HCR 142 cont.,

The section of line from Fort Nelson to Zama has been considered as a separate pipeline for the purposes of this evaluation. This link is required for both Prudhoe Bay deliveries to AGTL, and for Mackenzie Delta deliveries to Westcoast; i.e., an exchange will take place at the Zama Lake connection. The line consists of 144 miles of 36" pipe, with two compressor stations totaling 53,000 hp.

In developing the cost of facilities required for the Prudhoe Bay natural gas, this link was considered as part of the Prudhoe Bay system because the line will be installed for the Prudhoe Bay gas prior to the Delta gas coming on-stream. A credit must therefore be given to the Prudhoe Bay system in the form of a transportation charge when the Delta gas comes on stream.

In actual fact, although this line must be installed in 1981 for the Prudhoe Bay gas, in 1983 when Delta gas comes on stream the flow in this loop will actually be lower than it would have been if the Delta gas did not come on stream. This situation results from the exchange of Delta gas at Zama originally dedicated to flow through the Westcoast system with Prudhoe Bay gas at Fort Nelson.

Westcoast Transmission Company Limited has a great deal of experience in actual design and construction of facilities. Current costs for materials and construction are also readily established by the Westcoast staff resulting from their experience in operation and construction. Therefore we feel that the cost estimates for the Westcoast portion of the Fairbanks Corridor Study as performed by Westcoast are realistic.

5.2 Expansion of the Alberta Gas Trunk Line System

The Alberta Gas Trunk Line system is the main natural gas transmission system in Alberta. The sources of gas for this system are currently all within the Province of Alberta. The AGTL system currently moves an average of approximately 5,000 MMcfd from the Province.

The existing system has a pick-up point at Zama (point of receipt for arctic gas), and has a major delivery point at Empress (point of delivery for arctic gas). The additional facilities required for the Arctic gas will consist mainly of looping and addition of compression.

There will be cost savings resulting from utilizing the existing system as the existing sources deplete and excess capacity becomes available.

Pipeline design and construction of the 42" and 30" looping for the Alberta section will be conventional, with only a small amount of winter construction in the northern portion of the Province. The total distance from the Zama connection to Empress following the existing system is 778 miles.

Year	Prudhoe Bay MMcfd	MacKenzie Delta MMcfd	Total MMcfd
1980 - 81	677	0	677
1981 - 82	1,001	0	1,001
1982 - 83	1,313	576	1,889
1983 - 84	1,537	899	2,436
1984 - 85	1,539	1,201	2,740

The costs of facilities for the AGTL portion of the proposed Fairbanks Corridor pipeline system were developed by FPL from comparison of cases 3, 4, and 5 from the response to the National Energy Board (NRB) Deficiency Letter No. 8 to Foothills Pipe Lines Ltd.

These three cases contained complete design, facilities, construction schedules, construction costs, etc. for different flowing conditions. The flows proposed for the Fairbanks case fall between either cases 3 & 4 or 3 & 5, depending on the year. The required facilities for the Fairbanks case were arrived at by interpolation between the appropriate cases which have already been developed for the NEB.

The initial on-stream dates and changes in flows are the same for the Fairbanks case as for the cases studied for the NEB.

The Alberta Gas Trunk Line Company Limited has a great deal of experience in actual design and construction of facilities and has current costs for materials and construction. AGTL has a large and competent staff continually developing forecasts, design and optimizing procedures. Therefore we feel that the cost estimates for the AGTL portion of the Fairbanks Corridor Study performed by AGTL are realistic.

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5.3 Pro-Rata of Expansion Costs

The cost of the AGTL and Westcoast systems have been allocated to Prudhoe Bay or Delta system costs in quantities proportioned to the volume throughputs as given in Table 1 - 1. As noted previously, the Fort Nelson to Zama line costs have been included in the costs of the Prudhoe Bay system, although some debit in the form of a transportation charge would undoubtedly be assessed against the Delta gas as part of a Zama Lake exchange agreement.

Total costs for expanding existing systems for Prudhoe Bay gas and Delta gas are shown in Table 5 - 1 and Table 5 - 2.

TABLE 5 - 1

FAIRBANKS CORRIDOR PIPELINE SYSTEM - CAPITAL COST ESTIMATE

EXISTING SYSTEMS EXPANSION - PRUDHOE BAY NATURAL GAS

	1975	Escalated Costs (000's)							
	Costs	1978	1979	1980	1981	1982	1983	1984	Total
Fort Nelson to Sumas (Westcoast Expansion)	$ 264,305	-	-	144,350	67,481	42,453	100,785	44,663	399,732
Fort Nelson to Zama	153,176	-	-	167,500	18,000	21,600	-	-	207,100
Zama to Empress (AGTL Expansion)	516,400	-	112,370	230,303	138,434	142,280	93,288	-	716,675
TOTAL 3	$ 933,881	-	112,370	542,153	223,915	206,333	194,073	44,663	1,323,507

TABLE 5 - 2

FAIRBANKS CORRIDOR PIPELINE SYSTEM - CAPITAL COST ESTIMATE

EXISTING SYSTEMS EXPANSION - MACKENZIE DELTA NATURAL GAS

	1975	Escalated Costs (000's)							
	Costs	1978	1979	1980	1981	1982	1983	1984	Total
Fort Nelson to Sumas (Westcoast Expansion)	$ 144,395	-	-	-	54,605	127,916	2,808	28,677	214,006
Fort Nelson to Zama	-	-	-	-	-	-	-	-	-
Zama to Empress	275,956	-	-	-	-	247,437	128,700	43,000	419,137
TOTAL 4	$ 420,351	-	-	-	54,605	375,353	131,508	71,677	633,143

5.4 Foothills Pipe Lines Ltd. and AGTL (Canada)

The transmission lines required for the Fairbanks Corridor System for Mackenzie Delta gas are virtually identical to the proposed FPL and AGTL (Canada) systems at a flow of 1.6 BCFD. These systems are over-sized from a pipe diameter standpoint, as they would be capable of operations at an ultimate input of 2.4 BCFD when fully powered. Costs for these systems as estimated by FPL and AGTL are given in Table 5 - 3 along with the total costs of the expanded system for Delta gas.

TABLE 5 - 3

FAIRBANKS CORRIDOR PIPELINE SYSTEM - CAPITAL COST ESTIMATE

MACKENZIE DELTA NATURAL GAS

	1975	Escalated Costs (000's)							
	Costs	1978	1979	1980	1981	1982	1983	1984	Total
Mackenzie Delta to AGTL (Canada)	$ 1,680,800	-	97,900	617,400	836,900	675,700	135,500	40,500	2,403,900
AGTL (Canada) to Zama	84,563	-	-	4,300	86,000	29,700	-	-	120,000
Zama to Fort Nelson (1)	-	-	-	-	-	-	-	-	-
Fort Nelson to Sumas (WTCL)	144,395	-	-	-	54,605	127,916	2,808	28,677	214,006
Zama to Empress (AGTL Expansion)	275,956	-	-	-	-	247,437	128,700	43,000	419,137
TOTAL 5	$ 2,185.714	-	97,900	621,700	977,505	1,080,753	267,008	112,177	3,157,043

(1) Cost of Zama to Fort Nelson section included in cost of Prudhoe Bay Natural Gas.

APPENDIX "A"

REFERENCE MATERIAL & BASIC DATA SOURCES

Company	Title
Alaskan Arctic Gas Pipeline Co.	Second Supplement to Application of Alaskan Arctic Gas Pipeline Company at Docket No. CP74 - 239, Dec. 30, 1974. Fourth Supplement to Application of Alaskan Arctic Gas Pipeline Company at Docket No. CP 74 - 239, Mar. 3, 1975.
The Alberta Gas Trunk Line Co. Ltd.	Submission to the National Energy Board Part 1 Supply & Requirements Part 2 Gas Supply and Sales Contracts Part 3 Facilities Part 4 Financial Part 5 Public Interest All dated May, 1975. Responses to National Energy Board Deficiency Letter No. 8, Feb., 1976.
The Alberta Gas Trunk Line (Canada) Limited	Submission to the National Energy Board Part 1 Supply & Requirements Part 2 Gas Supply and Sales Contracts Part 3 Facilities Part 4 Financial Part 5 Public Interest All dated May, 1975.
Brackett, William W. Testimony	Hearings before the Committee on Commerce and the Committee on Interior and Insular Affairs; United States Senate, 94th Congress, Second Session; Mar. 24, 1976.
Canadian Arctic Gas Pipeline Ltd.	Submissions to the National Energy Board Section 14.e - Alternative Corridors and Systems of Transportation, Mar., 1974. Supplement to Applications and Exhibits relative to Alternative Routing for The Alaska Supply Lateral across the Mackenzie Delta; Aug. 15, 1975.

Company	Title
El Paso Alaska Company	Submissions to the Federal Power Commission, Volume II Tab Z - 1, Engineering and Cost Details, Sept. 24, 1974.
	First Supplement to the Application, Volume 1, Mar. 3, 1975.
	Direct Testimony and Proposed Hearing Exhibits, Docket Nos. CP 75 - 96 et al, Nov. 7, 1975.
Foothills Pipe Lines Ltd.	Submission to the National Energy Board Part 3 Facilities Part 4 Financial Part 5 Public Interest All dated April, 1975
	Miscellaneous work sheets and notes on FPL's analysis of the Fairbanks Corridor Alternative.

APPENDIX "B"

TRANSPORTATION COST CALCULATIONS

(1975 Dollars)

An engineering cost of service calculation has been performed for each transportation component on the basis of the following formula:

Cost of Service

$$\$/MMBtu = \frac{\text{Capital factor x (total undepreciated investment including AFC in 1975 dollars)}}{\text{Net energy delivered in MMBtu per year}}$$

$$+ \frac{\text{Annual operating cost in 1975 dollars}}{\text{Net energy delivered in MMBtu per year}}$$

A capital factor of 17.5 per cent has been employed for all components. This value was derived from an economic and financial review of the proposed Foothills Pipe Line. The "net energy delivered" in the above formula is the energy delivered to either the Sumas or Empress delivery points or a total of the two. The use of the ultimate systems delivery as the denominator in the above formula yields a correct overall systems transportation cost, but does not charge an explicit internal tariff for each component of the system. However, because the cost of fuel has been excluded from the operating costs of each system, the "constant volume" cost of service approach must be utilized for total consistency. To obtain a correct internal tariff for each component, it would be necessary to include a fuel cost for each system component which would reflect the cost of service of the upstream components.

The Prudhoe Bay gas transportation cost was based upon the total 1984 undepreciated investment (in 1975 dollars) as 1984 is the first year of ultimate flow from Prudhoe Bay. The Mackenzie Delta gas transportation cost was based upon the total 1985 undepreciated investment (in 1975 dollars) as 1985 is the last year for this evaluation. However, flows from the Mackenzie Delta are forecast to increase beyond 1985. The combined systems cost of service was based upon the total 1985 undepreciated investment (in 1975 dollars) as 1985 had the highest annual volume forecast in this evaluation.

The Operating and Maintenance costs (O & M) were based upon numbers supplied by Foothills Pipe Lines Ltd.

