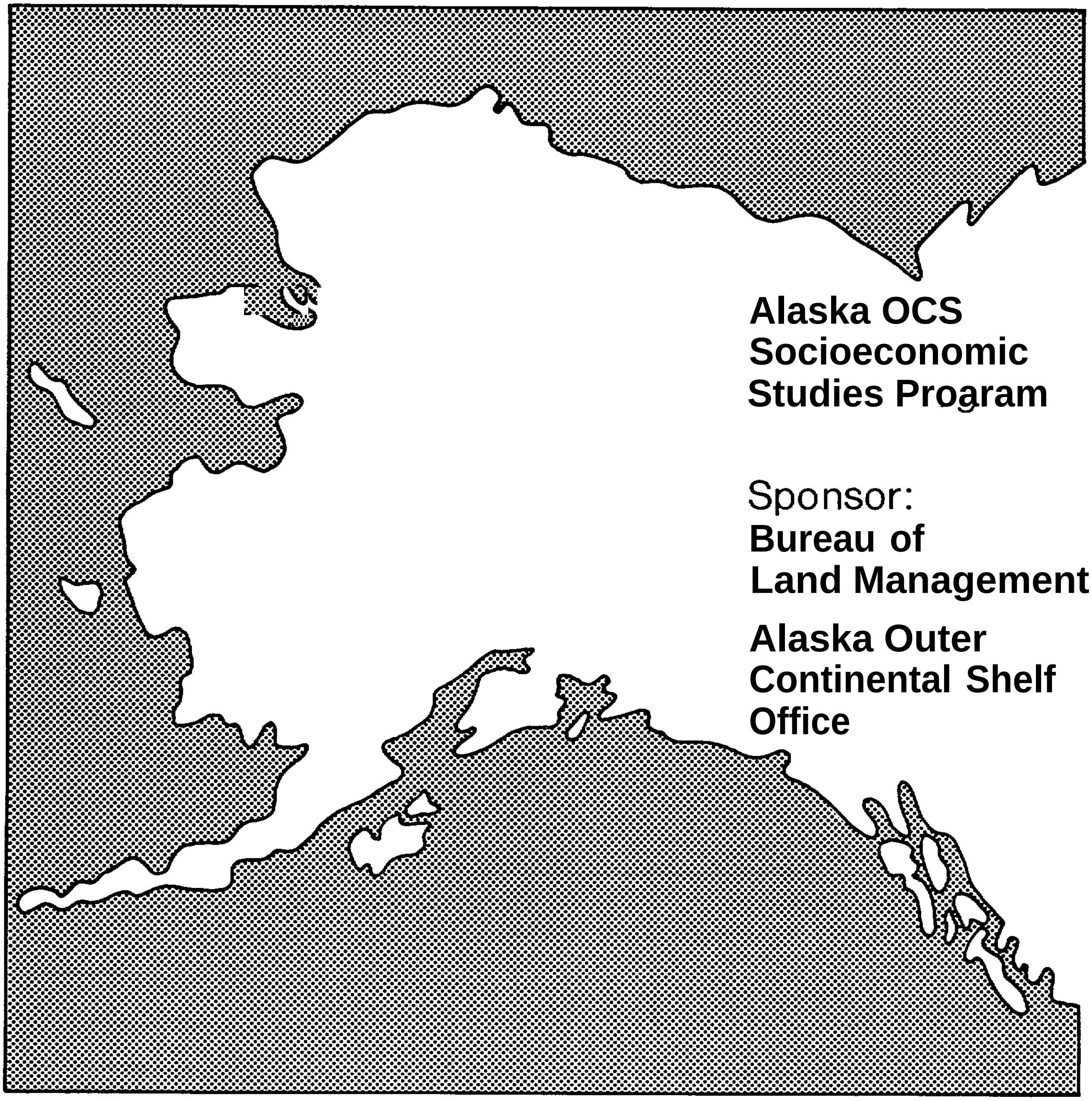
Technical Report
Number 20



Alaska OCS Socioeconomic Studies Program

Sponsor:
Bureau of Land Management
Alaska Outer Continental Shelf Office

Beaufort Sea
Petroleum Development Scenarios
Transportation Impacts

The United States Department of the Interior was designated by the Outer Continental Shelf (OCS) Lands Act of 1953 to carry out the majority of the Act's provisions for administering the mineral leasing and development of off-shore areas of the United States under federal jurisdiction. Within the Department, the Bureau of Land Management (BLM) has the responsibility to meet requirements of the National Environmental Policy Act of 1969 (NEPA) as well as other legislation and regulations dealing with the effects of off-shore development. In Alaska, unique cultural differences and climatic conditions create a need for developing additional socioeconomic and environmental information to improve OCS decision making at all governmental levels. In fulfillment of its federal responsibilities and with an awareness of these additional information needs, the BLM has initiated several investigative programs, one of which is the Alaska OCS Socioeconomic Studies Program.

