The applicant should utilize Alyeska access roads, air fields, communication systems, and construction camp sites to the maximum extent possible.

5) In order to reduce siltation, streams with silt bottoms should not be excavated until immediately prior to pipelaying.

6) The contract for construction should include provisions to protect the completed erosion control measures from damage due to equipment and pedestrian traffic, concentrated runoff, and other controllable causes. Contractors should be required to repair any such damage which may occur while the contractor is in areas where revegetation is in process.

7) The recommendations concerning water resources made in the U.S. Department of the Interior Final Environmental Impact Statement for the proposed Arctic Gas Project (which are relevant to the El Paso Alaska proposal) should be adopted.

8) When El Paso Alaska engages qualified consultants to perform the proposed periodic species identifications, air and water quality sampling, meteorological measurements, and review of preconstruction and construction procedures, special attention should be given towards providing

information in those areas where this pipeline route deviates from the vicinity of the Alyeska pipeline route, such as along that portion of the El Paso Alaska pipeline from the Lowe River to Gravina, or from Livengood to Cape Starichkof.

9) Pursuant to the National Historic Preservation Act of 1966 and the Archaeological and Historical Preservation Act of 1974, staff recommends that the applicant should be required to initiate a cultural resource survey and salvage program in order to minimize the loss of cultural resources (historic and prehistoric sites, structures and objects) due to pipeline-related activities. The applicant should allocate sufficient funds for such a program and should allow a reasonable period of time for adequate surveys, preservation, and salvage.

The surveys should cover the pipeline corridor, including all areas that would be affected by construction of the pipeline and related facilities. The surveys and salvage should employ the services of competent archaeologists, historians, and other relevant specialists and should be made in full cooperation with the appropriate State Historic Preservation Officers (SHPO) and officials of the Department of the Interior. The surveys and salvage should be adequately coordinated to insure reliable, comparable, and scientifically viable results as well as for the expeditious execution of all operations. Construction personnel should be instructed on the importance and identification of cultural resources.

In order to provide the most straight-forward coordination, assuring quality control, the proper phasing of surveys and investigations with construction schedules, and procedural compliance with the pertinent statutes and all state and Federal jurisdictions, the staff recommends that the entire sequence of work be administered by the Departmental Consulting Archaeologist in the Department of the Interior, utilizing funds received from the applicant as authorized by Sections 3(a) and 6 of the Archaeological and Historical Preservation Act of 1974

The survey and salvage program should include the following:

a) Prior to the determination of final alignments and locations of project-related facilities and in consultation with the appropriate SHPO, the applicant should have conducted cultural resource surveys to include at least the following:

   i. the review of background historic, prehistoric, and pertinent environmental data and existing information on historic and prehistoric resources, including the National Register of Historic Places;

   ii. the intensive field inspection of the pipeline corridor, borrow areas, and other related areas of potential impact;

   iii. the identification of all locatable historic and prehistoric sites subject to possible effect and areas of probability of archaeological site occurrence;

   iv. an evaluation of the significance of discovered sites, a determination of their eligibility for inclusion in the National Register of Historic Places, and analysis of the impacts expected from pipeline-related construction.

b) Before construction of the pipeline and related facilities, the applicant should avoid and/or mitigate adverse impacts on significant sites and areas of cultural resource concentration including at least the following:

   i. the avoidance of significant sites, including those on or determined to be eligible for inclusion on the National Register of Historic Places, by changes in the pipeline alignment or by other alterations in the locations and design of project-related facilities;

ii. where avoidance of sites is not prudent or feasible, the salvage of those sites in consultation with the appropriate SHPO and in a scientifically acceptable manner.

c) During the construction phase of the pipeline, support facilities, borrow areas, etc., archaeologists should accompany construction crews through areas where a probability of significant archaeological site occurrence exists, in order to identify sites previously overlooked and to recover cultural remains discovered during construction.

d) Artifacts and other materials removed from sites on Federal lands should remain the property of the Federal government; artifacts and other materials removed fron non-Federal lands should be disposed of after analysis and as agreed upon by the survey coordinator and the landowner(s) under applicable state laws.

e) Reports should be made periodically to appropriate state and Federal agencies, including the FPC, on the results of all operations, and a final program report should be issued at the completion of the entire program.

10) El Paso Alaska should use cooling towers before releasing the heated seawater from the plant or use an air-cooled heat exchange system in place of the proposed seawater cooling system or a combination of these systems and submit an engineering, economic, and environmental analysis to the FPC staff justifying why such systems would or would not be feasible.

In the event that a totally air-cooled heat exchange system is not feasible, the following conditions should be met.

a) Preliminary investigation seems to indicate that the counterclockwise circulation in Orca Bay would direct the heated water released from the proposed seawater cooling system outlet towards the proposed docking facility. (See

Figure 1.2-3 in Volume III of El Paso Alaska's certificate application in Docket No. CP75-96.) El Paso Alaska should conduct an investigation to determine whether vapor rising from the thermal effluent plume would reduce navigational visibility especially in the winter months to the extent that safe docking procedures would be impeded significantly. A further study should be conducted to determine if the configuration of the small boat and construction vessel dock would be such that heated water would become trapped in the marine terminal area, thereby hindering the swift dissipation of the thermal effluent. El Paso Alaska should submit these studies to the FPC along with possible changes in the location and design of the seawater outlet. 1/

b) The applicant should design and implement a comprehensive monitoring program to quantify the magnitude and areal extent of the effects of the warm water discharge on Orca Bay, Sheep Bay, Cook Inlet, and other nearby potentially affected waters.

c) The applicant should submit a definitive plan concerning the feasibility of using the warm water discharge from the LNG facility for mariculture.

d) Prior to the start of construction of the LNG facilities, the applicant should conduct a study to determine the effects of the warm water discharge on the chemical, physical, and biological environment. The study submitted to the FPC should include:

i. Detailed design features of the cooling system intake, outfall, pumps and process equipment, traveling screens, trash racks, chlorine injection system, mussel traps, and any other peripherial systems or devices associated with the seawater cooling system;

ii. he collected environmental data necessary for the assessment of the possible effects of a once-through seawater cooling system.

11) The applicant should be required to use all excess overburden materials from cut and fill operations for landscaping within the LNG plant site boundaries in order to avoid unnecessary disturbance of other areas.

12) The applicant should designate construction barge and tug channels and anchorage sites in the Prince William Sound area. The locations of these areas should be designed in cooperation with the local fishing industries so as to minimize disruptive impacts on fishing and crabbing activities. 1/

13) The existing topography at the residential sites should be maintained by limiting grading activity to the minimum necessary for each of the 65 proposed dwellings, and the access roads should follow existing contours. 1/

14) Analysis of experimental data at the Sans Sault test facility (65° 45'N, 128° 49'W) indicates that it is possible to grow sufficient plant cover over the pipeline in the northern boreal forest to provide some insulation to permafrost. This statement must be tempered, however, with the fact that the results from the test site do not necessarily represent the amount of plant cover that would be obtained during the actual full-scale operation to revegetate the pipeline. It does show that a good plant cover is possible in the boreal forest region and that further research could define the procedures necessary to ensure the practicality of pipeline revegetation. The revegetation measures should include the following.

a) All disturbed areas should be seeded with an appropriate combination of agronomic forage grasses and, if available, native grasses, and fertilized in sufficient amounts to insure rapid growth and dense ground cover. In those areas, such as the tundra, where seeding with grass would not be effective, stripping and seeding of the organic mat should be used.

b) On slopes greater than 10°, erosion control mats should be staked down to hold the soil until the grass germinates and the seedlings become firnly established. Shrub cuttings should be used as stakes to hold the erosion control mats in place. The cuttings would take root and further aid in soil stabilization.

c) Additional fertilizer should be applied in the second and third growing seasons to maintain growth of the grasses, and in those areas where regrowth was poor, grass seed should be reapplied.

d) Further research should be conducted to ascertain techniques necessary to ensure successful revegetation in all areas of the pipeline right-of-way.

e) The applicant should evaluate the restoration and revegetation procedures of the Alyeska pipeline project and incorporate the best of those into the proposed project.

15) The seeding of agronomic forage grasses, which require fertilization when grown in nutrient poor arctic soils, should be required to provide a quick cover to control erosion for the first few years until native plant species can invade and be established.

16) The environmental training program proposed by El Paso Alaska should be made mandatory for all personnel. The training program should be designed and administered by qualified instructors experienced in each pertinent field of study, and every available method should be employed to see that the project workers understand and use the techniques necessary to preserve archaeological, geological, and biological resources.

17) The proposed LNG tanks should be provided with top and bottom fill line capability in order to prevent the occurrence of "rollover" conditions in the tanks due to potential varying densities of incoming LNG with the LNG already in the tanks.

18) A density monitoring program should be implemented, using the proposed onsite laboratory facilities, which would periodically check the density of LNG flow to the storage tanks to determine the need for top or bottom filling.

19) The proposed LNG facility's seawater intake system should be redesigned so the water flows directly into the trash racks without flowing through any intake pipes. This would increase the area of the intake surface, thus decreasing the velocity of the water entering the cooling system and enabling more weak-swimming organisms to avoid entrainment.

20) Organisms washed from the screens should be returned as soon as possible to a suitable environment outside the influence of the cooling water system.

21) Since adult salmon tend to migrate near shorelines and juvenile salmon feed in the same area, the pump basin with its racks and screens should be located in deep water away from shore.

22) The periodic scheduled venting (blowdowns) of the gas pipelines and compressor stations should be accomplished so as to avoid unnecessary disturbance of wildlife, such as during caribou calving and nesting periods. Blowdown silencers should be installed in areas of sensitive wildlife concentrations to mitigate the impact of unscheduled blowdowns.

APPENDIX D

RISK ASSESSMENT OF CASUALTIES ASHORE FROM LNG SHIP ACCIDENTS AT PORT GRAVINA, NIKISKI, AND STARICHKOF

Introduction

The marine transport and handling of LNG is a hazardous operation. Spills of LNG from ship collisions in or near harbors and docks could result in the formation of a flammable vapor cloud that could drift ashore and cause loss of life and property inland. The purpose of this risk assessment is to estimate the probability of such undesirable events in the vicinity of the proposed terminals.

Tanker Accidents in Alaska

In order to assess the risk to the public from LNG tanker accidents in Prince William Sound, and Cook Inlet, Alaska, data from oil tanker accidents in these areas have been obtained from the U. S. Coast Guard, along with data on total Tanker traffic from Waterborne Commerce in the U.S. From these data casualty rates are obtained.

The Types of accidents included in this study are collisions (ship to ship), rammings (ship to object), and groundings. These types of accidents are considered to be the most likely to result in LNG spills, if they occurred to LNG tankers. Explosions or fires could pose a danger to shipboard personnel, but the presence of flames would preclude the formation of a flammable vapor cloud.

For this study the inbound and outbound transits for all self-propelled tankers with a draft of 18 feet or greater are included. However, the USCG accident reports list vessels by gross tons and length. Since there is no direct relationship between draft and gross tons or length, individual casualty files were examined.