TRANSPORTATION COST CALCULATIONS
(1975 Dollars)

1. PRUDHOE BAY GAS

1984 Total delivered Prudhoe Bay gas - Sumas - 281,541,000 MMBtu
- Empress - 616,941,000 MMBtu
Total 898,482,000 MMBtu

a) Prudhoe Bay to Ft. Nelson

1975 Capital Cost	$3,716,468,000 x .175	=	$	650,381,900
1975 O & M		=		65,399,300
	Total Cost of Service	=	$	715,781,200

b) Ft. Nelson to Sumas

1975 Capital Cost	$ 264,305,000 x .175	=	$	46,253,400
1975 O & M		=		11,855,200
	Total Cost of Service	=	$	58,108,600

c) Ft. Nelson to Empress

1975 Capital Cost	$ 669,576,000 x .175	=	$	117,175,800
1975 O & M		=		37,712,900
	Total Cost of Service	=	$	154,888,700

Section	COST($)	Volume (MMBtu)	Transportation Cost $/MMBtu
a) Prudhoe Bay to Ft. N.	715,781,200	898,482,000	0.80
b) Ft. Nelson to Sumas	58,108,600	281,541,000	0.20
c) Ft. Nelson to Empress	154,888,700	616,941,000	0.25
Total to Sumas			1.00
Total to Empress			1.05

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ENVIRONMENTAL OVERVIEW

PROPOSED

ARCTIC GAS PIPELINE SYSTEMS

Prepared for:

NORTHWEST PIPELINE CORPORATION

Prepared by:

Gulf Interstate Engineering Company

April 14, 1976

INDEX

INTRODUCTION

The selection of any pipeline route across Alaska and Canada, delivering natural gas to the northwestern United States, must address itself to a variety of criteria which both support and deprecate that selection. A "select route" can only be chosen when alternative routes are considered and the projected resultants of each construction plan have been carefully evaluated and compared. Proponents of any one of the several routes proposed for Trans-Alaska/Canada pipelines can usually select from the available data, those facts which support one proposal; similar data can be employed to denigrate the undesirable alternatives. Regardless of the route proposed, all relevant facts must be considered; those which support one particular route and those which mitigate against that route selection.

The major alternative pipeline routes, thoroughly researched and fully documented, can be easily identified as the Fairbanks Corridor route, much of which is in Alaska, and the Arctic Gas System route which is primarily a Canadian route. The proposed Fairbanks Corridor gas line affords some very unique advantages to the State of Alaska and to the U. S. economy as a whole, while the Arctic Gas System route favors Canada's economy. The committed delivery of gas to Fairbanks and other communities in proximity to the Fairbanks Corridor route has been advocated by the State of Alaska. The tax base and revenues accruing to Alaska from such an Alaskan route can be utilized for important developments now and in the future, as Alaska continues to expand and diversify its economy. The selection of the Fairbanks Corridor route is enhanced by the commitment to utilize American financial institutions, American labor and American capital goods in the development of the gas pipeline from Prudhoe Bay to the Canadian border. From the Canadian border to Ft. Nelson, the route would be essentially supplied by Canadian goods and services.

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The proposed Fairbanks Corridor gas pipeline would transport Alaskan gas from Prudhoe Bay, Alaska, to Zama, Alberta, Canada. Thus, from Prudhoe Bay to Delta Junction (AK.) the gas line would parallel and share the corridor of the existing Trans-Alaska Oil Pipeline (Alyeska Line). A second corridor, the Haines products pipeline, would be shared from Delta Junction (AK.) to Haines Junction (Y.T.) The Fairbanks Corridor proposed route then parallels the Alcan Highway from Haines Junction (Y.T.) to Ft. Nelson (B.C.). A new corridor would be established from Ft. Nelson to Zama (Alta), another 140 miles east. The Fairbanks Corridor line would be 1650 miles long, (pg. 12), 954 miles (58%) of which is on existing pipeline corridors. The entire line is served by existing all-weather roads. The proposed pipeline will connect with the Westcoast Transmission System and the Alberta Trunkline system to transport the gas to the lower 48 states.

The Arctic Gas System proposed gas line would transport gas east from Prudhoe Bay (AK.) to Richards Island and Tununuk (N.W.T.). Collecting additional gas from the MacKenzie Delta area, the proposed pipeline would turn south and follow the broad, alluvial MacKenzie River valley to Ft. Simpson (N.W.T.). From Ft. Simpson to Zama (Alberta), the proposed line goes approximately south and east across the Great Slave (lake) plain. Proceeding south from Zama, the Arctic Gas route generally parallels the existing Alberta Trunkline system to the lower 48 border. This proposed Arctic Gas System line is 2676 miles long (pg. 12); no existing pipeline corrodors can be utilized along the first 1251 miles and little of this portion is accessible by all-weather roads.

The Fairbanks Corridor proposal includes utilization of existing capacity with additional facilities south of Zama. Expansion of existing facilities is, comparatively, an environmental advantage to new construction; therefore, we have limited our review to those sections from Prudhoe Bay to Zama.

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1A

ENVIRONMENTAL QUALITIES OF FAIRBANKS CORRIDOR LINE

The origin at Prudhoe Bay is an Arctic coastal plain; continuous perma-frost with frequent intrusions of ice (ice lenses). These soils are typically silty, moraines and when the summer heat melts the upper surface (active layer 1.5 - 4'), such soils will not support heavy equipment. Winter activities are expedited by the very hard, dense matrix formed when these silty soils are solidly frozen. Arctic tundra is fragile in both winter and summer. The surface soils support a marginal vegetative cover of plants which are unique in that they exist in very cold, very wet (in summer) and very acidic soils. These plants must grow, mature and reproduce in aproximately eight to ten weeks.

The very sensitive tundra ecology, as a whole, is intimately connected to the short growing season, the fragility of the soils and the vegetative cover which furnishes forage to a variety of animals. The fauna of the tundra includes many transient birds and mammals who visit the area for mating and/or feeding. Many predators feast upon the smaller mammals whose population explodes every summer. The luxuriant, but short-lived, summer plant life thus establishes an important food chain; birds, fishes, mammals and even invertebrates thrive during the short summer.

In the winter, the migrants have moved south, only a relatively small population of birds and mammals move about under the snow. Some predatory birds and mammals exist on these snow dwellers, but biotic activity, though not really absent, is certainly quiescent in the winter season.

The destruction of tundra soils and vegetative cover during the winter or summer can have far reaching effects on the tundra ecology for years to come.

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The proposed route of the Fairbanks Corridor pipeline is directed south from Prudhoe Bay, and after traversing approximately 60 miles of coastal tundra, enters the foothills and eventually the mountains of the Brooks Range at Atigun Pass. The Brooks Range features moderately high rugged mountains of mainly paleozoic and precambrian rock. This area requires the proposed route to wend its way through the naturally occuring mountain passes, frequently following stream beds, glacial scours and valleys. Some of the existing Alyeska corridor in these areas would have to be extended and/or the proposed Fairbanks Corridor could be re-aligned.

The entire Brooks Range and its foothills are founded upon bed rock. The overlaying soils may vary from a few feet to a few inches. This area is one of continuous perma-frost but not of the same fragile soils and plant cover as the tundra/Arctic coastal plain. The bedrock foundation allows heavy equipment to operate in the Brooks Mountain Range and surrounding foothills in either the winter or summer. Only the heavy "spring melt" water runoff may preclude year-round access to this area.

The fauna of the Brooks Range is not particularly unique, but the Brooks Mountain Range is important to any consideration of the nearby tundra ecology. The caribou herds which summer on the tundra migrate through the Brooks Range and as herbivores, they are an important aspect of of the Brooks Range ecosystem. The Brooks Range system features permanent populations of raptor birds, sheep, bears, wolves, foxes, smaller mammals and a variety of fishes, and lower vertebrates, all deserving of protection. Many of these animals may range into tundra areas for feeding, mating and nesting. Any interruption of the nearby tundra ecology can have vast implications on the Brooks Range ecosystem as well as the local tundra ecology. Impacts upon the Brooks Range ecology would, in turn, effect the nearby tundra. As an example, very late spring "break-up" provokes a rapid snow melt; water cascading down the mountain peaks and flooding the river plains can wash away or "drown out" many of the herbaceous plants. This loss

of plant material can cause mass starvation for the last remnants of the Caribou herd migrating through the mountain ranges. The weakened caribou attract more predators and enhance the fecundity of those resident in the area. The presence of the weakened caribou as readily available food takes some predator pressure off the anadromous fish and other species preyed upon. These animals thus can increase their populations. The following season, this ecological upset becomes even more widespread.

The treeline starts in the southern extremity of the Brooks Range, an upland spruce-hardwood forest. South of the Brooks Range the soils and vegetation (tree cover is complete but stunted) are probably not as fragile and sensitive to "impact" as those north of the range. Granted, continuous perma-frost exists south to Bettles Field, (approximately 100 miles north of the Yukon River). Frequent ice intrusions can complicate construction techniques, but the soils are more readily reclaimed and except for trees, vegetative cover can be reconstituted in a few growing seasons.

The area north of the Yukon River to the southern edge of the Brooks Range features many braided stream drainages and broad alluvial valleys. These broad alluvial valleys are frequently water logged and swampy in summer; "spring breakup" and the usual flooding temporarily exclude almost any form of activities in May or June, but fall and winter seasons are ideal times for work in these areas.

The ecology of this upland spruce-hardwood association area between the Yukon River and Bettles Field, is again highly susceptible to soil and floral changes, but here the herbaceous plant cover is denser and more sustaining of a variety of animal life, than that which occurs in the coastal tundra, or the mountains. The winter season supports larger numbers and greater varieties of herbivores and predators. Man has intruded permanently into these areas, but the population is extremely sparse.

The spruce-poplar forest, starting north of Fairbanks and south of the Yukon River still features discontinuous perma-frost, but the soils are even less fragile than those north of the Yukon River. Vegetative cover is quite varied, but the trees are still stunted and grow very slowly. The tree cover is mixed, deciduous and evergreen, and does afford a greater abundance and variety of wildlife. The moose is an important addition to the list of animals found in these northern forests. The upland northern forest is not continuous; isolated stands of bottom land trees become denser and more frequent until the northern reaches of the Tanana Valley near Fairbanks show a nearly solid block of mixed evergreen and deciduous forest except where urbanization or development have occured.

Previous construction in this forest area has left a very obvious corridor cleared of trees, but the secondary impact of construction upon the surrounding vegetation and animal biota has not obviously depleted the wilderness qualities of this northern forest. Construction, of the existing Alyeska Corridor and facilities have left a secondary impact in urbanized areas around Fairbanks.

The proposed Fairbanks Corridor gas line from Delta Junction to the Canadian town of Haines Jct. (Y.T.) would traverse an existing pipeline corridor. The Haines products pipeline has been constructed along this route (1954) and some preliminary environmental analyses have been done. An obvious cleared corridor exists between Delta Junction and Haines Junction; it lies close to the Alcan Highway along 80+% of its route.

Along this proposed route, (to Haines Jct. (Y.T.)), the forest becomes denser with a greater variety of trees and taller canopy. The consequent increased brush and ground cover provide a greater carrying capacity for the animal biota. Reclamation of the disturbed forest lands is incomplete in the sense that trees are permanently removed from the Haines products pipeline corridor, but secondary floral reclamation, i.e., brush, grasses, edible plants, has been rapidly achieved in forested lands. In any such forested lands, selective tree plantings can aid in erosion control and soil conditioning. Fertilization and seeding with exotic, as well as indigenous, plants can provide a rapid recovery of any construction sites.

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The proposed Fairbanks Corridor route from Haines Junction (Haines products pipeline veers south to the Port of Haines AK) to Ft. Nelson in the Yukon Territories will parallel the Alcan Highway. This area from Haines Junction to Ft. Nelson is one of primal wilderness; tall thick northern forests, rugged hills and peaks going to over 6,000 feet elevations. Canyon, Whitehorse, Watson Lake and Ft. Nelson are the major towns bordering this route and the wilderness attracts many tourists to all these towns. The forests here support a variety of game animals, moose, bear, caribou (both barren ground and woodland species) and even deer. The higher peaks are inhabited by sheep (Stone and Fannin) and prairie and waterfowl abound.

There is evidence of glaciation and erosion with many large meandering rivers. The Liard River is the primary drainage and braided streams have formed many elongated lakes in this area.

The soils, climate and rainfall support rapidly succeeding forest and marsh areas. Timber cut or burned areas are rapidly reinvaded by brushy plants. Lowlands are eroded away to lakes in some areas and filled in to become meadows in other areas. Everywhere there is evidence of rapid, natural succession, and the diverse physiography and plant life maintains a high carrying capacity for the varied animal populations.

The many lakes, streams, ponds and rivers that exist along this proposed Fairbanks Corridor route, require almost unique and individual description. Those rivers and streams north of the continuous perma-frost line (North of Bettles Field) are easily compromised by frost heave/slump, frost bulb formation, aufeis formation and extensive springtime erosion. Where Alyeska has crossed such rivers and streams, many of these natural phenomena have been "corrected". Erosion has been controlled with rock riprap and/or extensive dike construction

These arctic drainage waters are important aspects of the arctic ecology as a whole. Both anadromous and catadromous fish, as well as water fowl and shore birds, rely heavily on the integrity and natural succession of these arctic drainages.

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The waters south of the continuous perma-frost line are not as sensitive to thermal/mechanical damage as those arctic drainage streams, but certainly physical and chemical changes can compromise the ecological integrity of the streams all the way to Zama. Not only fish and mating-nesting birds, but a variety of furbearers and other animals use the streams and riparian areas to drink, eat, mate and reproduce.

The Fairbanks Corridor route would cross 21 major rivers in Alaska and 9 major rivers in Canada. Approximately 450 water crossings would be required; each small stream or pond plays an essential part in the microclimate and ecology of the surrounding area.

In summary, the proposed route of the Fairbanks Corridor, 1650 miles, traverses the very unique Arctic coastal tundra, the rather special Brooks Mountain Range and then ranges southward through classic subarctic and northern forests. This includes areas of high rugged mountain peaks, broad alluvial river plains, lakes, rivers and hundreds of streams. It is an area that man has invaded before; where he will continue to encroach. This vast, northern and arctic wilderness can be used by man and with conscientious efforts, his use can proceed without any notable adverse impacts upon the land.

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1B

ENVIRONMENTAL QUALITIES OF THE PROPOSED ARCTIC GAS SYSTEM LINE

The proposed Arctic Gas System line (the "Prime Route") originates in Prudhoe Bay and travels in a southeasterly direction parallel to the Beaufort Sea coastline to Richards Island (N.W.T.). This proposed route, after entering the Mackenzie Delta Area at Tununuk Jct. then heads in a more southerly direction through the Northwest Territories toward Zama Alta.

The coastal arctic tundra along this route, Prudhoe Bay to MacKenzie Delta, is highly susceptible to the unmitigated impact of man's intrusion; such a route traverses the Arctic National Wildlife Range. The Arctic National Wildlife Range was set aside because the area is so sensitive in all aspects of its ecology. (See pages 1 and 2, re Tundra Ecology, Section A). The few intrusions upon the Range, radar and communication sites, seismic crews, have all left their permanent impact upon the Wildlife Range. Further intrusions upon this Wildlife Range would result in additional degradation which would not be widely accepted by state or federal agencies, environmental groups, or the public in general.

The environmental qualities of the proposed Canadian Arctic Gas Pipeline project are best addressed in sections. The route, as specified, originating at Prudhoe Bay, would cross more than 400 miles of continuous permafrost to the Mackenzie Delta area and Richards Island. This is the area of fragile, unstable soils, plant cover that has only a marginal existence and animal life intimately connected to the soil and vegetative cover of the tundra. There are no roads in this tundra.

From the Mackenzie Delta area (Tununuk Jct.) the route moves south to Ft. McPherson.

The Arctic Gas route would move south from the Ft. McPherson area, cross the Peel Plain muskeg and finally enter the Franklin Mountain system; the tree line starts near Ft. McPherson. In the Franklin foothills and mountain

area, the proposed route proceeds in a southerly direction following the Mackenzie river flood plain. The route passes through the Great Bear Plain staying west of the Norman Range (an alluvial lowland lies east of the range). There is a "winter" road connecting Ft. Norman and Norman Wells paralleling approximately 60 miles of the proposed route, but this road is impassable in the summer.

The route continues in a southerly direction and crosses the Great Bear River near Ft. Norman, parallels the Mackenzie River and crosses the McConnel Range (still part of the Franklin Mountains) which poses high rolling hills. Another "winter" road parallels the route from Ft. Norman south to approximately 63^{o} latitude.

Proceeding further south, the area near Ft. Simpson (approximately 62^{o} latitude) is the confluence of the Liard and the Mackenzie Rivers; a large delta/lowlands (the Great Slave Plain) exists here. An unpaved highway (N.W.T. - Rt. 1) comes from the east; the pipeline route goes south and slightly east of Ft. Simpson, crossing the Mac enzie River. At 60^{o} latitude (further south) a segment of Canadian National Railroad crosses the Mackenzie Highway. The Mackenzie Highway provides a means of transporting goods into northern Canada from Edmonton and other centers.

An "all weather" gravel road exists between Ft. Simpson and the Steen River. From there a paved road leads south to major centers of transport (Edmonton). Zama can be supplied from this paved road. North of Ft. Simpson to Ft. Norman and beyond, there are only "winter roads". For a few miles south of Ft. McPherson, there are paved roads. Therefore, approximately 700 miles of the proposed Arctic Gas line route is inaccessible by existing roads.

The Mackenzie River Transport system is used in the summer months to transport goods into the interior of Northern Canada. Access from the Beaufort Sea is for about 6 weeks in July and August. Few large port or dock areas exist along the Mackenzie or Liard Waterways.

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Physiographically the lands traversed by this proposed Arctic Gas line range from Arctic coastal tundra, south to Northern Rocky Mountain Forest. The tundra area is critical (See page 1, Section 1A), clearly only winter-time access is feasible and even the most conscientious efforts cannot avoid some primary, secondary and very long term impacts upon these lands.

In just 8 or 10 weeks, all the tundra vegetative cover must mature and reproduce itself. The herbivorous animals which migrate onto the tundra areas, consume tons of forage and in turn, supply food for the carnivores that also live in the summer Arctic. Fish and birds rely upon the thousands of small streams and ponds which form each summer when the upper layers of permafrost soils melt (active layer 1.5 - 4 feet). Each summer, new stream channels develop, washing fresh organic and inorganic nutrients toward the Beaufort Sea. Some braided streams silt-up and become lush grassy meadows. Others may erode away their banks and bottoms to form new lakes or roaring torrents. The entire tundra is a pond-dotted swamp in summer.

Vehicular and even pedestrian traffic tears up the delicate roots of lichens and herbaceous plants growing in the summer tundra.

Winter time traffic is less destructive to the soil and plant cover, but plant and animal life under the snow can suffer from the movement of heavy equipment.

Leaving the Arctic tundra, one enters the muskeg areas around Ft. McPherson and the Mackenzie Delta. This is approximately the northern extremity of the tree line. Without the stabilizing mechanics of large root systems, the treeless muskeg forms large watery polygons. Soil is water logged or ice bound and peat bogs abound. Still in continuous permafrost zones, these muskeg areas display frequent ice intrusions.

The Mackenzie River Plain near its northern terminous is one of braided streams, transient lakes, fragile soils and delicate plant cover. Even the most judicious route selection cannot avoid many stream and river crossings in this Mackenzie river plain. Each stream channel and/or tributary to the Mackenzie poses nearly unique characteristics; soils, hydrology, flora and fauna each may require extensive work prior to route selection.

Leaving the Mackenzie River Plain and the Franklin Mountains area the proposed Arctic Gas system route exploits the relatively flat topography and silty, alluvial soils of another river flood plain, the Great Slave (lake) Plain. Stands of evergreen and deciduous trees occur in this area of discontinuous perma-frost and become dense northern forest at the border of Alberta. Any type of construction in densely forested areas does leave a semi-permanent swath across the landscape, but under-canopy can be restored and probably completed in 1 or 2 years. Even in this forested area which extends down into Alberta (Zama) access is difficult; construction could probably not be carried out until roads were constructed.

The entire route from Mackenzie Delta to Zama in Alberta traverses relatively flat, open country. Water crossings are frequent and problematic. The pipeline segments in northern tundra soils could be constructed only in winter, and service and access to the area would be difficult in any season.

Animal life along the proposed Arctic Gas System route is typical of the high arctic grading southward into sub-arctic forest biota. The woodland caribou and its domestic cousin, the reindeer, are special animals, scarce in Alaska, but common in British Columbia and Alberta. The woodland caribou rarely herds up like the more common barren ground caribou and hence does not pose extensive monitoring problems; reindeer, even feral reindeer, are herd animals.

Raptor birds, large mammals, smaller food chain animals and fur bearers are all part of the northern forest ecology which extends north beyond the area around Ft. Norman. North of 60^{o} Lat., the complicated tundra/muskeg ecosystems prevail. Trapping and fishing are important to the scattered residents of interior northern Canada; the human population is, however, quite sparse north of Ft. Norman.

Along the proposed Arctic Gas System route there are few towns, cabins, hospitals, airfields, or other facilities. Certainly construction of the proposed line would provoke extensive urbanization/development of adjacent lands. Many residents of isolated subarctic communities resent the thought of nearby construction.

ESTIMATED ROUTE MILEAGES

FAIRBANKS CORRIDOR

	Miles
Prudhoe Bay	0
Atigun Pass	110
Yukon River	345
Fairbanks	450
Delta Junction	545
Scotties Creek	735
Haines Junction	954
Ft. Nelson	1510
Zama	1650

ARCTIC GAS

Prudhoe Bay	0
Richards Island (Tununuk Junction)	350
Ft. Norman	775
Wrigley	904
Ft. Simpson	1050
Zama	1251
To Lower 48	2676

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2A

ENVIRONMENTAL IMPACTS OF CONSTRUCTION OF FAIRBANKS CORRIDOR LINE

One significant aspect of the proposed Fairbanks corridor is the proposed "common use" of the existing Alyeska Pipeline Corridor. The proposed Fairbanks Corridor line leaves the Alyeska Corridor at Delta Junction (A K.) and thereafter heads southeast to Scotties Creek where it crosses into Canada. This section of the route from Delta Junction to Scotties Creek and into Canada to Haines Jct. would traverse territory where another pipeline corridor exists, the Haines products pipeline. The route in this section also parallels the Alcan Highway up to and and across the Yukon Territory to Ft. Nelson in British Columbia.

The vast experience and documentation of the Alyeska oil pipeline is elegantly applicable to the proposed Fairbanks Corridor line. Both the Alyeska and Haines products pipeline corridors are intact and suitable for this proposed Fairbanks Corridor pipeline. The proposed route from Delta Junction (A K.) to Fort Nelson (B.C.) generally parallel and adjacent to the Alcan Highway, would exploit this existing access road. The Alcan Highway, although built more than 20 years ago, still provides a great deal of preliminary information and experience both of which can be applied to this Fairbanks Corridor project.

In addition to the information and experience which can be applied to the entire Fairbanks Corridor, the entire route as proposed is served by a network of all weather roads, airfields, towns, camps, hospital facilities and military installations. Exploiting all the cleared right of way and service roads, the Fairbanks Corridor Pipeline has approximately 700 miles of right-of-way clear, and not more than 100 miles of access roads (spurs from existing roadways) to construct. The impact of the construction of this proposed Fairbanks Corridor is fairly well defined, taking advantage of previous data and experience gained on the adjacent

liquid pipelines. These impacts of construction are physical/chemical, biotic and socio-economic.

The physical/chemical impacts of construction are merely incremental along most of this proposed pipeline. Alyeska has already constructed the work pad and has developed and tested the proper construction techniques. The Alyeska corridor and work pad will require minimal maintenance. This means that only small amounts of additional land would be used in Alaska, land irrevocably committed to supporting or covering a chilled gas pipeline. To maintain the work pad width would require gravel from borrow pits already well established in Alaska.

Soils and rivers would be compromised as would the sensitive permafrost areas. Again the physical/chemical impacts of construction, using the existing pipeline corridors, is only a fraction of that impacted by the previous pipelines. Subsidence, slump and erosion problems have all been resolved by Alyeska; a mere extension of existing technology and techniques solves the majority of problems for the proposed gas line. The specialized construction methods or materials used by Alyeska will be copied where pertinent and altered where the chilled gas line problems are different than hot oil line problems.