Cook Inlet, Alaska

The USCG data for Cook Inlet are given in Table 1.1/ This table provides an indication of the nature of the navigational hazards for tanker operations in Cook Inlet. The most frequent casualty type for the period was rammings, either at docks or with ice. The harsh winters of 1970-71 and 1971-72 resulted in a large number of rammings with ice and in ice-related casualties. In most cases, rammings at docks

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1/ The staff is indebted to Lieutenant James Commerford and Lieutenant James Fernie, Information and Analysis Staff, Merchant Marine Safety Division, U. S. Coast Guard, for these data.

were found to result from environmental factors such as ice, strong winds, strong tidal currents, or a combination of these factors. These external forces were either the cause or a contributing factor in 17 of the 19 accidents

TABLE 1

Tanker Casualties, 1969-1974
Cook Inlet, Alaska

	Casualty Types			
Calendar Year	Collisions	Rammings at Docks	Rammings with Ice	Groundings
1969	0	2	0	1
1970	0	1	0	1
1971	1	2	3	0
1972	0	3	3	0
1973	0	0	1	1
1974	0	0	0	0
TOTAL	1	8	7	3

(excerpt from Appendix A, Vol. I of this FEIS)

Only one collision involving a tanker was recorded: a fishing craft struck a tanker in Kennedy Entrance. The tanker received little damage, but the fishing craft sank. At this time, collisions appear to be a minor hazard in Cook Inlet due to the low volume of traffic and wide navigable waters.

The approximate locations of the accidents are shown in Figure 1. Most were clustered around the petroleum docks at Nikiski and Drift River, and in the upper region of the Inlet where ice and tidal currents are most severe. Fewer accidents occurred in the lower regions of Cook Inlet where there are less severe ice problems.

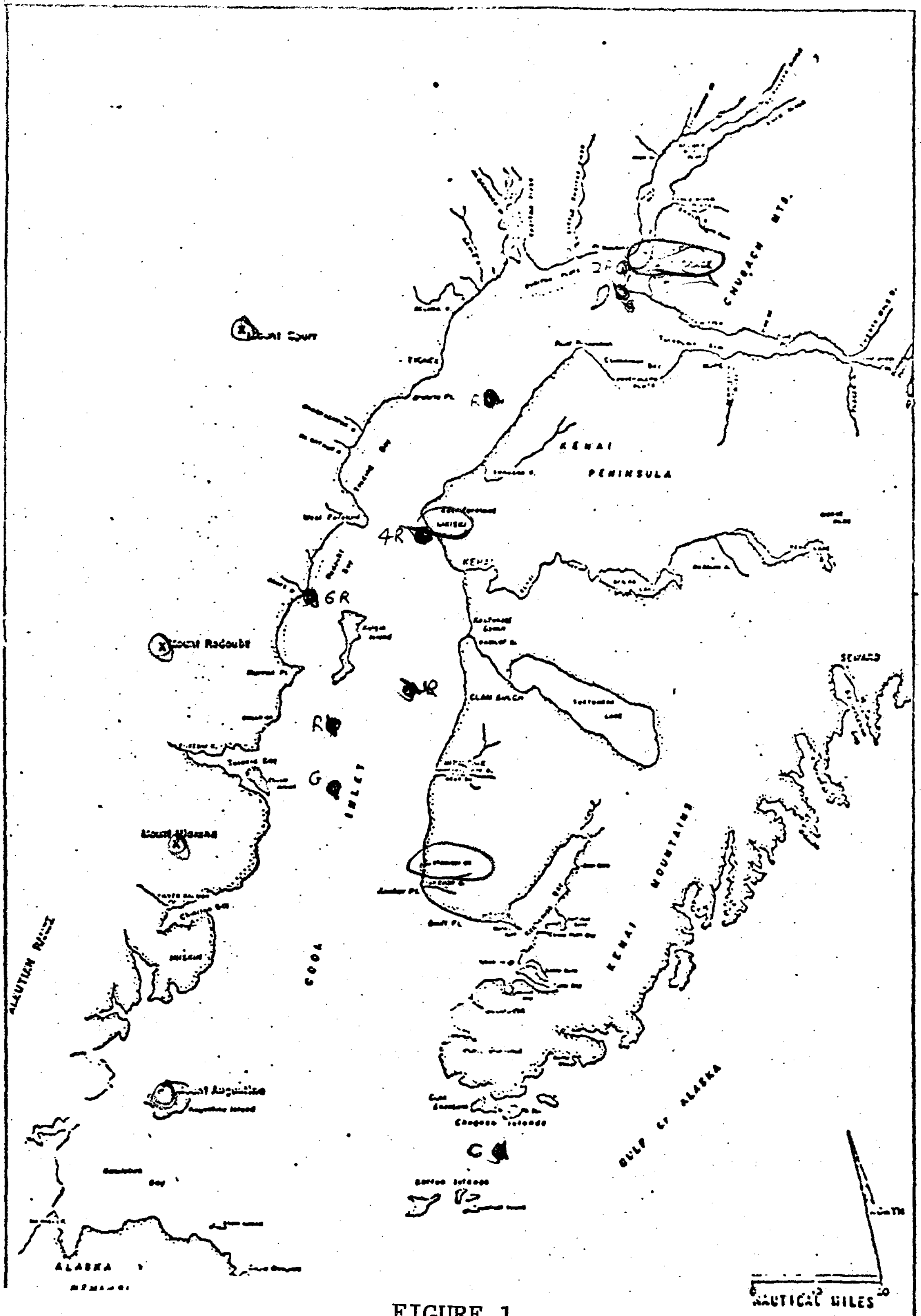

FIGURE 1
Locations of Casualties, Cook Inlet
(excerpt from Appendix A, Vol.1 of this FEIS)

The number of tanker trips for the same period was approximated from the tanker trips to Anchorage, Alaska given in Waterborne Commerce of the U.S. These data are given in Table 2.

TABLE 2

Estimated Tanker Trips, 1969-1974
Cook Inlet, Alaska

Calendar Year	Location: Anchorage	Nikiski	Other	Total
1969	91	129	245	465
1970	84	129	245	458
1971	70	129	245	444
1972	72	129	245	446
1973	65	129	245	439
1974	72	129	245	446
TOTAL	454	774	1,470	2,698

(excerpt from Appendix A, Vol. I of this FEIS)

This source does not include tanker trips for the petroleum docks at Drift River and Nikiski which account for a major portion of the tanker traffic in Cook Inlet. Estimates of tanker trips for these locations have been made based on oil production figures[1/] and are given in Table 2 also.

From these data the tanker casualty rate is calculated to be

= 19 casualties/2698 trips

= $7.0 x 10^{-3}$ per transit

1/ Alternative Sites for LNG Facilities in the Cook Inlet/Kenai Peninsula, Alaska Area, Oceanographic Institute of Washington, Oct. 1975, pps. 4-12 to 4-15.

Prince William Sound, Alaska

Prince William Sound currently has little tanker activity, most of which is limited to the docking facilities at the Port of Valdez. However, the completion of the Trans-Alaska Oil Pipeline in 1977 will result in an increase of three tanker trips daily at Valdez. When the project achieves its maximum daily production in 1980, it is anticipated that there will be about six tanker trips daily. 1/

The proposed LNG terminal at Port Gravina, shown in Figure 2, would serve LNG tankers only. Thus encounters with other vessels in the vicinity of the pier should be minimal. However, the LNG tankers would share the proposed shipping lanes in Hinchinbrook Entrance and the lower portion of Prince William Sound with petroleum tankers and other ships (Figure 2).

The number of tanker trips for the Port of Valdez for 1969-1974 is shown in Table 3. The data were obtained from Waterborne Commerce of the U.S. and include only self-propelled tankers having a draft of 18 feet or greater.

TABLE 3

Tanker Trips, 1969-1974
Valdez, Alaska
(excerpt from Appendix A, Vol. I of this FEIS)

Calendar Year	Tanker Trips
1969	61
1970	62
1971	50
1972	47
1973	56
1974	63
TOTAL	339

1/ Prince William Sound Vessel Traffic System, Final Environmental Impact Statement, Department of Transportation, U. S. Coast Guard, February 1975.

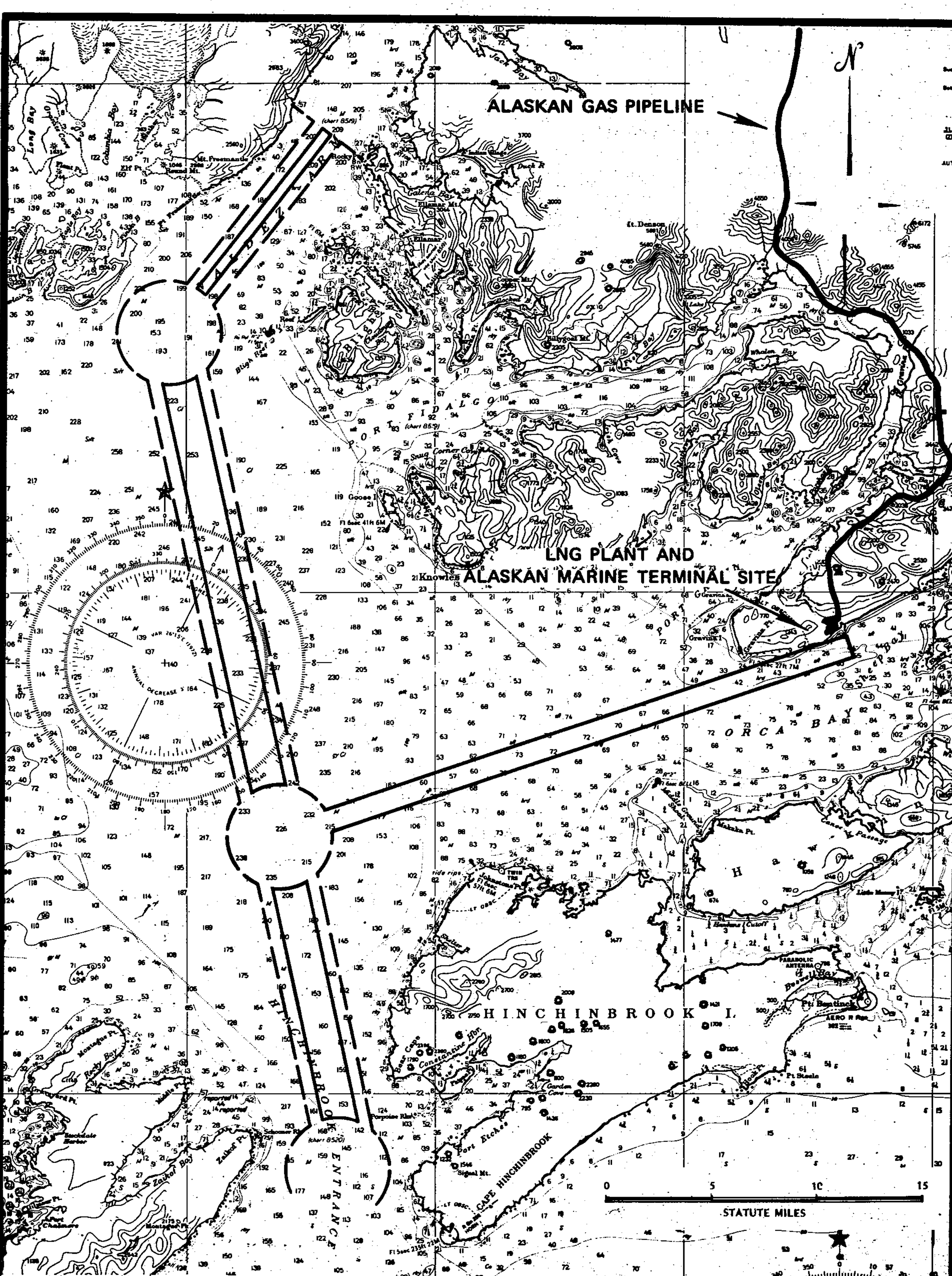

Figure 2. - Prince William Sound Alaska

Figure 2. Prince William Sound Alaska

TRANS ALASKA GAS PROJECT

ALASKAN PORT SCENARIO

II-578

FIGURE 25

The USCG casualty files list two minor tanker accidents in Prince William Sound for this same period. Both were groundings; one occurred at Valdez, the other in Orca Inlet. Thus the accident rate is taken to be:

$$2/339 = 5.9x10^{-3} \text{ per transit}$$

A vessel traffic system for Prince William Sound is scheduled to become operational with the completion of the Trans-Alaska Oil Pipeline. The VTS will include a traffic separation system from the Hinchinbrook Entrance to Valdez Arm (Fig. 2) with precautionary areas located at the Hinchinbrook Entrance and the entrance to Valdez Arm. A limited-traffic area will be established in the Valdez Arm north of Rock Point to Port Valdez. Vessel movements in this area will be monitored and directed by a Vessel Traffic Center equipped with radar surveillance.