Alyeska has established and had accepted (by various agencies) specific stipulations regarding construction and restoration. These stipulations are eminently suitable for the Fairbanks Corridor line. Certainly back-fill, erosion control, berming, diking, and ditching are all conventional techniques applied equally to both lines. Refrigerated coils, frost plugs, thaw control foundations and floatation techniques, state of the art technology for arctic construction, can all be applied to this proposed construction.

Revegetation, fertilization and even animal supportive stipulations are already established. Raptor nests, migration routes, nesting and hatching sites are defined and identified. Anadromous and catadromous fish streams are enumerated and their sensitivities defined for specific construction time "windows".

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With the exception of the approximately 60 mile stretch of Arctic coastal tundra immediately south of Prudhoe Bay, all areas along this proposed pipeline route can be constructed with defined stipulations for wildlife protection. Plans for the Arctic coastal plain, limited to early winter construction in areas where there is no visible Alyeska Corridor cannot assure that "under snow" flora and fauna will not be impacted/destroyed. In other areas, the detection of the animals and their nests, etc., coupled with the animals' mobility and escape tactics, provides for maximum survival for 99+% of the animals involved. Underground animals, moles, shrews, etc. may be undetected and thus injured or destroyed by construction activities in any season. Surface, arboreal and airborne species are readily seen and thus protected. All construction on and along the preformed and existing Alyeska corridor will have negligible impact upon those animal species which can be seen from the right of way.

The young of all species are protected by current stipulations. Limiting construction activities to periods outside the "time window" of whelping or hatching would avoid compromising existing populations. Birds and migratory water fowl are protected by selecting construction seasons in late fall. Game animals are frightened by man's activities, but their sensitive migrations, calving and mating periods are protected by the selection of construction seasons. Small fur bearers are possibly threatened - certainly their habitat is compromised, but again the experience gained from Alyeska has identified individual beaver lodges and fox dens. These animals can be protected.

In summary, the proposed Fairbanks Corridor gas pipeline can have only an incremental impact upon the existing Alyeska and Haines pipeline corridors. There is little or no opportunity for synergistic impacts upon the terrestrial or aquatic environments because the construction periods can be varied over many months to protect the soils, animals, fish and waters.

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Actual construction of this proposed gas line could (pending negotiations which seem favorable) employ much of the existing machinery and labor force which has built the Alyeska line. All the other facilities and appurtenances which serviced Alyeska could be utilized for this proposed line. Logistics costs would be drastically reduced and construction totally expedited.

The Alcan Highway from Haines Junction (Y.T.) to Ft. Nelson (B.C.) would serve this proposed Fairbanks Corridor pipeline. New right of way would have to be cut and established near the highway and east from Ft. Nelson to Zama (Alta). Preliminary survey work would align the exact route of the line and also identify historic and archeological sites as well as sensitive biotic areas. This entire route, 706 miles, from Haines Junction to Zama would clear and grade approximately 4,278 acres of permanent and an additional 4,278 acres of temporary right of way based upon 50 feet wide temporary plus 50 feet wide permanent. The loss of such acreage in the northern forest zone may actually increase the net energy flow into the plant biosystems. Removal of tree cover allows forbs and herbaceous species to succeed into the right of way; all herbivores then exploit this "pasture".

Restructuring and revegetation can actually enhance the right of way in alpine, lowland, plains and forest areas. As in the Alaskan portion of the line, streams and major rivers, can be crossed during "safe" seasons when fish, soils, water and stream beds are least sensitive. The terrestrial construction will be selected to protect migrations, nesting, mating and whelping of animals. Waterfowl, only transient summer visitors, are best avoided; construction in riparian zones will be in late fall and early winter.

Previously noted by preliminary surveys, raptor nests, dens, hunting ranges, forage sites, and specific species territories will be identified. Identification and subsequent stipulation provides maximum protection for the species concerned.

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2B

ENVIRONMENTAL IMPACTS OF CONSTRUCTION OF PROPOSED ARCTIC GAS SYSTEM LINE

The U. S. Department of Interior and the U. S. Federal Power Commission have considered the Arctic Gas Pipeline system "in depth". Several aspects of the Arctic Gas Pipeline project indicate an exacerbated impact on both the Alaskan and the Canadian Arctic environments. The segment from Prudhoe Bay to the Mackenzie Delta proposed to cross the Alaskan Arctic Wildlife Range. This segment, nearly 400 miles, would not only cross a National Wildlife Range, but such a route would also traverse the Arctic coastal tundra which may not be fully restored/reclaimed for the life of the pipeline.

The construction of any pipeline between Prudhoe Bay and the Mackenzie Delta poses very special environmental problems. Such a line must either deviate south and then north again (adding approximately 260 miles) to circumvent the Arctic National Wildlife Range or route directly across the width of this preserve. This route would also traverse "Old Crow Flats", a Canadian Arctic game preserve lying west of the MacKenzie Delta. The route through these reserves would cross approximately 200 miles of Arctic Coastal tundra in Alaska and 150 miles of such tundra in Canada.

Tundra construction cannot occur in the summer time without elaborate pre-conditioning. The moist surface layer (active layer of perma-frost) is nearly swamp-like. Heavy vehicles cannot find support, water seeps into trenches - even footprints leave a water-filled track. These tundra soils are marginal in their qualities, and only the hardiest plants survive. Revegetation in such areas is difficult and may take several years of attentive work to complete. The summer growing seasons are only 8 to 10 weeks, but average 20 hours of sunlight per day; only rapidly maturing and flowering plants can be used in revegetation.

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Vast herds of caribou migrate east and west along this coastal tundra plain. Summertime construction would compromise the feeding, mating and calving of these caribou. These caribou are herbivores but they are an essential basis of the carnivorous food chain. Anything that compromises tundra ecology has secondary and even tertiary effects on the ecosystems of the nearby mountains and streams where raptors, predators and other herbivores live, but range into the tundra. Thus, damage to the tundra has far reaching effects on fish, fowl and animals, for several years to come.

Arctic coastal plain weather probably only allows December, February, and March for construction activities. January temperatures and winds preclude any real accomplishments by man. Construction along the Arctic coastal plain could require more time than estimated. Marine access is limited to approximately 5 weeks in July and August. All material and equipment would have to be delivered along the beaches in that short time. New snow roads would have to be built each year starting in November. Vast amounts of heat are needed to melt the water used in snow road construction. Ponds, streams and near surface aquifers cannot be drained since extensive lowering of water levels endangers both resident and migratory fish. Few, if any areas in the Arctic coastal tundra offer suitable building materials. Gravel, rock and select sands would have to be transported into the area. All these facts tend to slow down construction progress across the Arctic tundra. A chilled gas line is problematic in both winter and summer in such tundra areas. Frost bulbs form around the pipeline buried under streams and also those buried under slip-soils (muck). This can occur winter or summer.

Any chilled gas line can solidly freeze the streams which are normally flowing under the winter ice. Frost heave can occur winter or summer where the line temperature is different than the ground temperature. The variable drainage patterns which are naturally occuring in the tundra may provoke rapid erosion of the pipe cover in some areas and sedimentary burial of the pipe in other areas.

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The much higher (than gas) heat capacity of water, collecting incident radiation 20 hours a day in summer, can create large ponds of 80^{o}F water. The chilled gas line traversing such ponds and streams could be warmed to above freezing and thus subside into the permafrost layer. A 42-inch chilled gas pipeline transporting 23^{o}F gas may have to be laid at least five feet into the permafrost layer below the active surface layer. Thus, a 9 to 12 foot deep trench is required, with stream crossings possibly a depth of 18 feet. All these probable problems require preliminary study and even experimentation, before construction can proceed. The Arctic Gas System line, heading east out of Prudhoe Bay, would cross 20 major rivers and several tributary streams in the Arctic Coastal Region. Literally, the entire Arctic coastal drainage system between Prudhoe Bay and Mackenzie Delta must be traversed by this Arctic Gas System line.

Winter construction may rely heavily on blasting. The so-called Arctic Ditch Digger as used by Alyeska (Alyeska's 10" fuel gas line) cannot trench in frozen alluvial silt. A unique population of animals and a few plant species, thrive under the tundra snow in winter. Escape and evasion for these biota is limited; many would be killed during wintertime construction.

The spring flowering season on the tundra is short-lived and very sensitive to soil and water changes as well as the movement of heavy equipment. Animals start their migrations into the tundra. Mating and nesting is initiated. Fowl migrate into the area. Construction must cease in early May in such sensitive areas. The early fall (September) season is the peak time of southward animal migrations. This is during or shortly after many animals have calved, hatched, or whelped. Intense human activities during the fall season provokes the abandonment of many offspring plus the interference with migrations. Even after the summer heat has dried out some of the tundra, the soil is still moist and easily compressed. Construction should not start until the active soil layer is again frozen.

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The route south from Mackenzie Delta as proposed by Arctic Gas System crossed approximately 750 miles of broad alluvial river plains which feature many braided streams, unstable stream banks and moist, acidic, fragile soils. (Approximately 200 miles of the proposed route from Mackenzie Delta to Zama is in the area of continuous perma-frost). Of the remaining route, approximately 700 miles, lies in areas of discontinuous perma-frost. Both zones are problematic; even forested discontinuous perma-frost features ice intrusions. There are a few established sources of rock, select gravel or sand near the proposed route. Such proposed borrow pits in river plains may compromise flood control in the river drainage systems.

There are approximately 50 river crossings classed as navigable between the Mackenzie Delta and the Hay River in Alberta (Zama); about 1150 streams must be crossed. Each water crossing is costly in time and money. Construction across the essentially treeless, muskeg, plains areas would require "double ditching" (top soil is removed first and set aside, ditch is completed, topsoil is then replaced on top of backfill) techniques in an effort to expedite restoration of the area. Approximately 200 more miles of treed muskeg can pose similar construction problems.

Service and access roads would have to be built before the pipeline construction could commence. Approximately 700 miles of roadway must be constructed. Some of the southern roads could be built in the summer months, but several hundred miles of snow roads are required. Winter construction periods, at best only 4 months per year, are demanded along some 500 miles of this proposed route. Both roads and the pipeline, per se, would be restricted to this limited construction scheduled. Because of the very intense chill factors, the Anderson Plain and Arctic Slope areas would probably not permit work in January and early February, therefore three months or less work could be scheduled.

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In addition to the primary and long term impacts of construction and the limited construction schedule, there would be secondary construction projects. Approximately 18 docks and pier facilities would have to be constructed to service this pipeline route, all in environmentally sensitive or restricted areas. Piers built on the Beaufort Sea coast would probably be removed after construction terminated. The Skagway to Whitehorse road and rail facilities would probably have to be expanded to aid delivery of material to Fort Nelson. Air strips and helipads necessary for any large construction project, would have to be built or expanded and in the sensitive tundra and other areas, these air strips would require frequent repair and rebuilding. Construction and maintenance of these air strips is a constant environmental threat, especially where building materials must be transported into the area.

In summary, the access to the proposed Arctic Gas System route is not complete. The impact of road, sea, and air facilities which must be constructed on or near the right of way serves only to increment the impact of the pipeline construction.

Approximately 1/2 of the anadromous fish and their escapements which occur in the Mackenzie Delta/Beaufort Basin could be jeopardized even by wintertime construction of the Arctic Gas System line between Prudhoe Bay and Fort McPherson. The winter construction seasor does protect most of the tundra migrators, but fur bearers which provide an income vitally essential to many northern Canadian trappers, would be disturbed and threatened by winter time construction activities, especially south of the Great Bear Plain. The many stream crossings may have a long term effect on beaver, as well as marine mammals.

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Waterfowl are not jeopardized by winter time construction, but extended construction periods (late April through September) could endanger segments of the vast nesting areas in the river plains of the Yukon Territory. Game animals, moose, bear, caribou, sheep, deer and goats could be protected and preserved during winter construction periods. Spring mating and migrations could be protected, but again extended construction would pose a threat to some species.

Sport fishing in each and every stream or lake crossed in the winter time could be drastically compromised both directly that winter and secondarily the following spring. Winter construction, trenching and ice breaking, could allow streams and ponds to freeze solid. The exclusion of oxygenated water coupled with "total freeze" would kill many larger fish species. The area trenched and restructured would be unstable the following spring. The concomitant changes in turbidity, conductivity, pH and oxygenation, etc. which occur during rapid water run-off over newly constructed stream burials would have drastic effects on spring season nesting and hatching as well as migrations of both catadromous and anadromous fish. The effects on fish could thus be long term and widespread. Smaller fish species and bottom dwellers are not drastically threatened by wintertime construction activities, but they are compromised by the springtime after-effects of construction. Again spring break-up, occuring simultaneously in many streams which were crossed, has a synergistic effect.

Raptor birds (significant populations exist in the Richardson and Franklin Mountains) can be protected, winter and summer, but only with very conscientious efforts. Raptor nests and a variety of historic and archeological sites would have to be identified before any construction activities could be initiated. This survey work could require more than one full year.

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2C

SUMMARY COMPARISON OF ENVIRONMENTAL IMPACTS OF CONSTRUCTION

The single most unique difference between the Fairbanks and the Arctic Gas System proposed trans-Alcan gas line is the existence of the Alyeska oil line along 545 miles of the proposed Fairbanks Corridor. Another pipeline, the Haines products Pipeline, from Fairbanks A K. to Haines A K., provides an existing corridor for the Fairbanks Corridor from Fairbanks or Delta Junction south into Haines Junction Y.T. From there to Ft. Nelson (556 miles) the Fairbanks Corridor proposes to parallel the Alcan Highway. From Ft. Nelson to Zama, 143 miles, access would be along the right-of-way.

Common corridor usage has been advocated and approved by regulatory agencies as well as the industry for many years. Federal Power Commission guidelines published at 18 CFR Section 2.69 provide that in locating proposed facilities, consideration should be given to the utilization, enlargement or extension of existing rights-of-way belonging to either Applicant or others such as pipelines, electric power lines, highways and railroads. The use of such corridors is economic and expedient.

The six years experience and data collection which defines the Alyeska line can be elegantly applicable to the proposed Fairbanks Corridor. The Alyeska route was constructed only after several years study and negotiations. Besides the experience, there can be a common use of camps, airfields, work spaces and facilities which served the Alyeska line. There need be few environmental impacts from secondary construction. The Fairbanks Corridor route can use established, environmentally acceptable all-weather roads which serve the entire line. Prudhoe Bay to Ft. Nelson. There exists experienced logistics, transport loading and docking facilities, etc.

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Besides the existing labor and personnel to construct the pipeline, there is a reservoir of expertise, both private and governmental, to monitor the engineering and environmental stipulations which define the pipeline. These people, with construction and accessory skills, can work year-round on at least 80% of the proposed Fairbanks line.

In addition to these points, the Fairbanks Corridor line does not cross the Arctic National Wildlife Refuge. It crosses only 60 miles of sensitive Arctic coastal tundra and that will be on the existing Alyeska line work pad.

Construction of the Fairbanks Corridor line is further expedited by the availability and proximity to ideal construction materials, soils, gravel, select sands, etc. Borrow pits are already established and in use.

The Fairbanks Corridor route, as selected, features proximity to established oil and gas fields in the Petroleum 4 reserves and the far western boundaries of potential Alaskan oil/gas fields. (Bering Sea). Proximity to potential gas fields at Copper River, Middle Tanana and Kandik Basins, where small gas "finds" are established, is another feature. "Manned and ready" military installations, available in the event of any emergency, lie all along the Alaskan portion of the Fairbanks Corridor as proposed.

In addition to the experience, equipment, skills and techniques provided by Alyeska, existence of Alyeska's line means that all impacts of construction can be incremental. The proper selection of stipulations (which are now well founded) cite the ideal time, area, temperature, water level, barometric pressure or equipment necessary to provide maximum protection to the environment at hand.

The Fairbanks Corridor Route passes near the Denali Fault, a high seismic risk area. Fairbanks township has sustained seismic shocks of 7 to 8 Richter. The proposed gas line, utilizing established technology, will be built to withstand 8.5 Richter (8.5 Richter is Seismic Resistance of the Alyeska line).

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Experience has shown that only a case by case investigation can determine which engineering and construction techniques (burial, surface lay or suspension/elevation) will provide the utmost in safety, reliability and environmental protection for any pipeline. Aesthetics may be compromised where the proposed pipeline is exposed; valve sites, etc. would be exposed. These exposed segments of pipe would be less than that of the Alyeska line, which is already accepted. Therefore, only incremental aesthetic impacts would be expected.

The proposed Arctic Gas System line from Prudhoe Bay to Zama is about 400 miles shorter than the Fairbanks Corridor route. The Arctic Gas System line does not pass near an established fault line or high seismic risk zone. Taking advantage of the flat topography and alluvial soils of the MacKenzie and other river plains, the Arctic Gas route will be reportedly totally buried.

In all other respects, the Fairbanks Corridor gas line, as proposed, affords countless construction advantages which represent important savings in time, effort, and money. The Fairbanks Corridor gas line employs established right of way along most of its route. The in-depth environmental analyses for a large portion of the proposed route is completed, established and stipulated. Supportive systems, camps, airfields, access roads, even men and equipment, are in place and can be used. Environmental impacts for the Fairbanks Corridor line will be incremental to those impacts already established by the Alyeska line.

Environmental impacts of the Arctic Gas System line would be multiple; one for the access and service facilities and one for the pipeline itself.

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3A

ENVIRONMENTAL IMPACTS OF OPERATION AND MAINTENANCE OF THE PROPOSED FAIRBANKS CORRIDOR LINE

The entire Fairbanks Corridor route, Prudhoe Bay to Ft. Nelson, is accessible by all weather, heavy duty roadways. In the Canadian segment from Haines Jct. (Y.T.) to Ft. Nelson B.C. (556 miles) the selected route of the pipeline may not be directly alongside the Alcan Highway and accessory roads would be built, but the main roadway (Alcan) has existed for 20 years and is in constant use. Marine access to this roadway system can be established at Haines, Skagway, Prudhoe Bay and even Anchorage or Valdez; Prudhoe Bay is used only in summer. Along the eastern leg from Ft. Nelson to Zama (Alta) access would be along the right of way.

Two large cities, Fairbanks and Whitehorse, lie on the proposed Fairbanks Corridor line and these cities could absorb the influx of supplemental/service businesses which would support the gas pipeline. Fairbanks provides frequent flights to the Anchorage International Airport and two railroads, the Alaska RR and the White Pass and Yukon RR (a narrow guage road) serve the separate cities of Fairbanks (from Anchorage) and Whitehorse (from Skagway).

Those features of operations and maintenance for the proposed Fairbanks Corridor gas line which differ markedly from those of the Arctic Gas System pipeline, all take advantage of the excellent access to the Fairbanks Corridor route. The presence of the Alyeska hot oil line also provides some distinct operational and maintenance advantages to the Fairbanks Corridor gas line; pending future negotiations, many supportive systems and facilities can be shared with Alyeska.

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The unique advantages provided to a chilled gas line which follows the proposed Fairbanks Corridor are enumberated below:

1. Some shared costs and services with Alyeska Pipeline.

2. Availability of industrial groups which can provide assistance in the event of an emergency.

3. Maintenance protocols already established and accepted by all monitoring agencies concerned.

4. Established work force of agency experts who can monitor and help with maintenance problems.

5. Established telecommunications systems.

6. Accepted and tested emergency and safety systems which could protect operations of both lines, i.e., seismic episode shut-down.

7. Established roads, airports, etc. which support maintenance procedures.

8. Established and trained security nearby; many military bases are proximal to the line.

9. Established or under construction, port areas which can provide maintenance equipment.

10. Year-round, ready access to almost the entire line. In an emergency, there is no segment of the line that could not be reached by maintenance equipment.

11. Established fish and wildlife jurisdiction and control over sensitive areas "opened" to sportsmen by access and maintenance roads.

12. The "chilled gas" temperature, $23^{o}F$, is maintained to protect sensitive perma-frost areas. The Fairbanks Corridor crosses only about 230 miles of continuous perma-frost zone; the Brooks Mountain Range and foothills lie within perma-frost zones, but being founded on bedrock, this is not a fragile frost sensitive area. The maintenance of the selected $23^{o}F$ temperature and supporting insulation and engineering therefore poses a

problem only directly proportional to the amount of perma-frost, non-stable soils traversed. (Arctic Gas System route would cross approximately 550 miles of continuous perma-frost and 700 more miles in discontinuous perma-frost, very fragile sensitive soils).

13. Preventive maintenance, site and road restoration, erosion control, revegatation, restocking and supplementary seeding can all be performed during the entire year, but special emphasis will be on summer time activities, along the Fairbanks Corridor. The summer time efforts permit immediate control of "spring break-up" erosion and slump problems. Summer activities also allow access to water (not ice) for hydrostatic retesting of the pipe segments.

14. The close and parallel route of the two lines, Alyeska and Fairbanks Corridor, could allow a common seismic safety network to be installed and maintained. Though both lines pass through high seismic risk zones and both lines are/can be constructed to resist 8.5 Richter magnitude earthquakes, the installation of vibrosensometers and the "quake warning" radio net (out of Palmer A K.) can afford "state of the art" technological protection to both lines.

3B

ENVIRONMENTAL IMPACTS OF OPERATION AND MAINTENANCE OF THE PROPOSED ARCTIC GAS SYSTEM LINE

A thorough description of the marine and highway access to the proposed Arctic Gas System line can be found in section 2B. This section points out that snow roads are the proposed means of access to that segment of the route which crosses the Arctic tundra. Snow roads cannot be used in the months April through October; emergency access to the line would have to be via plane or helicopter for at least six or seven months per year.

Those segments of the Arctic Gas system pipeline which would be constructed south of the tundra, would presumably be serviced by the roads built during the construction phase of the Arctic Gas System line, approximately 300 miles. These roads could be easily maintained and used year-round, but this implies that only 1/4 of the line is readily accessible year-round on all weather roads.

Summertime access to a pipeline routed thru the tundra or muskeg not only compromises the soils and vegetation of the area but also the animals living in their summertime haunts. Aircraft can easily spook a herd of musk ox or caribou into a stampede which tramples the young and injures adults as well. All terrain vehicles are equally damaging to both the physical and biological environment.

The proposed Arctic Gas System line relies heavily on snow roads, with no system proposed for summertime access. The lack of year-round access is the basic important difference between the Arctic Gas and Fairbanks Corridor lines. A summary of the unique environmental aspects of operation and maintenance of the Arctic Gas System line is listed on the following pages.

1. Only in the winter season (December - April) can all parts of this proposed line be serviced. Access in spring, summer and early fall must be by helicopter or airplane. All terrain vehicles and even pedestrian traffic can be harmful to the tundra and barren muskeg north of the tree line. Summer ranging animals are mating, calving or nesting; they are susceptible to impacts from aircraft and vehicles.

If the applicant or the Canadian government builds an all-weather road from Steen River to Ft. McPherson, then much of the potential damage done by maintenance crews/operations is obviated (The road itself will have a negative impact on the environment). The points below assume no all weather road is constructed.

2. Winter or any season, access to the pipeline will be difficult; the movement of supplies and equipment for emergency work will be problematic and invariably damaging to the environment. Snow roads would have to be rebuilt/restructured each winter. Summer access would probably occur only in the event of a dire emergency, except in those northern forest areas where all weather roads can be built.

3. If the Arctic Gas System pipeline were constructed as proposed, the segment from Prudhoe Bay to MacKenzie Delta would pose nearly insurmountable maintenance and access problems. Access would be in the winter season only, but in the winter season Prudhoe Bay is iced in, limited to helicopter loads only. Material deliveries for emergency repairs would be severely curtailed.