Risk Assessment

The assessment of risk for potential LNG terminal sites in Alaska follows the treatment given in Appendix C. of Volume III with appropriate tanker accident probabilities and values for other factors inserted in the probability model. Three sites are examined: Port Gravina (Fig. 2), and Nikiski and Starichkof (Fig. 1). Gravina has been proposed by the Applicant; Nikiski, by another Applicant in another docket; and Starichkof, by the FPC staff in this FEIS.

Where the numerical factors in the probability model are different from those chosen in Appendix C, Volume III they are discussed below.

Probability of Proper Wind Direction

Gravina - From the meteorological data for Cordova, Alaska given in Attachment 1, Vol. II, the probability that wind from the SE would occur and carry a LNG vapor plume from a ship spill toward the LNG plant is estimated to be less than 10 percent on an annual basis.

Nikiski - From the meteorological data for Homer, Alaska 1/, the probability that wind from the WSW would occur and carry a LNG vapor plume from a ship spill toward the LNG plant is estimated to be about 25 percent on an annual basis.

1/ Local Climatological Data, National Climatic Center, Ashville, North Carolina, 1974.

Starichkof - From the previous meteorological data for Homer, Alaska, the probability that wind from the WNW would occur and carry a LNG vapor plume from a ship spill toward the LNG plant is estimated to be about 5 percent or less on an annual basis.

Plume Ignition Probability On Shore

Gravina - The ship dock is about 600 meters from the LNG plant on shore (Vol. II, Fig. 12). From Fig. A2, Attachment 1, Appendix C, Vol. III a LNG spill larger than 4000 m^3 would be necessary in order for a plume to reach the plant. From Table 1, Appendix C. Vol. III such a spill will occur with a probability less than $1x10^{-4}$.

Nikiski - The ship dock is about 650 meters from the proposed LNG plant on shore (Fig. 1-10, Vol. II). From Fig. A2, Attachment 1, Appendix C, Vol. III a LNG spill larger than 5,000 m^3 would be required in order for a plume to reach the plant. From Table 1, Appendix C, Vol. III such a spill will occur with a probability less than $9x10^{-6}$.

Starichkof - The ship dock is about 1,300 meters from the proposed LNG plant on shore (Fig. 1-11, Vol. II). From Fig. A2, Attachment 1, Appendix C, Vol. III a LNG spill larger than 30,000 m^3 would be required in order for a plume to reach the plant. From Table 1, Appendix C, Vol. III such a spill would occur with a probability less than $1x10^{-30}$, which is negligible.

Probability of Plume Ignition On Shore

At the three sites in question we assume that the only source of ignition reached by a LNG plume is the liquefaction plant, which was the situation at Point Conception (Appendix C, Vol. III). Thus we take the value for probability of plume ignition used there: 0.98.

Number of Persons Exposed to Fire On Shore

Lacking more specific information about the number of persons employed at the liquefaction plants proposed, we assume 100 people exposed at the three sites in question. This value was used for the Point Conception LNG plant (Appendix C, Vol. III) and the Port Gravina LNG plant by the Applicant.

Results

The probability model used is composed of the factors given in Appendix C, Vol. III and the values for each factor given there and in the preceding discussion. The results are given in Table 4 for each of the three terminals in queston. The results are given in terms of probability of fatality per person per year. This measure of risk has personal meaning and is convenient for comparison with many types of risk, which was done in Appendix C, Vol III.

The present results indicate that the fire risk ashore from LNG ship spills at Gravina, Nikiski, or Starichkof is negligible. Thus the operation of an LNG terminal at any of these three proposed locations appears to be acceptable.

Probability Factors

FACTOR	SITE		
	Gravina	Nikiski	Starichkof
	VALUE		
Single-trip probability of a tanker accident	5.9×10^{-3}	7.0×10^{-3}	7.0×10^{-3}
Reduction factor for double hulls in LNG ships	0.25	0.25	0.25
Probability of damage in vulnerable area	0.67	0.67	0.67
VTS reduction factor	0.25	0.25	0.25
Probability of no plume ignition at spill site	0.04	0.04	0.04
Probability of proper wind direction	0.10	0.25	0.05
Probability of the smallest LNG spill large enough to reach the public on shore	1×10^{-4}	9×10^{-6}	1×10^{-30}
Probability of plume ignition on shore	0.98	0.98	0.98
Number of persons exposed to fire on shore	100	100	100
Probability of fatality per person exposed	0.10	0.10	0.10
Number of LNG deliveries per year	425	425	425
Probability of fatality per year	negligible	negligible	negligible
Probability of fatality per person per year	negligible	negligible	negligible

OCT 10 1975

APPENDIX E

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

BNG-SOD/EES
El Paso Alaska Company
Docket No. CP75-96 et al.

Admiral John B. Hayes
Commander, 17th Coast Guard District
Box 3-5000
Juneau, Alaska 99802

Dear Admiral Hayes,

The staff of the Federal Power Commission is presently involved in the preparation of a draft environmental impact statement (DEIS) concerning the proposal by El Paso Alaska Company to transport Alaskan North Slope natural gas by pipeline to an LNG liquefaction terminal at Gravina Point in Prince William Sound, Alaska. In the staff's analysis of alternate pipeline routes and LNG liquefaction terminal sites, Cook Inlet was given serious consideration as a potential location for the proposed LNG liquefaction terminal. In order to more fully evaluate potential site ratings as provided to the staff by its site selection contractors, and to substantiate the staff's own site analysis, it is necessary to obtain certain official information and opinions on navigational safety from the United States Coast Guard. It is therefore requested that the Coast Guard provide answers to the following questions:

1) What is the Coast Guard's assessment of shipping safety as it presently exists at Nikiski in the area of the Phillips-Marathon, Standard Oil, and Collier piers?

2) Would ice conditions at Nikiski (below the Forelands, immediately south of the Collier plant - see attachment) pose a significant hazard to the navigation, docking, or loading of LNG tankers? It is requested that any available background information on 1) the severity and magnitude of the ice conditions, 2) the frequency of occurrence of

severe ice conditions, and 3) the extent of the hazard which would be created by the ice conditions on the safety of tanker operations, which was used to make that determination, be provided.

3) As an LNG tanker would maneuver into position for docking procedures at the proposed berth site at Nikiski, identify the frequency and extent of time delays that could reasonably be expected due to ice conditions?

4) With automatic shutdown systems on the LNG loading arms capable of stopping flows in a maximum time of 48 seconds and quick release mooring lines to the tanker, is it possible that the ice conditions or a combination of the ice, tide and current conditions could change quickly enough to create a significant hazard of a break or rupture of the LNG loading arms?

5) Would operations of an LNG terminal immediately south (see attachment) of the existing industries at Nikiski pose a significant hazard to the safety of those existing facilities?

6) What would be the Coast Guard's official position regarding the development at Nikiski of:

(A) The LNG terminal proposed by Pacific Alaska LNG Company requiring approximately 60 LNG tanker arrivals per year?

(B) A combined terminal which would be capable of processing the volumes of gas from both the Pacific Alaska and the El Paso Alaska Company proposals requiring up to 350 LNG tanker arrivals per year?

In particular, would it be the Coast Guard's official position that either (A) or (B) above would pose a significant navigational or loading hazard in the waters of Cook Inlet?

7) It is requested that the Coast Guard also respond to questions 2 through 6 above, as they relate to the potential alternate LNG terminal site north of the existing piers at Nikiski, as shown on the attachment. Would the Coast Guard's assessment of navigational safety regarding LNG operations at the northerly site differ from their position on the southerly site?

8) In reference to any navigational or loading safety hazards which you may have identified in the answers to the above questions, what effect would the establishment of a formal vessel traffic system in Cook Inlet have on reducing or eliminating those hazards? Would a vessel traffic system be implemented in Cook Inlet in the event of increased tanker arrivals per year into Cook Inlet due to LNG tanker operations?

Responses to these questions will be used to assist the staff in its alternate LNG terminal site selection analysis. The staff has been in contact with the Coast Guard Marine Safety Office in Anchorage through Commanders Nichols and Gordon and Lieutenant Commander Thompson to discuss the writing of this letter, and will remain in close contact with them in the future. If any questions arise concerning this letter, please direct inquiries to Mr. Richard Hoffmann, Federal Power Commission at (202) 275-4564.

The proposed distribution date of the staff's DEIS on the El Paso Alaska Company (El Paso) proposal is November 15, 1975. The Coast Guard will have the opportunity at that time to review El Paso's preliminary design plans and comment on the staff's analysis of the project.

Your cooperation in this matter will be greatly appreciated.

Very truly yours,

Secretary

Attachment 1: Map of the Nikiski Site

cc: Commander R.C. Nichols
Commanding Officer
MSO Anchorage
Post Office Box 1286
Anchorage, Alaska 99510

Commander L.D. Gordon
Executive Officer
MSO Anchorage
Post Office Box 1286
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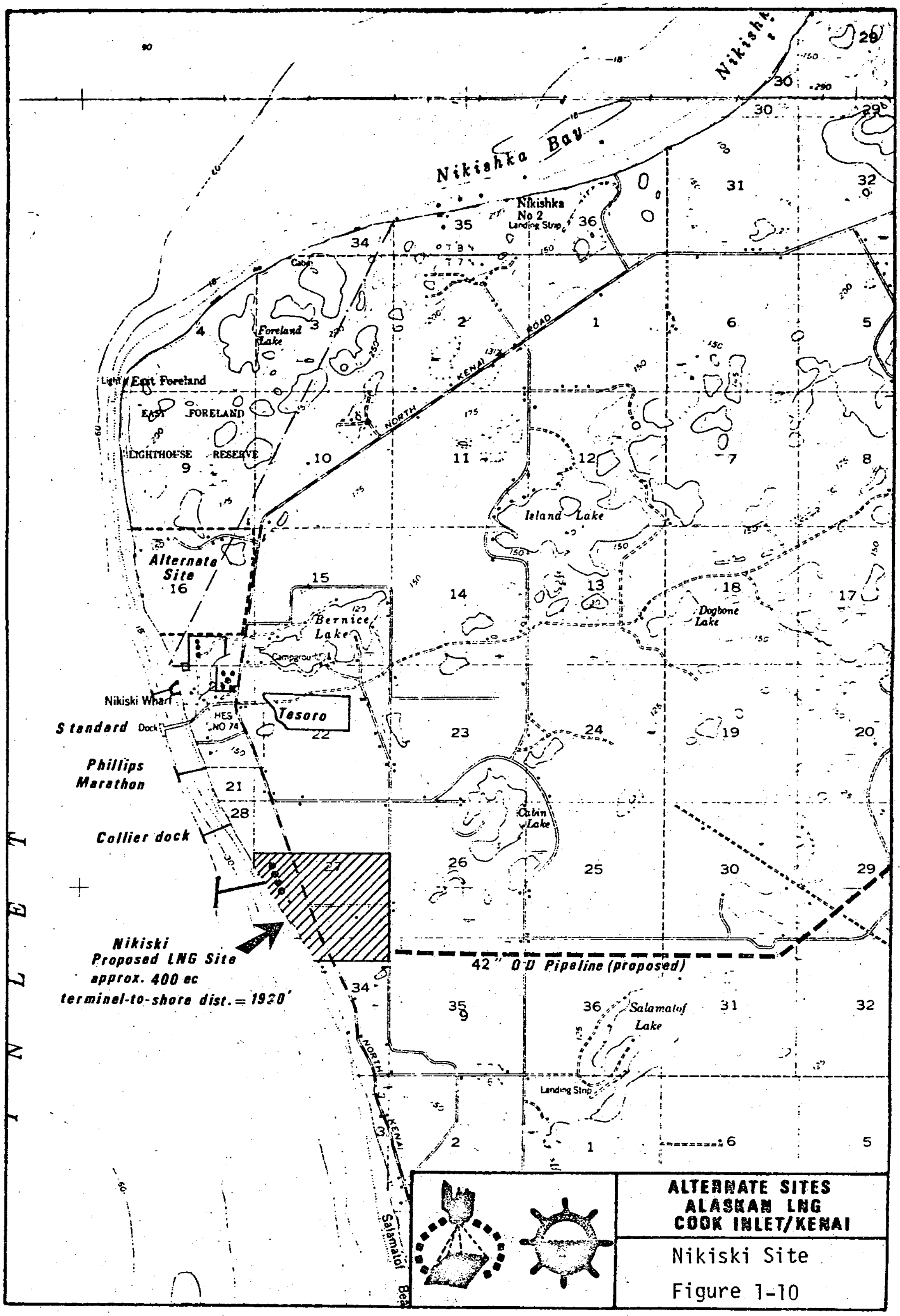
Lt. Commander Thompson
District Representative
17th Coast Guard District
Post Office Box 3-5000
Juneau, Alaska 99802