4. The many small streams and rivers traversed by a buried chilled ($23^{o}F$) pipeline will require constant attention. Frost heave and frost bulbs, as well as slippage in active perma-frost layers, all will demand restructuring and reclamation. Ideally, such work should be after the spring break-up, in early summer. Again, limited summer time access precludes extensive, environmentally acceptable, maintenance activities.

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5. Even if a complete gas line access road were built, service sites and facilities, airfields, storage yards, housing and fuel depots would all have to be built and maintained all year long; such secondary construction imposes additional impacts upon the fragile tundra/muskeg lands.

6. Access and maintenance roads which are built may be an impetus to tourism into the Yukon and Northwest Territory. New methods of access to previously isolated areas could attract sportsmen and tourists in general. Such an influx of tourists and hunters especially may be of doubtful value.

7. The areas around Ft. Nelson and Zama have established and accepted plans for compressor stations, monitoring facilities and etc.

8. Arctic Gas Systems has not specifically defined its telecommunication and electrical power facilities. Telecommunications systems are essentially complete throughout northern Canada. Without the availabiltiy of a widespread power grid system, electrical power supplies are frequently generated on a local basis.

3C

SUMMARY COMPARISON OF ENVIRONMENTAL IMPACTS OF OPERATION AND MAINTENANCE OF A PROPOSED GAS LINE

The Fairbanks Corrodir pipeline will occupy 545 miles of existing Alyeska corridor. In this location, the Fairbanks Corridor can share a large amount of its operation and maintenance systems with Alyeska (some by negotiation, some by governmental directive). Most of the ancillary systems, telecommunication, power, storage and service yards, housing and even skilled labor are presently available to the Alyeska operation and could be shared or transferred to the Fairbanks lines.

The Fairbanks Corridor line does not pass through a National Game Refuge and traverses only about 60 miles of fragile tundra type soils. Even these tundra areas have seasonal road access; thus, excluding the springtime floods, virtually all of the Fairbanks line is accessible by vehicle the year round.

The proposed Arctic Gas System line, in contrast, does not have complete road access. In fact, snow roads are the proposed method of access during construction of most of the Arctic Gas line and presumably, snow roads would furnish access for maintenance and operations.

The Arctic Gas System line, from Prudhoe Bay to Tununuk, crosses more than 400 miles of fragile, frozen, tundra soil, part of which lies within the National (U.S.) Arctic Wildlife Range. No ancillary facilities or systems exist for the operation and maintenance of the proposed line and even wintertime (snow road) access to much of the line is environmentally damaging. Summertime access to the line in the tundra area would be limited to helicopter. The secondary supportive construction which would serve the operations and maintenance of the proposed Arctic Gas System line would definitely compromise the tundra areas and incrementally impact the remaining muskeg and forest areas traversed by this system.

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SOCIO-ECONOMIC ASPECTS OF CONSTRUCTION OF A PROPOSED GAS PIPELINE

4A. Socio-economic features of construction of the proposed Fairbanks Corridor line.

The social and economic impacts would fall primarily on areas already impacted, directly or indirectly, by the Alyeska oil pipeline. With fewer construction workers employed over a shorter period of time than on the oil pipeline, the impacts probably would not be as significant. The impact on Fairbanks and on the remainder of Alaska would not be of the magnitude of the Alyeska impacts since the number of workers would be less than for Alyeska and since services have expanded in the last few years under the pressures generated by Alyeska. Fairbanks would probably continue to be the center of construction activity. Compared with the Arctic Gas system, the longer pipeline needed within Alaska for the Fairbanks Corridor line will require a larger workforce over a longer period of time and will pass through less isolated areas. Thus, property taxes would be greater and worker income would be greater. The Fairbanks Corridor pipeline will be constructed by many of the workers who have been employed in constructing the oil pipeline. There will be some impact on private services, especially in the areas of housing, private health care, utilities, communications, transportation, financial, retail, and leisure services, but the impact should not be significant since these services have been developed in response to the activity on the oil pipeline.

The Fairbanks Corridor route could have more serious effects on those areas outside the oil pipeline corridor, that is, from Delta Junction southeast to the Canadian border. While the towns along the Alcan Highway escaped the direct impacts of Alyeska - such as happened in Valdez or Fairbanks - they did experience increased demands on services due to those people moving into Alaska along the highway. As a result, towns such as Tetlin Junction experienced some economic expansion that would tend to absorb to some degree the impacts generated by the proposed Fairbanks Corridor route. The major revenue impacts of the gas pipeline on the State of Alaska

would result from personal income taxes, certain excise taxes, gas production tax revenues, royalty payments to the state, and state property taxation of the pipeline. Construction of this gas transmission system would have a multi-faceted impact on the socio-economic environment of the State of Alaska. It would produce jobs for existing workers completing the Alyeska line, maintain state and local revenues, and further stimulate the Alaskan economy. This in turn would extend the current demand for social services, schools, housing, health care, and public safety. The proposed pipeline will pass approximately 200 miles from Talkeetna, which is one of the suggested sites for a proposed new capital of Alaska. (The other proposed sites are Fairbanks and Anchorage). Thus, with the addition of a smaller diameter spur-line, the proposed pipeline could furnish a natural gas supply to the new capital.

Gas pipeline construction might have a minimal direct adverse impact on the sport fishing industry and minimal impact on the forest industry. Mining could be expected to grow somewhat because of the improved access to mineral rich areas. Agriculture would continue to diminish in importance in relation to the entire economy, but tourism could be expected to grow. Construction of a gas pipeline would extend the demand for transportation services associated with Alyeska and thus provide additional revenues on existing capital investment in Alaska. The construction effort would utilize the barging, trucking, and aircraft resources of the state. The construction of this pipeline system could have a significant influence on Alaskan Natives. The growing demand for material goods has had obvious impacts. This is a major feature that has resulted from the exposure of the Natives to a non-Native culture. Since these goods must be bought, the Natives have become increasingly dependent upon a cash economy. This in turn, has resulted in a decline in the harvesting of subsistence resources and alterations in the nature and significance of the social institutions derived from that activity. The potential pipeline-related causes of interference with the subsistence resources utilized by the Natives consist of disruptions to the habitat of fish and game as the result of construction or operational activities, and increased competition from the non-Native population for the limited available resources.

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4B. Socio-economic features of construction of the Arctic Gas System line.

It is estimated that a lesser number of workers will be employed in Alaska on the Arctic Gas pipeline. Approximately 2,400 workers will be required during the peak winter construction period. The gas pipeline would provide approximately 20% of the number of jobs created by the oil pipeline. Therefore, the total impact on employment and personal income will be small, but beneficial. Since there is virtually no housing available, mobile construction camps will be required.

During construction, state and local governments along the pipeline will benefit from motor fuel taxes, and personal and corporate income taxes. However, production would be destroyed in agricultural and forest lands throughout much of the route. Some of the land would be out of production for only a short time, but other lands would be out of production for the life of the project. There would be some adverse impacts because of short-term surges of demand for housing, demand for federal, state and community services; and increased competition for recreation, education, transportation, and entertainment. Subsistence trapping would be interrupted during construction of the system.

4C. Summary comparison of socio-economic features of construction.

Construction of the proposed Fairbanks Corridor line through Alaska is scheduled to begin in 1979. The rate of growth in employment is expected to slow down in 1977 after construction of the oil pipeline is completed. Construction on the Alyeska project will begin to taper off in 1977 when the system is scheduled to begin operations. Thus, construction of the proposed gas line could provide continued employment for some workers engaged in constructing the oil pipeline. The gas pipeline will provide continued benefits to the business economy of Alaska from the requirements for supplies, materials and equipment. The existing work camps currently being used in constructing the oil pipeline can be used in constructing the

gas line; thus, there will be no impact from construction of a large number of work camps. Existing highway and utility systems will provide required services. No large expenditure of capital funds will be required for providing these services and there will be no requirements for large scale use of scarce resources.

Construction and support workers, choosing to stay in the areas along the Alyeska line will be able to find jobs. Additional tax dollars will not be required to support these people.

Contrasting with the utilization of existing housing, transportation facilities, medical facilities, recreational facilities, etc., producing additional profits on existing capital investments, the Gas Arctic route would require all new facilities. New capital investments based on short-term payout will result in additional inflation in the areas affected.

SOCIO-ECONOMIC ASPECTS OF THE OPERATION AND MAINTENANCE OF A PROPOSED GAS PIPELINE

5A. Socio-economic aspects of the operation and maintenance of the proposed Fairbanks Corridor line.

Since the Fairbanks Corridor routing is 1650 miles in length and passes near areas of potential development, it would make possible the future use of considerably more natural gas in Alaska than would the Arctic Gas route. These potential users would be fuel users such as utilities and residential and commercial users in the Fairbanks area, and an iron ore processing facility. In addition, revenues from the state property tax would be larger because of the greater length of pipeline in Alaska and the consequent increase in property subject to tax.

Permanent revenues derived from the completed pipeline and pipeline operations would soften the impact of lost construction revenues on completion of the Alyeska line. Construction of the gas pipeline would maintain some of the available jobs for those workers choosing to stay in the area, thus keeping them off welfare rolls.

One of the purposes of this route is to provide natural gas to the Fairbanks area. The availability of an assured gas supply in Fairbanks will increase the potential for development. In addition, this routing will pass closer to the proposed sites for the new capital of Alaska. Regardless of the site which is finally chosen, this pipeline will be available to furnish gas to the proposed capital site. Both the Fairbanks Corridor line and the Arctic Gas line will require a compressor station and/or operation and maintenance facility at Prudhoe Bay. It is estimated that approximately 40 workers will be employed to operate the station.

5B. Socio-economic aspects of the operation and maintenance of the Arctic Gas System line.

The Arctic Gas System will be approximately 195 miles in length in Alaska. This system will transport gas through a relatively underdeveloped portion of the state of Alaska. This pipeline would not furnish gas to any of the larger cities in Alaska.

The airstrips and helicopter landing sites required for operation of the system would create a continuing impact on the fragile Arctic tundra. Because of the unstable soil conditions, periodic reconstruction may be required. It is estimated that 18 docks and piers will be required to facilitate marine delivery of materials to Skagway, Prudhoe Bay, and Mackenzie Delta. The increased traffic at the Mackenzie port may result in interference and delay in delivery of supplies to the Arctic islands. In addition, the existing railroad from Skagway to Whitehorse would probably require expansion and additional maintenance.

5C. Summary comparison of socio-economic aspects of the operation and maintenance of the proposed Fairbanks Corridor line.

The proposed Fairbanks Corridor line will provide permanent benefits to the Prudhoe Bay area, to Fairbanks and to Alaska. The Prudhoe Bay area will benefit from the additional workers required to maintain and operate the compressor station. The Fairbanks area will benefit from the availability of an assured supply of natural gas. The State of Alaska will benefit from the increased tax revenue derived from the greater length of gas pipeline in the State, and also benefit from the reduced number of potential welfare claimants.

SELECTED ENVIRONMENTAL IMPACTS

Some of the impacts on the environment of the proposed Fairbanks Corridor line and the Arctic Gas line, based on the Final Environmental Impact Statement issued by the Department of the Interior, may be summarized as follows:

(a) Climate

Fairbanks Corridor - Alaska

The construction, operation or repair of the pipeline will have little, if any, impact on climate. It will not affect regional temperatures, winds or precipitation. Available information indicated that micrometerological changes will result from compressor station emissions. Ice fog conditions may occur in the villages or camps along the route.

Fairbanks Corridor - Canada

The short-term effects of construction and operation of the proposed pipeline on climate will be minimal. Local and transitory ice fog, the only impact, will not be deleterious to the climate. If airstrips are not sited at elevations higher than equipment such as compressors, ice fog could interfere with aircraft movement for a few hours before wind disperses it.