Attachment 1



ALTERNATE SITES
ALASKAN LNG
COOK INLET/KENAI

Nikiski Site

Figure 1-10

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
COMMANDER (m)
17TH COAST GUARD DISTRICT
FPO SEATTLE 98771

OFFICIAL FILE COPY

5900
14 NOV 1975

Mr. Kenneth F. Plumb
Federal Power Commission
Washington, D.C. 20426

Dear Mr. Plumb:

This is in reply to your letter of October 10, 1975 (reference BNG-SOD/EES, El Paso Alaska Company, Docket No. CP75-96 et al) requesting Coast Guard comments regarding siting of an LNG terminal in the Nikiski area of Cook Inlet. I will attempt to answer your detailed questions as thoroughly as possible, however, in some cases, data is simply not available to formulate specific answers.

In preparing this response, I have relied heavily on the experienced observations of the Commanding Officer of our Marine Safety Office in Anchorage, Commander R. C. NICHOLS, with whom members of your staff have been in contact regarding this matter. CDR NICHOLS and other personnel of his command have observed operations at Nikiski under severe winter ice conditions.

As you are perhaps aware, the tides and tidal currents in Cook Inlet are extreme. Extreme tidal range approaches forty feet in some areas. Average tidal currents are in excess of seven knots during large tides. When a wind-driven current reinforces the tidal current, the velocity is considerably increased. This occurs with some frequency during flood tides in the winter months when the wind is southwest. A recent survey in Cook Inlet by the NOAA Ship MACARTHUR reveals that under such conditions, currents in excess of eight knots are not unusual and velocities near eleven knots have been reported. Obviously, currents of this magnitude complicate the navigation and docking of a vessel. Further, the mooring lines and any ground tackle employed in securing a vessel to a pier in these currents are under considerable strain.

In conjunction with these tides and currents, winter ice presents the major problem to operations at Nikiski. Ice forms between November and April in the Upper Inlet and the strong currents keep much of the ice in nearly constant motion. Huge cakes of ice, some a half mile wide, move up and down the inlet at or near surface current velocities. Surface currents in the Inlet are such that the northerly flow (flood tide) tends to be along the east shore and southerly flow along the west shore. Thus, the most dangerous situation at Nikiski occurs during flood tides; a strong southwest wind aggravates the situation. The piers at Nikiski are completely exposed to these conditions. The ultimate danger is that of a large cake of ice or a buildup of smaller cakes and brash striking a moored vessel and causing it to break away from its mooring.

Turning now to your specific questions, I shall attempt to answer them as thoroughly as possible in the order posed in your letter.

Question #1: The close proximity of the piers and the nature of the cargoes handled, coupled with the maneuvering and mooring hazards created by the tidal range, swift currents and winter ice conditions, at times create an extremly hazardous situation. The primary hazard is the inability of vessels torn away from their loading berth or executing emergency break away procedures, to maneuver in heavy ice so as to prevent collision with other pier facilities or vessels in the area. The cargo lines to the loading berths at the existing Colliers Terminal (anhydrous ammonia), Phillips-Marathon Terminal (LNG) and the Standard Oil Terminal (petroleum products) are normally charged at all times. Therefore any collision with the cargo pipe trestles could spell disaster in terms of personnel injury, property loss and environmental damage. It is the mere existance and minimal physical separation of the facilities in this area - not the actual cargo transfer operations - which pose the greatest hazards.

Of the four existing facilities at Nikiski, vessels at the Colliers Terminal (southern-most facility) present the greatest hazard due to that terminal's exposure to the onslought of ice during flood tides, the inadequacy of the mooring, and vessel manning procedures. Any vessel breaking away from the Colliers Terminal on a flood tide, and not under control, could be swept down on other facilities and/or vessels to the north. The following are examples of previously unreported mishaps which have occurred in recent years:

1971: A Mexican tanker had to clear the terminal under emergency conditions due to ice build-up. As she let go, she lost power due to icing of sea suctions.

1972: Barge PAC 312 broke away due to ice conditions and the assisting tug lost power due to icing of sea suctions.

1973: (1) An ammonia tanker had to clear her berth due to ice conditions and failing mooring lines. She lost power as she cleared the berth. This vessel had refused to keep her engine room manned and ready.

(2) The vessel COPAA parted her mooring lines and heavily damaged the pier.

Colliers management personnel have proposed corrective action to reduce the possibility of accidental breakaways at their pier. CDR NICHOLS will be meeting with Colliers representatives on November 24 to discuss this and other matters.

Only with the most cautious and prudent safety measures such as, but not limited to, quick disconnect capabilities, fully trained vessel and dockside personnel, maintaining ship's engines in an on-line or immediate standby status, and retention of a pilot on board, should cargo operations be conducted during ice conditions. If vessels and facilities at Nikiski do not observe these precautions voluntarily, the Coast Guard Captain of the Port can make such operating conditions mandatory. A limitation on the number of vessels allowed in the port area might be imposed under severe conditions.

Enclosure (1) is a copy of a letter written by a master of the LNG tanker SS POLAR ALASKA regarding his concern over an incident at Nikiski on January 8, 1975. This is another example of a "near miss" which might have become a catastrophe.

Questions 2 & 3: As should be clear from the answer to Question #1, ice conditions definitely pose a hazard to the navigation, docking and loading of LNG tankers and delays due to ice conditions can certainly be expected. Evidence of this fact is set forth in enclosure (2) which contains various vessel Boarding Reports prepared by Phillips-Marathon. It will be noted that during one period in March of 1972, the SS POLAR ALASKA was delayed in loading for six days by severe ice conditions.

The extent of the potential hazards created by severe ice conditions is obvious to anyone who has observed the situation firsthand. Only extremely cautious and prudent vessel and cargo handling procedures can provide acceptable levels of safety during the ice season. In the absence of such procedures, there exists an unacceptable risk to the safety of the port, the vessels therein and the surrounding community.

Question #4: This is not likely if the proper precautions mentioned above are observed aboard the vessel. During severe ice conditions a duly qualified and licensed pilot should be posted on the bridge of LNG tankers. Using both visual procedures and radar, he should be able to detect the larger floes capable of tearing the ship from her mooring in sufficient time to initiate emergency breakaway procedures. Presently, Marathon can secure cargo transfer operations and purge the cargo arms in approximately two minutes and can clear the arms in twelve minutes. Obviously, the creation of additional facilities would compound the problem as more than one vessel might be required to execute breakaway procedures simultaneously or in coordinated sequence.

Question #5: Yes. As mentioned, the ice on a flood tide sweeps down on the piers from a southwesterly direction, a situation which is compounded when accompanied by a westerly wind which tends to force the ice further inshore. Under such conditions the proposed southern facility would receive the full force of the moving ice. Under severe conditions, it would be virtually impossible for a vessel to make an approach or remain at the pier. Any vessel leaving the pier, accidently or purposefully, could be set down on existing facilities or vessels to the north.

Question #6.A: The addition of any other LNG facility in this location will substantially increase the risk to life, property and the environment. The establishment of a second LNG facility would likely give rise to mandatory procedures during ice conditions. Possible examples of such procedures are a live bridge watch, engines on immediate standby, pilot aboard, quick release devices on cargo and mooring lines, and permitting only one LNG vessel in port at any given time. Imposition of these or other procedures would depend on the severity of current and ice conditions, traffic density, loading times and other matters.

Question #6.B: The answer is basically the same as that to 6.A, except to note that a sixfold increase in traffic suggests a sixfold increase in risk. Control measures and mandatory procedures would likely be increased accordingly. Certainly the number of facilities is a matter of concern, but just as important is the number of on-going operations, regardless at which or how many facilities they are conducted. Simply stated, additional facilities and/or additional operations complicate an already marginal situation.

Question #7: If proper mooring facilities were developed, the northern site might be somewhat less hazardous than the southern site, but not significantly so. Although time delays due to ice might be somewhat less frequent at this northern site, the time delay situation at the existing sites to the south would be virtually unchanged. Further, as the existing facilities would provide some protection during flood tides, the possibilities of vessel breakaways at a northern site may be somewhat lessened. However, the overall danger in the port area is not reduced, for the existing facilities to the south remain unprotected and vessel breakaways from them would pose a distinct threat to a northern site. Generally then, while the northern location is better for the particular facility located there, the overall hazard to the entire port area is essentially the same.

Question #8: The establishment of a formal VTS in Cook Inlet would have little real effect on the problem as it currently exists. Current federal regulations allow a Coast Guard District Commander or Captain of the Port to control vessel movement in hazardous circumstances irregardless of whether or not a VTS is in effect in a particular waterway. The establishment of a VTS might simplify and streamline the procedures for vessel movement control, but in any event, if additional facilities are constructed at Nikiski, vessel movement control will undoubtedly be required either within or without a formal VTS.

The requirement for a VTS in Cook Inlet depends upon many factors besides the Nikiski situation, but certainly the significant increase in traffic which would be generated by the proposed additional facilities at Nikiski would be an argument in favor of a VTS. The need for a VTS in Cook Inlet would be determined by future analysis of traffic patterns and densities as this and other developments materialize.

In summary, the siting of any additional LNG terminal in the Nikiski area poses a significant hazard to the safety of life, property and the environment. From the standpoint of safety as compared with the proposed Gravina location in Prince William Sound or numerous other possible locations in Southcentral Alaska, Nikiski is quite frankly, a poor choice. I strongly recommend that cognizant officials of your agency visit Nikiski during winter conditions before any decision is made in this matter.

5900

As a final item, I am in receipt of a copy of a letter to you from the Alaska District Corps of Engineers regarding this matter. I must disagree with statements therein to the effect that ice conditions in Cook Inlet neither impede navigation nor prevent use of commercial docks in Cook Inlet. Our information, such as that provided in the enclosures, suggests otherwise.

Sincerely,

J. B. Hayes

J. B. HAYES
Rear Admiral, U. S. Coast Guard
Commander Seventeenth Coast Guard District

Encl:
(1) Ltr from Master, SS POLAR ALASKA dtd 10 Feb 1975
(2) Miscellaneous Boarding Reports prepared by Phillips-Marathon for their Nikiski facility, 1971 - 1975
(3) Phillips' Petroleum Company descriptive brochure

Copy to:
COMDT (G-W)(less enclosure 3)
MSO Anchorage (less enclosures)
Alaska District, Corps of Engineers (less enclosure 3)

Enclosure (1)

POLAR LNG SHIPPING CORPORATION

February 10,1975.

Mr.

R.D.Yuill

Alaska Transportatio Service Co.

Shapp Building

7 Nihon Odori,Naka-Ku

Yokohama,Japan

RECEIVED NOV 17 10 09 AM '75

Danger of two or more ships moored at Nikiski dock.-

FROM THE BELL BOOK: Voy.86-B Draft; F. 25' 00" A 28' 00"
Date: Jan. 8,1975
Port: Nikiski Berth: Phillips 66 Pier
At 0400 S.B.E.
At 0520 Pilot onboard : Mr.G.Robinson
At 1105 Let go Stbd.Anchor At 1140 Start mooring
At 1325 F.W.E. At 1330 All Fast

FROM PORT NIKISKI DOCK TIDE TABLES. ** Standard Time used :
Wed,Jan.8,1975 Time 0105 Ft.17.2/ Time 0644 Ft.5.8/ Time 1236 Ft.20.1/Time 1950 Ft.0.5

Dear Mr.Yuill,

as you are aware the port of Nikiski,Alaska,consists of three Piers which accomodate oceangoing ships.

The Northern one is "Standard Oil Pier",the middle one is "Phillips 66 Pier" and the Southern one is "Collier Pier".

The LNG Carriers SS "Polar Alaska" & "Arctic Tokyo" dock at "Phillips 66 Pier".

At 1330 hours,January 8,1975 the SS "Polar Alaska" was moored - port side - at "Phillips 66 Pier" and after the normal operations of loading arms connection,Coast Guard inspection etc.,loading was in progress.

Around 1300,January 8,1975 the Tanker SS "Hillier Brown" moored - port side - at "Standard Oil Pier" for loading operations.

Few minutes before 1600 the SS "Hillier Brown" gave a warning by mean of a serie of blasts indicating that there was a danger.In fact almost immediately she broke loose from "Standard Oil Pier"and started drifting suothward.

The entire crew of the SS "Polar Alaska" was immediately alerted for an emer - gency cast off and at 1600 loading was stopped.

The SS "Hillier Brown" was under engine and steering controls and managed to steer a course clear of "Phillips 66 Pier",nevertheless she passed dangerously close to the SS "Polar Alaska" and proceeded to the port of Homer.

At 1620 on January 8,1975 loading was reasumed onboard the SS "Polar Alaska" and the crew dimissed.

By this letter I point to the fact that,expeccially in winter time,there is a constant danger when two or more ships are moored at Nikiski Piers and I beg you to take all the steps to avoid a situation which jeopardize the ships and their crews.

Yours very truly

Capt.S.Szalay,Master SS "Polar Alaska"

JAN 1971

ENCLOSURE (2)

Boarding Report #16/17-R-1

Vessel: SS Arctic Tokyo   Voyage: 16A   Port: Nikiski

Vessel's Movements	Hrs.	Date
Homer Pilot boarded	0715	1/12/71
FWE Nikiski	1520	1/12/71
Cast off Nikiski	0155	1/14/71

Remarks:

Bunker	Heavy F.O.	Diesel F.O.
Arrival dock	1040 LT	153 m^3
Received	1105 LT	m^3
On hand departure	2125 LT	153 m^3

Water	
Arrived dock	350 mt
Departure dock	280 mt

Nitrogen	
Arrival dock	38 m^3
Departure dock	34 m^3

Draft	FWD.	AFT
Arrival	27'00"	28'02"
Departure	32'00"	33'00"

Weather conditions last voyage:

Rough sea first day out of Yokohama. Later smooth.

Cargo Operations	Time	Date	Hours
Chicksan connected	1540	1/12/71	
Cool-down commenced	1545	1/12/71	
Cool-down completed	0030	1/13/71	9.75
Loading commenced	0030	1/13/71	
Loading completed	0045	1/14/71	24.25
Chicksan disconnected	0115	1/14/71	
LNG shipped, bbls.	438,940		

DELAYS:

From	To	Hours	Reason
0030, 1/12/71	2130, 1/13	1.2	Loading with one LNG Chicksan - Ice
0410, 1/13/71	0520, 1/13	1.2	Stopped loading - Ice
1610, 1/13/71	2000, 1/13	3.8	Chicksans disconnected - Ice
	TOTAL HOURS	5.0	

Attending:

Owners Personnel: G. Timlin, C. Kuehl

Others: IAP, 1 man for survey of Ansul equipment.

Boarded At:

Nikiski

Material Received:
250 GCR Log Forms
KMV Advise Notes: 79599, 78738, 79148, 79163, 79547, 79602
Spares per P. O. 2339A (Molecular Sieve, PH-1480, 1/8" Pellets, 4 Angstrom)

Material Unloaded:
Spares per P. O. 2305A
1 TS Element
Vacuum equipment, vacuum adaptors

Crew Joined:

Crew Repatriated:
2nd Officer Gerin

1. Operations

Severe ice conditions were expected and as a precautionary measure, loading through one liquid arm, permitting faster disconnect, was decided upon. Loading was stopped between 0410 and 0520 January 13. Loading was stopped and Chicksans were disconnected between 1610 and 2000 hours of same day. Loading was resumed 2000 hours, utilizing both liquid arms.

Though ice was not as heavy as expected and did not form solid between ship and shore, a total of 22 lines were employed to tie vessel up.

Engine and bow thruster were kept ready and employed during last hours of tide to maintain vessel's position.

Generally under ice conditions, most favorable times for docking are first 90 minutes of flood tide. Period of severest ice drift are last two hours of flood and first two hours of ebb tide. It should be expected that pilots decide to have loading arms disconnected during this period if ice conditions get worse.

2. Shore Facilities - Quick Disconnect of Chicksans

Quick release device as per original installation had been removed when camlock flange connections were installed about June 1970. Up to this docking, no tests had been run and no data were available as to time factor involved for quick disconnect or loading with one liquid arm.

Loading with one LNG arm takes about 20 hours. Time assessed by extrapolating. Estimate had been 15 to 16 hours.

Quick disconnect takes at least 15 minutes and requires a minimum of two men. It is believed that the present arrangement of loading arms in view of a break-away device is inadequate and needs modification. Following features should be incorporated as a safeguard against tearing of Chicksans or a spillage of LNG:

a. A full flow valve at the tip of the liquid loading arms, automatically, mechanically, and independently from other systems actuated. Should also have manual feature.

b. A quick release connection at flanges of all loading arms. Automatic and manual, automatic function to be interlocked with valve as per point a.

c. A weak link in Chicksan to protect shore installation. (This might exist.)

3. Mooring Arrangements

Presently shore facilities incorporate two quick-release hooks which do not permit release of lines under load. These should be exchanged for a type that permits tripping under load. For all mooring wires, polypropylene forerunners should also be contemplated. These would permit cutting in case of emergency and would also provide elasticity.

4. TransSonics

Temperature sensor point 222 [illegible]

Reference bridge cord as returned from manufacturer was tested and operated satisfactorily.

5. Quick Closing Valves

Were opened manually during loading. Method of installation of pneumatic valve position indicator and/or alarmer was investigated.

6. Ballast Tank Level Transmitter

Ballast tank level transmitters were spot-checked and transmitters for Nos. 1 and 2 tanks calibrated.

7. Gas Sampling Lines

Sample point starboard pipe tunnel is plugged due to accumulated moisture being frozen. Exposed sampling line should be relocated into pipe tunnel.

8. Salt Water Service Pumps - Strainers

Strainers repeatedly plugged up with ice. Means for clearing of strainers (steam heating) are required.

9. Salt Water Service Pumps - Motors

Motors of pumps were grounded due to introduction of salt water while cleaning strainers. Crew disassembled, cleaned, and dried motors.

10. Sea-Chest Clearing

Sea chests were continuously cleared by steam. Water consumption 75 tons daily.

11. Ballast Tank Heating Coils

Water hammer was heard throughout all of the heated ballast spaces. Recent cracks found and nature as follows: #1 port DB 1 crack in axial direction, length 6"; #5 port DB 1 tee slipped sweat joint, 1 nipple slipped sweat joint; #2 trunk tank radial crack close to tee. Leaks are known to exist in #1 port tank, nature not known, tank not accessible.

12. Air Drier

Dew point was reported to be -34°C and found to be -29°C. Purge air was found to be approximately 5 m^3/hr. After installation of 1/4" needle valve last voyage, CE had been instructed to keep purge flow at a minimum of 17 m^3/hr. These instructions were repeated. 300 lbs. of molecular sieve supplied to vessel and CE instructed to replace charge as soon as possible.

Dust filters of sufficient capacity should be incorporated in dry air line down stream of drier.

13. Cargo Valves

During loading bonnet gasket of #1 cargo tank filling valve started leaking. As this gasket cannot be replaced in a loaded condition, temporary have to be taken to prevent spillage during discharging. Respective measures were suggested to CO.

This valve leaks in a closed position, which indicates that the seals of the seat are leaking through and should be replaced during repair period.

14. <u>No. 1 Ballast Tank</u>

CO reported that a mud accumulation of approximately one foot height had been found in this tank.

15. <u>Vibrations</u>

Chief Engineer reported that casing of starboard F. D. fan showed cracks and had to be welded. Cracks are believed to be caused by vibrations in aft body of vessel. Previously reported panelling effect and cracks found in fresh water tanks also indicate vibrations in aft body of vessel.

CO expressed opinion that vibrations did not increase and are stronger only with current and wind going with vessel or in shallow water.

16. <u>Vent Masts - Drains</u>

Drains of vent masts were spot-checked and ice found in drains of Nos. 2 and 5 mast. CO was advised to open drains to remove water in warmer climate.

17. <u>Bow - Searchlight</u>

Master recommended installation of a searchlight at the bow which would assist in detecting ice build-up.

18. <u>Mooring Wire</u>

During docking one breast line broke.

cc: ATSCO
G. Timlin
17-R-1
W. B. Emery II

Boarding Report #17/17-R-1 JAN 1971

Vessel: SS Arctic Tokyo Voyage: 17A Port: Nikiski

Vessel's Movements	Hrs.	Date
Homer Pilot boarded	10.40	1-31-71
FWE Nikiski	21.45	2-4-71
Cast off Nikiski	21.00	2-5-71

Remarks:

Bunker	Heavy F.O.	Diesel F.O.
Arrival dock	1089 m^3	153 m^3
Received	1121 m^3	m^3
On hand departure	2167 m^3	153 m^3

Water	
Arrived dock	385 mt
Departure dock	320 mt

Nitrogen	
Arrival dock	34.5 m^3
Departure dock	m^3

Draft	FWD.	AFT
Arrival	26'03"	28'06"
Departure	32'00"	34'00"

Weather conditions last voyage:

Cargo Operations	Time	Date	Hours
Chicksan connected	21.30	2-4-71	
Cool-down commenced	21.45	2-4-71	
Cool-down completed	06.00	2-5-71	8.25
Loading commenced	06.00	2-5-71	
Loading completed	18.38	2-5-71	12.60
Chicksan disconnected			
LNG shipped, bbls.	439,152		

DELAYS:

From	To	Hours	Reason
1-31-71, 10.40	2-2-71, 21.05		Waiting for cargo, LNG plant down.
2-2-71, 21.05	2-3-71, 07.37		Attempted reach Nikiski; returned due to heavy ice.
2-3-71, 07.37	2-4-71, 11.38		Waiting for ice to clear.
	TOTAL HOURS		

Attending:		Boarded At:
Owners Personnel:	G. Timlin	Homer
	C. Kuehl	Homer
Others:	Steiner	Homer
	Commander Bernhard, USCG	Nikiski

Material Received:
5 Cyl. O_2
Spares for governor valve Std. by generator: 2 pistons, 2 oil seals, 2 O-rings

Material Unloaded:
2 Safety Valves
Clevite Brush Recorder

Crew Joined:
Andreani
Pumpman Barilari

Crew Repatriated:
Antonelli
Pumpman Furlan
Oiler (name unknown) sick

1. Vessel's Movements

1.1 Arrived Katchemak Bay 1-31-71, 10.40, and dropped anchor thereat, waiting for LNG plant to get full cargo. Plant operated on reduced capacity due to leakage in an Ethylene compressor.