Arctic Gas

There will be no significant impact on regional climate; however, climate will have a major impact on the construction and operation of the pipeline in the arctic and the subarctic. The cold air temperature, combined with winds and the long winter darkness, will cause extreme stresses on personnel, materials, equipment, and machines.

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(b) Topography, Geology and Soils

Fairbanks Corridor - Alaska

Some landscape changes in topography will be caused by borrow areas, ditch mounds, and buildings. A major portion of this route is located in forested, rolling topography and is associated with a major existing transportation system (the Alcan Highway). Therefore, it is believed that the overall impact on topography will be slight.

This route will serve the Prudhoe Bay oil and gas fields, the Kandik Basin, the Middle Tanana Basin and the Copper River Basin.

Construction and operation of a gas pipeline will have little, if any, impact on the development of hardrock minerals and energy producing minerals except for oil, gas, sand and gravel. The 735 mile segment of the Fairbanks Corridor in Alaska will not affect the overall distribution or abundance of perma-frost in Alaska. Perma-frost will affect the pipeline. The route crosses approximately 230 miles of continuous perma-frost and approximately 505 miles of discontinuous perma-frost. In perma-frost terrain, disturbance or removal of the plant cover and peat layer causes thawing of the perma-frost and deepening of the active thaw layer. The impact on soil along the route can be minimized by avoiding disturbance to the vegetation protecting those soils.

Fairbanks Corridor - Canada

Topographic impacts of the proposed pipeline constructed along 915 miles of right of way in Canada are considered to be minor. Most of these impacts would be secondary manifestations of more serious geologic impacts such as thermokarst development, gullying and stream siltation, and accelerated mass wasting.

Construction of a pipeline and ancilliary structures will require great quantities of sand and gravel or crushed rock for such purposes as pad foundations, backfill in trenches, and roadways. Suitable materials sources are generally abundant along the corridor, but are relatively scarce in some segments. Other than the consumptive use

of construction materials, the construction and operation of a gas pipeline will have no impact on metallic or non-metallic resources and their extraction. Trenching and other pipeline construction activities would impact topsoils to a variable degree ranging from complete destruction to partial burial. This routing will not cross major areas of agricultural lands; thus, there is little potential for major impact on agricultural uses of soils.

Arctic Gas

The major unavoidable effect on topography would be the excavation of at least 108 borrow pits averaging about 14 acres each. In addition, plans call for a nearly continuous berm of soil (several feet high and about 5 feet wide) directly over the pipe. (DOI Final EIS, Canada, March, 1976, p.321).

A buried chilled pipeline poses special geologic problems such as heaving of the pipe and disruption of shallow ground-water movement. It has not been demonstrated that the integrity of the pipeline can be maintained everywhere in the perma-frost area. Thawing of ice-rich, fine-grained permafrost materials could locally result in serious impacts such as soil liquefaction, slope instability, differential settlement of the ground surface, disruption of drainage, and accelerated erosion along as much as 800 miles of the route north of Ft. Norman on the Main Line and on the supply line laterals. Approximately 30 million cubic yards of construction material from borrow pits and quarries will be required for construction of the pipeline system.

Adverse effects on agricultural soils would be minor except on the right-of-way of the proposed pipeline, permanent roads, temporary access roads, and other graded or filled areas. These effects would be significant only in areas of agricultural development, mostly south of Ft. Simpson on the Main Line and on the delivery lines in southern Canada.

(c) Water Resources

Fairbanks Corridor - Alaska

Construction of the pipeline will affect surface drainage patterns. Impacts associated with the pipeline, ditch, frost bulb, and mound will be long term and will result in wet conditions on upslope sides and dry conditions on downslope sides. Airfield, future compressor station and communication sites are considered to have no significant impact on surface drainage patterns. None of the streams along the route are utilized as municipal supply sources either through reservoirs or through other bodies of water connected to the streams.

Fairbanks Corridor - Canada

The degree of potential impact at stream crossings would depend upon the design and the measures taken during construction to minimize the impact. Four areas of concern are: (1) channel erosion, (2) icings, (3) depletion of streamflow during construction, and (4) drainage disruption.

The primary impact on ground water by the pipeline would be the disturbance of the shallow active layer overlying perma-frost during pipeline construction and operation. Disturbance of the thermal regime in the active layer would create new ground-water flow patterns, possibly resulting in aufeis, accelerated thermal degradation, accelerated erosion, frost heaving, and potentially explosive icing mounds. Another potential for impact on ground water would be the discharge of liquid wastes and leaching of sanitary landfills.

Arctic Gas

Excavation of materials and the placement of fill during construction of the proposed pipeline will alter numerous natural drainage channels. Erosion could be accelerated because of the potential for increased velocities and concentrated flows, steepened terrain slopes, soil disturbances and vegetation modification. Changes in the subsurface drainage caused by pipeline construction, soil compaction, or the frozen

annulus around a chilled pipe could result in conversion of subsurface flow to surface flow and thus increase erosion. Changes in the form of drainage could alter the freeze-thaw, wet-dry, liquefaction, or other characteristics of soils leading to new or accelerated mass movement. A principal potential impact of such soil movements would be the disfiguration of the landscape and a decrease in the quality of water.

The proposed pipeline alignment would cross numerous streams and flood plains. Where the pipeline is buried at stream crossings, scour might expose the pipe and cause damage. Along the northern (Prudhoe Bay to Tununuk) one-third of the route, the formation of river icings (aufeis) could affect the integrity of aboveground structures as well as cause unpredictable effects on depths of riverbed scour.

The natural quality of water in streams or lakes would be impaired where construction-related activities, including the removal of vegetation, sand and gravel mining, and grading and filling for roads or camp buildings would add particulate matter. Adverse effects of sedimentation could largely be controlled during the life of the project, but would be unavoidable during construction.

Contamination of streams and lakes by deliberate or accidental discharge of toxic chemicals would be a long-term, continuing threat to water quality and plant and animal populations both in freshwater and marine environments. The effects could be critical along major waterways but cannot be quantified as they would depend for the most part on the incidence of accidental spillage and leakage of fuel oil and other toxic materials.

(d) Vegetation

Fairbanks Corridor - Alaska

Some existing underbrush and forest will be destroyed by the construction of permanent access roads, compressor station sites, borrow pits and other structures. A few temporary work pads will be required along the Alyeska portion of the route and an additional number will be

required in the portion along the Alcan Highway. Any merchantable timber stands that are cut will occur at scattered locations so that their loss would not be economically significant. Local stands would have value to nearby users and could be salvaged for local use. The right-of-way clearing will leave a rather straight line across the landscape. The percentage of land that will be affected is quite small when compared when the total width of right-of-way. No known plant species are threatened with total extinction on this route.

Fairbanks Corridor - Canada

In the portion of the route following the Alcan Highway, discontinuous perma-frost is present, although not widespread southeast of Whitehorse. The principal impact on vegetation would result from clearing of the right-of-way in the open, parkland forests of spruce and mixed woods and the permanent occupancy of land for compressor stations and other facilities.

Arctic Gas

Unavoidable effects of the proposed pipeline on vegetation would be relatively insignificant in terms of the total resource of plant communities. Losses of vegetation would occur on all land areas occupied by permanent roads, airstrips, compressor stations, wharves, stockpiles, borrow pits and other facilities. On the pipeline right-of-way, clearing of trees would cause a loss of forest productivity. In the long term, following abandonment of the proposed project, all vegetation should recover, although scars would be visible for many decades.

Throughout the lifetime of the proposed project, an apparently intractable problem in perma-frost zones would be unscheduled maintenance operations requiring movement of heavy machinery over land. Such operations could cause more damage to vegetation and terrain than would the initial construction of a pipeline. The adverse effects would be especially severe in the Arctic Coastal tundra where soils are ice-rich, recovery of stable terrain and vegetation is slow, and scars on the landscape are highly visible and long enduring.

(e) Wildlife

Fairbanks Corridor - Alaska

The construction of this pipeline system will affect wildlife populations in the following ways: (1) direct and indirect harassment or project-caused disturbance during critical periods of an animal's life cycle; (2) increased harassment and/or destruction of wildlife because of better access to area; (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 most of this alternative route closely parallels the trans-Alaska oil pipeline system, many of the impacts, e.g., noise and pollutants from gas compressor sites added to noise and pollutants from oil pump stations, will be cumulative. However, because there is no precedent for this combination of pipeline transportation systems, the additive effects, while based on best judgment, are mainly tentative.

Fairbanks Corridor - Canada

There is insufficient background material available to permit evaluation of impact of the use of this routing on fish and fish habitats. Since a large portion of the route has already been affected by highways, there would be less affect on wilderness areas when compared to other possible routings. The segment paralleling the Alcan Highway would be disturbed, but most of the area would eventually be revegetated. Construction of the pipeline would represent a temporary loss of habitat for small mammals in contrast to the permanent habitat loss that accompanied construction of the highway. Thus, the impact to animals along the highway would be less than the impact to animals in previously undisturbed areas.

Arctic Gas

The pipeline along the proposed route should have only a few unavoidable adverse effects on fish populations, if known and planned mitigating measures are sucessfully employed.

Most mammal species should be little affected along the proposed route if planned mitigative measures are employed. Winter construction would avoid contact with the Porcupine caribou herd if construction were halted in advance of the spring migration and no barriers to movement were left. Control of firearms and prohibition of hunting would remove a principal threat to game animals in the Arctic and Subarctic. Planned right-of-way alignments avoiding denning sites of wolves, foxes and grizzly bears along northern parts of the route will remove some of the principal threats to these species.

Adverse effects would be expected on such vulnerable species as wolverine, grizzly bear, and polar bear and to tundra populations of wolf in the Yukon and Northwest Territories. Although most potential adverse effects would be avoidable, noise disturbance by aircraft, harassment, and increased hunting pressure by hunters who benefited by increased accessibility of the area would be continuing threats to game animals and to the subsistence of Native peoples.

Use of the proposed route would adversely affect bird habitats on the right-of-way and in areas occupied by permanent facilities but the areas would be small relative to the total habitat resource.

Disturbances to migrating, nesting, feeding, molting and staging waterfowl and shorebirds and disruptions to the habitats used for these functions would be potential adverse effects at one time or another over essentially the full length of the proposed route. Especially critical habitat occurs along the MacKenzie River, in its delta, and along the shores, estuaries, lagoons and barrier beaches of the Yukon coast. Local summer construction of facilities, summer marine, river and air transportation, and noise of all kinds present throughout the operational period of pipeline, would be disruptive to waterfowl and shorebirds.

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(f) Economic Factors

Fairbanks Corridor - Alaska

The economic impacts of the Fairbanks-Alaska alternative route as developed by the University of Alaska econometric model (Scott, 1975) include: a property tax of $44 million, construction employment of 6,845, a capital value (pipe and compressors) of $2.2 billion, an increase in gross state product of $249.7 million, a total state employment effect of 23,900, an increase in real wages and salaries of $199.6 million, population growth of 33,400, an addition to personal income statewide of $572.7 million with an increase in per capita income of $463, and a total addition to state revenues of $156.5 million. All figures are projected to 1980. The concentration of pipeline construction supervisory and logistical functions in Fairbanks should result in an increase in the average income level. The incomes of local natives will be bolstered by continued pipeline construction.

Fairbanks Corridor - Canada

Construction of a pipeline would generate a relatively small overall net increase in population. Tourism, sport fishing and hunting and mining wouldprobably have a greater impact on population than the proposed pipeline. Construction and operation of the pipeline will contribute significantly to the established communities directly along the corridor. The infrastructure already existing along the Alcan Highway would be, in varying degrees, already able to support additional activities, and it is probable that upgrading and expansion of existing facilities could be accomplished easily. Increased economic activity should work to the advantage of any existing businesses that currently might be marginal. Without this proposed pipeline, further growth would be dependent on th level of activity in the government, tourism, and mining and mineral exploration.