1.2 Vessel left Katchemak Bay and proceeded to Nikiski 2-2-71, 21.05. Up to 40 miles south of Nikiski, pushed through soft ice, then hit heavier hard ice which was pushed through at full speed. Approximately 25 miles south of Nikiski, abeam of Kasilof, vacuum of main condenser rose due to ice-pluggage and speed had to be reduced to about 32 RPM. This speed being insufficient to push through the ice, Master decided to abandon attempt to reach Nikiski. Vessel returned to Katchemak Bay and anchored thereat 2-3-71, 07.37 hours.

1.3 On 2-4-71, 11.38, pilot boarded and vessel proceeded to Nikiski at 12.55, where she was docked at 21.54.

2. Personnel Movements

Undersigned arrived Anchorage Airport 2-4-71, 06.35 and was awaited there by Mr. G. Timlin and Mr. B. Steiner (Phillips), who had arranged for a charter plane. After a brief stop at Kenai to pick up a steel plate per undersigned's request, Homer was reached at about 08.30. At about 10.00 hours, pilot boat was boarded and vessel was boarded by above party at about 10.45.

Undersigned left vessel 2-6-71, about 02.45 at Homer, outbound.

3. Measures Taken to Prevent Ice-Pluggage

Two problems had been encountered:

a. Ice plugging strainers for salt water service pump, which supplies CW for L. O. coolers of generators. C/E feared a black-out due to too high an L. O. temperature.

b. Ice plugging main condenser, thus restricting CW flow resulting in loss of vacuum and maneuverability of vessel.

(Though ice was not found in main condenser, due to it not being inspected, ice was found in the strainers as per a. Intake for salt water service system being at approximately the same level as main condenser scoop injection, it is felt safe to assume that the cause for reduced CW flow to main condenser was ice.)

3.1 Chief Engineer was advised to use either General Service Pump or Bilge Pump to take suction from Flume Tank via Bilge System and supply to salt water service system. Flow estimated to be approximately 30 m^3/hr. Maximum capacity of Flume Tank: 1000 m^3. Water carried normally: 450 m^3 or supply for 15 hours. Operation was successfully tested.

3.2 Main Condenser

Several modes of (emergency) operation were successfully tested. (Refer drawing 814-17/1028)

3.2.1 From all Ballast tanks gravitating through one Main Ballast line V24 or V23 and V36 plus V35 into Main Condenser, back- [illegible] valve open. Simultaneously employing Ballast pump in forward pump room to replenish Ballast Tanks. If Ballast pump plugs, water supply in tanks is sufficient for at least five hours operation, gravitating. Head: about 1.5 kg/cm^2; Revolution obtained: 95 RPM; Vacuum: 95%; Differential temperature over condenser, CW: 20°C.

(NOTE: In switching operation from normal to back-flushing, engine output has to be reduced to about 40 to 60 RPM for a period of up to five minutes. Since this might be critical in heavy ice, it is recommended that vessels employ above described reverse flow method in winter time continuously while maneuvering in Cook Inlet.)

Main L. O. cooler served by water leaving condenser on intake side. L. O. temperature obtained: +42°C.

3.2.2 One tank crossover gravitating reverse flow pattern to condenser: Satisfactory for 30 minutes.

Vacuum: 95%
ME output: 95 RPM
At CW Condenser: 23°C

3.2.3 One or two tanks crossover being pumped by ER Ballast pump through V23 or V24 and recently installed 8" connecting line via V36 and V35 into condenser, reverse flow pattern:

Vacuum: 95%
ME output: 95 RPM
At CW Condenser: 22°C

(NOTE: This method would provide CW for about seven hours upon loaded departure.)

3.2.4 Ballast pump forward takes suction from sea and pumps through one Ballast Main line and valves V23/V24, V36, V35 reverse flow pattern into condenser. Should pump plug up, other Ballast line opens tanks to condenser per 3.2.3. This mode should be employed continuously when negotiating Cook Inlet upon loaded departure during winter months. Installation of a 16" gate valve in X-over line of forward pump room of Arctic Tokyo is required.

4. Main Generator - L. O. Cooler

C/E reported that he had opened L. O. cooler of Main Generator at Homer. He had found pitted areas, caused by corrosion or erosion. Four tubes were plugged. Cooler will be surveyed next time vessel comes into port. C/E reported that these pittings developed within the last two months, which is questionable.

5. Maintenance

Following equipment had been opened for maintenance and survey and was found in good condition: Main L. O. coolers; Generator L. O. coolers

FEB 1971

Boarding Report #17B/17-R-1

Vessel: SS Arctic Tokyo   Voyage: 17B   Port: Nikiski

Vessel's Movements		Hrs.	Date
Homer Pilot boarded		15.45	2-22-71
FWE Nikiski		22.35	2-22-71
Cast off Nikiski	about	02.00	2-24-71

Remarks:

Bunker	Heavy F.O.	Diesel F.O.
Arrival dock	1150 LT	153 m3
Received	958 LT	m3
On hand departure	2078 LT	153 m3

Water	
Arrived dock	400 mt
Departure dock	290 mt

Nitrogen	
Arrival dock	35.8 m^3
Departure dock	31.1 m^3

Draft	FWD.	AFT
Arrival	27'6"	28'6"
Departure	33'3"	33'6"

Weather conditions last voyage:

Very good. Smooth throughout.

Cargo Operations	Time	Date	Hours
Chicksan connected	23.40	2-22	
Cool-down commenced	23.50	2-22	
Cool-down completed	08.00	2-23	9.1
Loading commenced	08.00	2-23	
Loading completed	00.10	2-24	16.1
Chicksan disconnected	01.10	2-24	
LNG shipped, bbls.	439,042		

DELAYS:

From	To	Hours	Reason
2-23, 18.30	21.30, 2-23	3	Waiting Tide. Low tide - 2'.

TOTAL HOURS 3

Attending:

Owners Personnel: G. Timlin, C. Kuehl

Others:

Boarded At:

Nikiski

Material Received:

P. O. 2336A, Compressor Spares
P. O. 2342A, Feed Control Valve, Cage, and Plugs, 1-ported

Material Unloaded:

Crew Joined:

Chief Officer Dicasagrande
One 3rd Engineer

Crew Repatriated:

Chief Officer Fienger

1. Operations, Draught

Vessel had to delay loading for about three hours in order to overcome low tide of -2 feet. It is suggested that Messrs. Phillips Petroleum remove several existing shallow spots close to berth. Though these spots probably will not harm vessel (refer Polar Alaska first loading), prudence requires that Masters hold loading to assure a sufficient depth of water below keel.

2. Ice Condition Cook Inlet

When vessel docked, Inlet was free of ice. Approximately 24 hours later, water ways were covered with a thin layer of ice, which, though not harmful, packed tightly between shore and vessel and exerted a certain amount of pressure. Salt water system plugged by ice repeatedly.

3. Custody Transfer Equipment

Trans-Sonics gave erroneous print out, erroneous calibration readings on Channel 03, automatic resetting did not work. Print out was corrected by calibrating 60 Hertz frequency converter, calibration Channel 03 was adjusted. Fault in resetting function was traced to defective relay K5 in data control panel, which was exchanged.

4. Gas Analyzer Sequencer

Sequencer for gas analyzers had been reported malfunctioning. However, it appeared to be in good working order and no faults were found.

5. ASEA - Bridge Control

Vessel docked with bridge control in operation. Unit did not fail while ship was in port. Ammeter readings recorded did not indicate an excessive load. Phases R, S, T were equally loaded with approximately 1 amp. It is believed that a short exists in one of the components or either heat influences the load. This will be checked out with Mr. Timlin riding the vessel.

6. LN_2 - Vaporizer

Drain lines of LN_2 vaporizer froze due to low ambient temperatures. It is suggested to incorporate an alarm in the system that would warn if temperatures of drain get close to zero.

7. Boiler Water Consumption

Consumption of boiler water was stated to be about 37 tons per day. C/E suspects leaking heating coils and will check on it during loaded passage.

8. Nitrogen Samples

Samples of nitrogen were obtained from service system and analyzed. Results of analysis:

CO_2:	No Trace
Water Vapor:	5 to 7 ppm
Oxygen:	200 ppm

MAR 1971

(2)

[illegible] Oil Company
Anchorage, Alaska

Yokohama

Voyage and Boarding Report # 18/17-R-1

Vessel: SS. ARCTIC TOKYO   Voyage: 18B   Port: Nikiski

Vessel's Movements	Hrs.	Date
Homer Pilot boarded	14.15	3-13-71
FWE Nikiski	14.30	3-14-71
Cast off Nikiski	05.25	3-16-71

Remarks:

Bunker	Heavy F.O.	Diesel F.O.
Arrival dock	1060 LT	155 m3
Received	984 LT	- m3
On hand departure	2100 LT	155 m3

Water	
Arrived dock	400 mt
Departure dock	350 mt

Nitrogen	
Arrival dock	32.9 m3
Departure dock	31.0 m3

Draft	FWD.	AFT.	
Arrival	25'06"	25'06"	Homer
	22'00"	24'06"	Dock
Departure	33'00"	33'00"	

Weather conditions last voyage:

Cargo Operations	Time	Date	Hours
Chicksan connected	15.30	3-14-71	
Cool-down commenced	16.00	"	
Cool-Down completed	00.30	3-15-71	
Loading commenced	00.30	3-15-71	
Loading completed	03.55	3-16-71	
Chicksan disconnected	04.25	3-16-71	
LNG shipped, bbls.	438 844		

DELAYS:

From	To	Hours	Reason
3-13,17.20	20.30	3.1	Waiting Tide at Homer
3-14,04.10	11.20	7.2	At Anchor off Kenai, waiting Tide
3-15,04.45	17.30	12.4	Chicksans disconn. vessel off dock due ice
3-15,17.30	18.50	1.3	Chicksan re-connected, resumed loading

TOTAL HOURS 24.0

Attending: Boarded At:

Owners personnel: G. Timlin, C. Kuehl Nikiski

Others: V. Thom, Marine Service

Material Received:

P.O. 2085

Shipment of yorcalbro material, dropped for P.A.

Material Unloaded:

Instruction manual on ACC, order reproduce it and make up copies.

One copy left on board.

Crew Joined:

Electrician Linden

Pumpman Calipari

Crew Repatriated:

Electrician Mr. Castelli

Pumpman Bommarco

Messboy Scala, Sick

1) Vessel's Movements

Severe ice conditions in Cook Inlet were prevailing. Vessel anchored at Katchemak Bay to wait for tide. Upon docking, ice wedged between shore and ship and broke two lines, whereupon Pilot decided to abandon docking and anchor off Kinai to wait for next flood tide.

Vessel was safely moored 3-14-71, 14.30 and cargo operations started 15.30.

On 3-15-71 at 04.45 ice pressure was critical and loading had to be stopped and Chicksans disconnected. Vessel was moved off berth by about 50 feet and could not resume its original position for continuation of loading until next flood tide, 17.30 Hrs., whence ice was ~~chored~~. CLEARED

2) Vessel's Operation

Ballast water had been used for cooling of critical machinery components.

3) Terminal Operation

Quick disconnect was done inside of 15 minutes. However, it is believed that Chicksan arrangement needs improvement with regards to quick-disconnect features.

4) Terminal Gangway

Problems were encountered in removing gangway upon quick-disconnect. Present pivot-arrangement is not suitable and should be changed. Pivot aboard ship was damaged, also a part of adjacent rail.

5) Gas-Analysers

Gas-Analyser QIT 191 was calibrated in accordance with original calibration curve, found aboard. Additional calibration curve, sent to vessel by undersigned and allegededly not received, were held by Chief Officer. Chief officer was instructed how to calibrate gas Analysers, using these curves.

6) Cargo X- Over Quick Closing Valves

These valves were opened manually due to their allegded unreliability when opened by air.

7) Visitors

Mr. V. Thom of Marine Service visited the ship as advised by Mr. W.B. Emery

S/S POLAR ALASKA

VESSEL MOVEMENTS VOYAGE 39-B 3-14 thru 3-20 1972

3-14-72

Arrive Kachimak Bay	06:30
Pilot Aboard vessel	07:20
First line at Nikiski Dock	14:15
Cast off Nikiski Dock	16:00
Anchored in Kachimack Bay	22:18

Vessel was unable to get close enough to dock to secure vessel because of heavy ice concentrations of strong currents due to 26.4' tides.

3-15-72

Vessel underway from Kachimack Bay to Nikiski	03:50
First line at Nikiski Dock	11:25
All Fast at Nikiski Dock	13:00
Chicksans Connected	13:05
Commenced Cool Down	13:15
Stopped Cool Down due to tide flood ice conditions	16:10
Resumed Cool Down	17:00
Commenced Loading	23:20

After 16:00 during extreme ice condition one aft spring line synthetic end broke due to pressure on vessel and problem with winch, was repaired immediately by crew, and resecured. Tide was 27.8' with in excess of 100 percent ice coverage.

3-16-72

Loading stopped due to ice conditions	03:20
Chicksans Disconnected	03:30
Chicksans Reconnected	06:45
Loading Resumed	07:18
Loading Stopped	08:55
Chicksan Disconnected	09:10
Chicksans Reconnected	14:00
Loading Stopped	15:10
Emergency Disconnect of Chicksans	15:15
Emergency unmooring of vessel commenced	15:25
Vessel All Clear of Dock	15;40
Anchored at Kachimack Bay	21:46
LNG Loaded	235,185 Bbls

At L5:20 it was appearent that vessel could not hold position at dock due to strong current and heavy ice flows. One of the additional synthethic was 29.9' with over 100 percent ice coverage.

3-17-72

Undersigned boarded vessel in Kachimack Bay	13:30
Pilot Boarded Vessel	17:05
Vessel Underway	17:10

3-18-72

First line	01:15
Chicksans Connected	02:10
Commenced Loading	03:40
All Fast	03:00
Stopped Loading	03:40
Chicksans Disconnected	03:50
Emergency Unmooring	05:20
All Clear from Dock	05:40
Anchored at Kachimack Bay	12:00
LNG Loaded	35,000 Bbls

At 03:50 Extreme ice conditions were again encountered with a tide change of 27.3' experienced.

3-20-72

First Line	16:25	
All Fast	17:40	
Chicksans Connected	17:50	
Loading Commenced	18:05	
Loading Complete	23:25	
Chicksans Disconnected	23:55	
Cast Off	03:20	3-21-72

Total Cargo aboard on departure 439,722 Bbls
Vessel Received 108 LT Fresh Water
7937 Bbls Bunker

Ice conditions CONSIDERED by pilot worst ever seen Nikiski area was componded by strong tide currents.

Gary Timlin

DECK

4 TANK ELECTRICAL LINE TO PUMPS DECK PENETRATION

Above listed deck pentration was found to be leaking on deck. The leakage was around several of the lines and out of the penetration's clamp devise. Epoxy type compounds were supplied to the C.E. for temporary patch of leakage. It is possible there may be some increase of Methane in #4 tank barrier but none above normal was noted before vessel departure.

AFT SPRING LINE WINCH

A problem was reported with the operation of this winch both in unspooling and self tensioning operation.

RADAR AND BRIDGE V.H.F. RADIO

The large radar was reported to be blowing fuses. Problem was found to be the modulator tube (C1166). Due to there not being a spare aboard vessel Sun-Shine Radar of Homer was requested to board vessel to replace tube, check over radar units, and tune up bridge V.H.F. transmitter as its range has been limited. Captain has requested the cathode ray tube of the large radar be changed soon as it has many burned spots on the face.

ICE CONDITION ASSOCIATE PROBLEMS

It is the opinion of the undersigned that the crew of this vessel are to be commended for their effots, both without rest and at great risk to personal safety in endearouring to maintain this vessel at the loading dock under what were impossible circumstances. It is further felt that during future similar conditions no attempt be made to dock either vessel. Similar conditions being large tide footage change which causes strong current flows ~~and~~ WITH heavy ice coverage. There are approximatley 7 days in both February and March when this condition is possible.

ENGINE

BULKHEAD BETWEEN STBD. FLUME, BUNKER TANK

Chief Engineer reported finding water in bunker tank and found cracking areas between stbd Bunker, Flune and Diesel tank bulkheads. C.E. has re~~ported~~ QUESTED arrival at ship yard for dry docking with no diesel or bunker in stbd. tanks to allow repair and reinforcement.

L.P. Evaporator

C.E. Feels unit not functioning properly due to possible leakage in unit. He stated there was too much pressure drops in main steam exhaust system and feels we should check O_2 contrmpt of feed water to determine leakage.

L.P. STEAM SYSTEM

A problem was reported in this system which is causing insufficient steam flow but didn't have a change to discuss futher with C.E.

AUX. CIRCULATION PUMP FROM BALLAST TANKS

This unit was reported to be not functioning properly but later determined problem was caused by insufficient water head on pump.

GENERATOR OVERLOADS

C.E. Reported both main, forward, and aft generator overload during first two attempts to dock vessel. This to be explained further in his information letter.

BRIDGE CONTROL UNIT

This unit tripped the main engine once during manuvering due to failure of idling cycle. This failure only occured once and did not repeat.

MAIN ENGINE TRIPS

The main engine tripped three times due once to above mentioned problem and twice due to flame out on stbd boiler. This flameout was caused by problem with function of stbd damper control with high speed forced draft fan on. Plan to renew damper actuator in ship yard.

BOW THRUSTER

This unit overload a number of times due to ice flowing through unit.

Gary Timlin

Gary M. Timlin

GT:jmw
CC: R. D. Yuill
W. B. Emery 11

VESSEL DELAY 16 DAY 5 HOURS 55 MIN. REASON: Main Generator Failure

DEPARTURE

Cast-Off Nikiski 06:25 3/9/73

CREW JOINED

Illiano, U. - Bos'n
Giovammi, S.G. Oiler
Podda, A. 2nd Pumpman
Zelatore, M. Oiler
Trullu, G. Oiler
D'Alessandro, A. 1st Eng.
Ranieri, C. 3rd Mate

PASSENGERS

Steiner, H.
Steiner, J.
Steiner, K.
Jones, C.
Johnson, T.

CREW REPATRIATED

Calaminici, S. - Oiler
Forlan, B. 2nd Pumpman
Quondamatteo, E. Sailor
Giovani, V. Bos'n
DeFiore, L. Oiler
Staracle, S. 2nd Mate
Steccanella, R. 1st Eng.

MATERIAL ON BOARD

P.O. 2534AD - 2 ea. Spring Guides - Hydro-Pneumatic
P.O 2651AD - Seals & Vent Plugs, 6 ea. - Eng. Equip.
P.O. 2581AD - 6 Wiper Blades & 4 Block Assy. - Vynstruments
P.O. 2657AD - Recorder Charts-partial - Graphic Control
P.O. 2677AD - 2 Maytag Washers, Model A18CA - Harolds
P.O. 2678AD - 2 cases Potting compound-RTV-60 - Gen. Elect.
1 Case Dry Milk for - Mr. Yuill
P.O. 2580AE - Module - 2 gate valves - Galbraith
P.O. 2627AE - 2 Timer Motors - Rimer-Birlec
P.O. 2672AE - Coalescer Elements - Marine Moisture Control
P.O. 2645AE - Sol.Valve - Automatic Switch
1 Ctn. Swagelok Fittings
1 Set Stern Tube Seals - from Polar Alaska
13 Pair Coveralls

INITIAL EXPECTED VESSEL DELAY

Around 09:00 hours on 2/19/73 the undersigned received a call from Ed Brown of Phillips Kenai Plant stating Captain W. L. Johnson of Homer Pilots had called and stated it was his opinion the S/S Arctic Tokyo should not immediately proceed to Nikiski Dock because of a vessel presently being at Kenai Pipeline Dock and one underway to the Collier Carbon & Chemical Dock, which during its last attempted loading had broken away. He further had stated he felt the existing ice conditions caused this in his opinion, to create an unsafe condition for the S/S Arctic Tokyo to be moored at Phillips Marathon Dock. I was further informed that Mr. H.N. Olsen had told Captain Johnson the vessel was not to be delayed and to bring the vessel in to Nikiski Dock.

I immediately called Captain Johnson to get information directly from him and to again advise him that any decisions effecting the safety of the vessels are to be made by the Masters of the respective vessels and that he is to advise the Masters of his opinions with no outside influence from Phillips Kenai Plant personnel as they do not operate the vessels, and this was not their responsibility nor do they have any authority to issue directives to either he or the Masters of the vessels. It was agreed the S/S Arctic Tokyo would proceed to Nikiski on either the next flood tide or the one following as the Master of the vessel due at Collier Dock had agreed to be moored only during the ebb tide as they could not dock port side to.

MAIN GENERATOR

On 2/19/73 around 14:00 hours, while vessel was anchored at Kachemak Bay, the Chief Engineer decided to shut down the main generator, main feed water pump turbine to allow repair of a leak in the feed water recirculation line. After repair was completed they reportedly attempted to put the main generator back on line but could not get 440 VAC on the unit. Several hours were spent by the crew attempting to determine why the voltage would not come up.

At around 21:00 hours on 2/19/73, the undersigned received a call from the Homer Pilot Station stating the Master had requested the undersigned presence on the vessel to determine what the problem was with the generator.

At around 22:10 hours 2/19/73, the undersigned departed Kenai via chartered air craft for Homer, arriving at vessel around 23:00 hours and proceeded to assist in checking out generator. First indications were a possible shorted armature or rotor windings or faulty exciter unit as stator windings did not show any faults by meggar readings. It was determined there was not any excitation voltage present so the exciter was disconnected and the generator turned over to rated R.P.M. and the excitation voltage from the standby generator was inpressed on the main generator. The voltage started to come up but an arcing was observed at the aft end of the generator and the excitation voltage was immediately removed. This was around 03:00 to 04:00 hours, 2/20/73. On return to Kenai and at around 09:00 hours, 2/20/73 Westinghouse Repair Plant in Anchorage was contacted and requested they attend the vessel and confirm findings and initiate repair if possible.