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Arctic Gas

The proposed project would in some degree have an adverse effect on the desire and/or ability of the Native local residents to follow their traditional hunting-trapping-fishing land-based economy. A trend away from the land-related pursuits toward a wage economy, however, has already been established in many parts of the proposed route region. Therefore, in general, the proposed project could not be regarded as an initial cause, but it might be a potent factor in augmenting and accelerating this trend.

Some adverse effect, due to unemployment, might result in the post-construction phase of the proposed pipeline project when the labor force required would be only a small fraction of that needed during the peak years of construction. Other secondary activities in gas and oil exploration and development in the MacKenzie region might materialize and provide continuing employment for those displaced from jobs following the projected peak construction period.

(g) Sociological Factors

Fairbanks Corridor - Alaska

Sociological impacts will range from beneficial impacts such as cultural opportunities because of greater demand, to such adverse impacts as increase in crime, lower standards of housing, greater traffic problems, and an accelerated rate of decline of Native culture. Sociological impacts along the Fairbanks Corridor may be considered less disruptive than other alternative pipeline routes, because few communities not already affected by the Alyeska pipeline will be involved. Fairbanks currently serves as a major regional center for health care.

Fairbanks Corridor - Canada

The approximately 12,500 population along the Fairbanks Corridor in Canada was distributed in 1972-1973 as follows: Whitehorse 11,100, Watson Lake 555, Teslin 340, Haines Jct. 190, Carcross 190, Beaver Creek 120, Burwash Landing 65, Destruction Bay 80. It is reasonable to assume that, if the proposed pipeline were built in this corridor, there would be a moderate population increase, at least temporarily, in addition

to that which could be projected in the absence of any major new project. This would be generated by increased demands for services and recreation. The continuing need for an operational staff for the proposed pipeline could result in increased employment for the local residents or a migration of people from other areas seeking jobs, or both.

The impact of the project on housing and secondary service facilities is difficult to assess in the absence of a survey of existing facilities. The quantity and quality of existing housing in this region is probably no more than adequate for present needs, and more housing would be needed to accommodate even a small population increase. The need for more or better service facilities would vary depending on the communities and particular business. Expansion of at least some facilities would be needed in many of the communities.

Arctic Gas

To some degree the various activities directly and indirectly associated with the proposed pipeline project would be likely to result in significant relocation and concentration changes in the population of the northern regions, as well as in the net total increase. Depending upon how these situations were handled, what the attitudes of the local residents would be at that time, and what one's opinion is of such a change, these changes might or might not have an adverse impact.

(h) Land Use

Fairbanks Corridor - Alaska

There is no comprehensive land use plan for lands traversed by the Fairbanks Corridor route. Since it is located within an area already dedicated to transportation, it can be assumed that construction, operation and repair of the Fairbanks Corridor pipeline system will not change land use in the immediate area. The entire length of the route from Prudhoe Bay to the United States-Canada border is accessible by road. No existing national park, forest, wildlife refuge, or wild and scenic river areas are involved. Approximately 10 miles of the route near the Canadian Border is within the proposed Wrangell Mountains National Forest; the route would also traverse a proposed waterfowl refuge near Tetlin. No

other proposed forest, national parks, refuges, or wild and scenic rivers are known at this time. No areas of potential wilderness are involved.

The approximate land ownership on the route is shown on the following table:

Ownership	Miles	Percent
Federal Utility Corridor*	360	49
Proposed Wrangell Mountains National Forest	10	1
Military and other Federal	89	12
State	252**	35
Native	24	3
	735	100

*Occupied by Trans-Alaska Oil Pipeline System.
**Much of area has been transferred to private ownership.

Throughout the state, substantial portions of land are being transferred to the State of Alaska under the provisions of the Alaska Statehood Act. Similarly the Alaska Native Claims Settlement Act provides for transfer of land and minerals to Alaska Native Regional and Village Corporations. Both land transfer programs are still in their infancy. Any additional right-of-way required for the proposed pipeline will be acquired in accordance with these statutes, or as provided by the established procedures of the Bureau of Land Management.

Fairbanks Corridor - Canada

General land-use patterns would be little changed if a gas pipeline were to be constructed in the Fairbanks Corridor. The major impact during the life of the project would be the dedication of sites for compressor stations, some borrow pits, and communications facilities to pipeline-related uses for the duration of the project. Impacts during construction would include withdrawal of the right-of-way from other uses as well as the use of borrow pits and quarries that would not be needed for maintenance. Additional possible impacts during construction would be crowding of existing highways by additional traffic and changes in breeding and foraging habits of game animals, both of which might affect tourism.

Arctic Gas

Most of the 43,060 acres that would be used during the construction and operation of a gas pipeline is not under extensive development. Should the proposed project be adopted, the right-of-way (120 feet wide), the land occupied by borrow pits and quarries and by road that served only the project, and the land occupied by compressor stations, communications sites, material marshalling areas, wharves, and the like, would be committed during the construction phase of the project. After construction has been completed, much of the right-of-way and all temporary facilities, including borrow pits not needed for maintenance, would be available for nonpipeline-related use.

Prior to the construction and operation of any pipeline in Canada, it will be necessary to submit an application for "grants of interests in territorial lands" to the Department of Indian and Northern Development of the Government of Canada.

(i) Archeological and Historical Factors

Fairbanks Corridor - Alaska

Remnants of Alaska's early history are scattered along the route. The locations of many of these sites are well known and protected.

Some of the sites in the Fairbanks vicinity have been entered in the National Register of Historic Places. The adverse impacts of the proposed pipeline on these sites could be negligible if minor route alignment changes are made. Several, still visible, old trails would be crossed. Although only short segments of such trails would be disturbed, the visual and aesthetic impact to people using the trails could be adverse. The exact locations of some former trading posts and old villages are unknown. If studies presently being made fail to find these, the areas would need close monitoring during clearing and construction for the pipeline. As workers and others move north of the Yukon, vandalism and artifact hunting probably will increase in old mining areas such as Wiseman. This could cause a significant impact if old buildings or artifacts were destroyed or removed.

Some archeological sites have been identified near the route. In general, however, the extent of impact on the archeological and paleontological resources along the route is not known and cannot be assessed until a right-of-way survey is completed.

Surface surveys along the trans-Alaska oil pipeline already show that many sites exist and that the country is quite rich in both archeological and paleontological sites. For example, in the section between Livengood and Prudhoe Bay, 189 sites are listed.

Potential impacts of the system on prospectively valuable archeological areas include: destruction of sites without scientific investigation; destruction with partially completed scientific investigation; vandalism of unexcavated, partially excavated, or accidentally opened sites, and removal of artifacts (surface finds are often of great significance in the Arctic).

Archeological values may have an adverse impact on the completion of the system. Provisions of the National Historic Preservation Act of 1966, Executive Order 11593, and the Archeological and Historic Preservation Act (P.L. 93-291) require archeological values to be identified and protected. Thus, it is possible that the pipeline may be rerouted within the approved corridors to comply with this Act.

Fairbanks Corridor - Canada

Because so little information on archeological aspects of the Fairbanks Corridor is available, it is difficult to predict the impact of pipeline construction on the archeological resources of the region. Of course, all phases of construction involving land use could cause loss of, or damage to, archeological and historical resources. Construction of ancillary features such as compressor stations, borrow pits, stockpile sites, and wharves, as well as the excavation of a pipeline trench itself, could destroy potential archeological and historic sites.

Construction of a pipeline along this corridor would not appreciably increase the accessibility of archeological and historic sites because the proposed corridor roughly parallels for most of its length, existing roadways such as the Alaska Highway.

While construction of a pipeline could destroy potential archeological sites, it may also uncover some sites, which could be salvaged by professionals. Any new information thus obtained would probably contribute greatly to knowledge of the prehistoric inhabitants of the region.

Arctic Gas

The proposed pipeline would traverse the area through which early man is believed to have traveled after crossing the Bering land bridge into North America. Adverse effects on archeological resources along the proposed route would be inversely proportional to the extent and effectiveness of the archeological survey and salvage program. Some unidentified sites would very likely be damaged or destroyed, but their number and value cannot be estimated. Because of the limited knowledge of archeological sites in the Arctic and Subarctic, the potential loss of sites is especially critical.

(j) Recreation and Aesthetic Factors

Fairbanks Corridor - Alaska

During construction, there would be moderate recreational use of areas along the pipeline by workers. The proposed route will parallel either existing roads or other utilities. It parallels the trans-Alaska oil pipeline from Prudhoe Bay to Delta Junction. Thus, the aesthetic impacts should be considered in terms of adding another pipeline (or utility) to an area already partly disturbed by man (i.e., it is not comparable, to building a pipeline across any area currently undisturbed by man). Because of the existing development along most of this route, the addition of another pipeline will have only minor impacts on the aesthetic values. The Alyeska pipeline already provides private access to the vast area between the Yukon River and Prudhoe Bay. Public access is considered of doubtful benefit. The area north of the Yukon River is so vast that the impact of another pipeline on the total landscape will be small.

Fairbanks Corridor - Canada

Since the routing is roughly parallel to existing or planned roads for nearly all of its length, pipeline construction in it would have a visual impact on highway travelers. Proper restoration after construction could minimize the impact on tourism, in such areas as Kluane National Park.

Arctic Gas

In the regions traversed by the proposed pipeline north of 60^{o} N latitude, the main adverse effect on recreation resources would be in the form of landscape scarring from construction of the pipeline and related roads, borrow pits, airstrips, compressor stations, communication sites, wharves, etc. Other landscape scars would result if underlying perma-frost were to be thawed, causing settling and erosion.

The proposed project by itself would have adverse effects on some wilderness areas, notably the arctic coastal region. Of greater importance would be the major invasion of wilderness areas set off by the proposed project. By its roads and rights-of-way it would make the land more accessible to those who would come later. It would also stimulate related development in transportation, recreation and industry, as does any large project.

(k) Air Quality

Fairbanks Corridor - Alaska

With three categoric exceptions air quality along the Fairbanks Corridor route from Prudhoe to the United States - Canada border via the Alaska highway is considered to be very high. Exceptions are as follows:

1) Prudhoe Bay oil and gas field
2) Small towns and population enclaves along the highway between Fairbanks and the border.
3) Fairbanks with its particular combination of air related circumstances.

Fairbanks Corridor - Canada

There are highways in practically the whole length of the Fairbanks Corridor. Because of exhaust emissions from mobile and stationary internal combustion engines, air quality is probably lower than in more remote areas in the region traversed and in areas in similar latitudes along the proposed route.

Arctic Gas

Air quality along the pipeline route will be impacted during construction and subsequently at compressor station locations during operation of the pipeline. Factors which will have an impact are: exhaust emissions from construction equipment engines, dust produced by construction activities and release or escape of gas from the pipeline.

(1) Environmental Noise

Fairbanks Corridor - Alaska

Data on environmental noise associated with the Fairbanks alternative route are not available. North of the Yukon River the route is closely associated with a transportation corridor for the trans-Alaska oil pipeline and an access road. Adjacent areas, however, are undeveloped and are expected to have little environmental noise other than that produced by nature. South of the Yukon River the route is near an established highway. In Fairbanks noise levels are expected to be typical of a community of comparable size except that Fairbanks has a very high proportion of aircraft use because of its location as a major air center. From Fairbanks southeast to the Canadian border, the route is closely associated with an established highway. Noise associated with construction will be transitory.

Fairbanks Corridor - Canada

Ambient sound levels are slightly higher than along the Arctic Gas route. Since this routing follows existing highways almost all of its length, existing noise levels are higher along a greater proportion of this corridor than for any of the other corridors and routes. The addition of construction noise to existing highway noise constitute less of an impact than on alternative routes.

Arctic Gas

The construction noise will be short-term and widespread and will produce both indirect and direct noise. The indirect noise impact will be due to the road traffic generated by the project and the direct will be the construction site noise. During operation of the system, the compressor stations will produce continuous and fixed noises which will be long-term and more localized.

7.

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JP/GIEC
April 14/76