S/S POLAR ALASKA March 19th 1972

TIME SHEET - VOY 39 B & 40 A

MARCH 14th 1972

06 30	S.B.E. - Arrival at Homer Bay
07 20	Pilot on Board (Mr. Sweet) - Proceeding to loading Pier - Nikiski
14 15	First line ashore - Start mooring at Phillips Pier - Nikiski
16 00	Let go lines from Pier - Strong current and bad ice conditions
22 00	Let go Stbd. Anchor (4 sh.)
22 18	F.W.E. - Anchored in Homer bay.

MARCH 15th 1972

03 30	S.B.E. - Departure from Homer Anchorage
03 35	Start heaving up anchor
03 50	Anchor up - Proceeding to loading Pier - Nikiski
11 25	First line ashore - Start mooring at Phillips Pier
13 00	Moored at Phillips Pier - Engie on S.B.
13 05	Chicksans connected
13 15	Start cooling down
16 10	Stopped cooling down for bad ice conditions
17 00	Resumed cooling down
20 00	Crew on watch [illegible] for safety on lines
23 20	Start loading

MARCH 16th 1972

- 03 20	Stopped loading for ice
03 30	Chicksans disconnected
06 45	Chicksans reconnected
07 18	Resumed loading
09 10	Chicksans disconnected & stop loading for ice
14 00	Chicksans reconnected
14 15	Resumed loading
15 15	Stopped loading & chicksans disconnected for emergency
15 25	Start unmooring
15 40	All clear from the Pier - Proceeding to Homer anchorage
21 30	Let go Stbd. Anchor
- 21 46	F.W.E. - At anchor in Homer Bay

MARCH 17th 1972

16 45	S.B.E.
16 45	Start heawing up anchor
17 05	Pilot on board (Mr. Tingley)
17 10	Anchor up - Proceeding to Loading Pier - Nikiski

MARCH 18th 1972

01 15	First line ashore
02 10	Chicksans connected
02 46	Start Loading
03 00	Moored at Phillips Pier - Engine on S.B.
03 40	Stop loading
03 50	Chicksans disconnected for ice
05 20	Start unmooring from the Pier
05 40	All clear from the Pier - Proceeding to Homer kanchorage
46	Let go Stbd. anchor
	F.W.E. - Anchored in Homer Bay

Giuseppe FIENGA - MASTER

... OIL COMPANY
KENAI, ALASKA

DATE: March 22, 1972

BOARDING REPORT #

Vessel: SS Arctic Tokyo Voyage: 37 A Port: Nikiski

Vessel's Movements	Hrs.	Date
Homer Pilot Boarded	11:30	3-21
FWE Nikiski	17:45	3-21
Cast Off Nikiski	16:40	3-22

Remarks:

Bunker	Heavy F.O.	Diesel F.O.
Arrival Dock	365 LT	
Received	873 LT	
On Hand Departure	1238 LT	

Water		
Arrived Dock		mt
Departure Dock		mt

Nitrogen		
Arrival Dock	37.2	M^3
Departure Dock	34.5	M3

Draft	FWD.	AFT
Arrival	23'00"	28'04"
Departure	32'03"	32'11"

Weather Conditions Last Voyage:

Cargo Operations	Time	Date	Hours
Chicksan Connected	17:50	3/21	
Cool-Down Commenced	18:00	3/21	
Cool-Down Completed	02:45	3/22	
Loading Commenced	02:50	3/22	
Loading Completed	15:45	3/22	
Chicksan Disconnected	16:00	3/22	
LNG Shipped, Bbls.	386,555 BBLS		

DELAYS:

FROM	TO	HOURS	REASON
08:40 3/22	09:00 3/22		ICE
11:25 "	11:45 "		ICE

TOTAL HOURS :30

ATTENDING: BOARDED AT:

OWNERS PERSONNEL: Timlin & Geiger

OTHERS:

MATERIAL RECEIVED: Exchange walkie talkie + 2 additional batteries
2353- Siemens (Replaced Labyrinth Rings)
2410A-Hibon 2456A- Hibon Pumps
2426A-Honeywell 2427A- Honeywell
2428A- Honeywell 2459A- Diamond Power
2460A- Diamond Power 2461A-Honeywell
2466A- AAA Products 2472A- Project Inst.
2475A- SAAB Scania 2477A-Marine Moisture Control
2483A-Dresser Pacific B & C Supply 220 V drill

MATERIAL UNLOADED:
Deffective walkie talkie and 1 battery.

CREW JOINED: Glardian Salvatore- Galleyboy
Gambi Fortunato - Sailor

CREW REPATRIATED: Cutrulia Pietro- Massboy
Pastorelli Aug.- Sailor

DECK

ATEW CARD 42

This card was reported to have again failed so replaced card with new one received from Kockums and removed bad card to repair.

BRIDGE WINDOW WASHERS

Supplied C.E. with sufficient copper tubing and fitting to complete fresh water window washer system on bridge.

ICE CONDITIONS

Loading was stopped twice for possible mooring problems due to ice flow but tide currents were not sufficient to move vessel from dock. Crew was on standby in event of problems.

ENGINE

A.C.C. CARD # 50

This card reportedly failed during last passage to Japan. Replaced MC 660 I.C. and requested C.E. to test card during passagae as impossible to test card without gas firing.

MAIN ENGINE LUBE OIL PRESSURE SWITCHES

It was not possible to check the settings on these switches due to engine being on standby for possible ice problems.

Gary Timlin

Gary M. Timlin

GT:jmw
CC: R. D. Yuill
W. B. Emery 11

MARATHON OIL COMPANY
S/S POLAR ALASKA VOY. 72A (LOADING)
FEBRUARY 20, 1974

ATTENDANCE REPORT

Port of Registry - Monrovia, Libera — Gross Tonnage 44088 L/T

This is to certify that the undersigned did, on behalf of the Owners of the S/S Polar Alaska, attend on board said vessel on February 20, 1974, and thereafter while she was loading at Nikiski Terminal of Phillips Petroleum Co. for the purpose of reviewing any deficiencies of an operational nature in the vessel's equipment.

VESSEL MOVEMENTS

Arrival Homer S.B.E.	05:15	2/20/74
Pilot on Board	06:20	2/20/74
Berthed Nikiski	12:30	2/20/74

CARGO OPERATIONS

Chiksans Connected	13:45	2/20/74
Custody Trans. of Slack	13:55	2/20/74
Amount of Slack	294	Barrels
Start Cool-down	14:00	2/20/74
Start Loading	14:45	2/20/74
Finished Loading	03:05	2/21/74
Chiksan Disconnected	03:20	2/21/74
Custody Trans. of Cargo Loaded	03:50	2/21/74
Cargo Loaded	437,806	Barrels
Cargo In Transit	438,100	Barrels

DRAFT

DRAFT	FORE	AFT
Arrival	26'	28' 06"
Departure	31' 06"	33'

FUEL AND LN2

Fuel on Board Arrival	1448 LT	
Fuel Loaded	2622 BBLs	Note loading stopped due to severe ice conditions making it impossible to load minimum quantity
LN2 Arrival	30.5 M3	

MARATHON OIL COMPANY
S/S Polar Alaska Voy. 91 A (Loading)
March 25, 1975

ATTENDANCE REPORT

Port of Registry - Monrovia, Libera   Gross Tonnage 44088

This is to certify that the undersigned did, on behalf of the own of the S/S Polar Alaska, attend on board said vessel on March 25, 1975, and there after while she was loading at Nikiski Terminal of Phillips Petroleum for the purpose of reviewing any deficiencies of an operational nature in the vessels equipment.

VESSEL MOVEMENTS	TIME	DATE
Arrival Homer S.B.E.	04:30	3/25/75
Pilot on Board	06:10	3/25/75
Berthed Nikiski	12:45	3/25/75

CARGO OPERATIONS		
Chiksans Connected	12:55	3/25/75
Cust. Trans. of Slack	13:00	3/25/75
Amount of Slack	295	Barrels
Start Cool-Down	13:15	3/25/75
Start Loading	14:15	3/25/75
Finished Loading	03:10	3/26/75
Chiksn Disconnected	03:45	3/26/75
Cust. Trans. of Cargo Lded.	03:15	3/26/75
Cargo Loaded	438,745	Barrels
Cargo in Transit	439,040	Barrels

DRAFT	FORE	AFT
Arrival	20 Ft. 00 In.	30 Ft. 00 In.
Departure	33 Ft. 00 In.	35 Ft. 00 In.

FUEL AND LN2		
Fuel on Bd. Arr.	887	LT
Fuel Loaded	978	LT
Fuel on Bd. Dept.	1,840	LT
Port Cons.	25	LT

CARGO ON ARRIVAL		
Departure Negishi	9,682	Barrels
Arrival Nikiski	292	Barrels
Total Boil-Off	9,390	Barrels

DEPARTURE	TIME	DATE
Cast-Off Nikiski	04:00	3/26/75

CREW JOINED

Crescenti	2nd Mate
Cammalleri	Deckboy

CREW REPATRIATED

Ambrosino	2nd Mate
Lopparini	Deckboy

VISITORS IN ATTENDANCE

U. S. Coast Guard Inspectors: Capt. Binns, Lt. Mayberry, Comander Billingsl
Mr. R. D. Yuill, Marathon Oil Company.

MATERIAL ON BOARD

Engine:

P. O. 1012 P	Durmatallic
P. O. 1018 P	I.M.O.
P. O. 1025 P	I.V.A.

1 Box Hydrophore Pump Spares TRSF from A/T
1 Box Flux
1 Main Condensate Pump Stage Piece
1 Cylinder Acetylene

Gas Control Room

P. O. 911 P	Hibon
P. O. 1016 P	Lapp
P. O. 1015 P	M.S.A.

1 Box Gas Analyzer Filters
1 Box Gas Analyzer Carbon
2 Thermocouples
1 Scott Air Pac Cylinder

MATERIAL UNLOADED

2 ea. Ansul N^2 Cylinders for refill

U. S. COAST GUARD VESSEL SAFETY INSPECTION

The Emergency Shutdown System was tested for operation by equalizing the number two cargo tank barrier space low differential pressure transmitter and activating it's associated pressure switch.

QIT-101 was tested for proper operation and calibration and found in good order.

All pressure, temperature and methane percentage recordings were noted to be within normal limits.

ANSUL SK-3000 DRY CHEMICAL EXTINGUISHERS

Attending Fire Control System personnel completed the annual survey the SK-3000 extinguishers. Two each N^2 cylinders which were found with low pressure were removed for refill.

An official report of survey will be prepared and submitted to the undersigned by the firm of which a copy will be supplied to A.B.S., U.S.C.G. and the vessel.

Note! I did not observe vessel name but this name was supplied by dock personnel.

TERMINAL HAZARDS

During this loading a potentially hazardous situation developed. A Chevron Oil Tanker, M.V. Tuttle, began attempting to dock Port Side Too, at approximately 15:00, March 25, 1975, near the end of a flood tide. They were unable to secure the vessel and continued maneuvering until after 16:00 and the ebb tide had started. The S/S Polar Alaska's crew and the Phillips plant personnel were placed on standby in the event the "Tuttle" should lose control and be carried into the S/S Polar Alaska or the Phillips dock. Fortunately the "Tuttle" aborted their attempted berthing before the ebb tide current became to strong for the vessel to retain control.

This was the second time in the last year such a situation has developed.

MACHINERY SPARE PARTS INVENTORY

A corrected machinery spare parts count was secured from inventory binder number seven.

G. Timlin

G. M. Timlin
Port Engineer

GMT/kt

XC/ Mr. W. B. Emery II
Mr. R. D. Yuill

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FEIS