The Alaska OCS Socioeconomic Studies Program is a multi-year research effort which attempts to predict and evaluate the effects of Alaska OCS Petroleum Development upon the physical, social, and economic environments within the state. The analysis addresses the differing effects among various geographic units: the State of Alaska as a whole, the several regions within which oil and gas development is likely to take place, and within these regions, the various communities.

The overall research method is multidisciplinary in nature and is based on the preparation of three research components. In the first research component, the internal nature, structure, and essential processes of these various geographic units and interactions among them are documented. In the second research component, alternative sets of assumptions regarding the location, nature, and timing of future OCS petroleum development events and related activities are prepared. In the third research component, future oil and gas development events are translated into quantities and forces acting on the various geographic units. The predicted consequences of these events are evaluated in relation to present goals, values, and expectations.

In general, program products are sequentially arranged in accordance with BLM's proposed OCS lease sale schedule, so that information is timely to decision making. In addition to making reports available through the National Technical Information Service, the BLM is providing an information service through the Alaska OCS Office. Inquiries for information should be directed to: Program Coordinator (COAR), Socioeconomic Studies Program, Alaska OCS Office, P. O. Box 1159, Anchorage, Alaska 99510.

TECHNICAL REPORT #20 CONTRACT NO. AA550-CT6-61

ALASKA OCS SOCIOECONOMIC STUDIES PROGRAM
BEAUFORT SEA PETROLEUM DEVELOPMENT SCENARIOS: TRANSPORTATION IMPACTS

FINAL REPORT

Prepared for

BUREAU OF LAND MANAGEMENT

ALASKA OUTER CONTINENTAL SHELF OFFICE

Prepared by

DENNIS DOOLEY AND ASSOCIATES

for

PEAT, MARWICK, MITCHELL, AND COMPANY

August 1978

NOTICE

ALASKA OCS SOCIOECONOMIC C STUDIES PROGRAM
Projected Impacts of Beaufort Sea OCS Development
Assessment of Statewide and Regional Transportation Systems
Final Report

Prepared by

DENNIS DOOLEY AND ASSOCIATES for
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16. Abstract

The report analyzes the statewide, regional and local transportation impacts of Beaufort Sea petroleum exploration, development, and production. Alternative routings for goods and passengers to the area are developed for each mode. Next, facilities on these routes and carriers using them are described for current conditions. Next, an estimate is made of impacts related to non-OCS (Outer Continental Shelf) development up to the year 2000. Finally, impacts are individually assessed for the petroleum development scenarios--Camden-Canning, Prudhoe Bay-Small, Cape Halkett, and Prudhoe Bay-Large.

All personnel movements are assumed to use the air mode. Road traffic from Anchorage and Fairbanks will provide camp consumables and a small percentage of industrial goods except for the Cape Halkett scenario, whose distance from Prudhoe Bay makes road development too costly. Truck traffic is expected to be limited during spring freeze/thaw conditions, and during this period air freight will be used more extensively. More than 90% of freight is expected to reach the Beaufort Sea directly by the marine mode despite the short shipping season. The principal route will be via the Bering Straits, which is used by ocean-going tugs and barges; but river traffic on the Mackenzie River is expected to carry some freight, also.

Sufficient capacity is expected to exist on the Trans Alaska Pipeline (TAPS) at the time of expected peak production. It is assumed that oil and gas will use pipeline systems for delivery to ice-free ports or directly to markets. However, the high tariff on TAPS and interest by Canadian oil operators in developing a year-round all-water delivery system conceivably could lead to the use of an icebreaking tanker fleet.

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Purpose

The assessment of impacts from exploration, development, and production of offshore oil reserves in the Beaufort Sea is a multi-staged and multi-disciplinary undertaking. The first stage is to develop a set of petroleum development scenarios that are both technically and economically feasible and produce a sufficient range of impacts. The next stage is to develop data that can be used as primary input for socio-economic studies, which represent the next stage. Such data includes manpower, material requirements, and the scheduling of development activities.

The purpose of this report, which is one element of the socioeconomic studies, is to assess for individual scenarios the impacts on the local, region, and state-wide transportation systems, using data developed in the previous stage and, as appropriate, information developed by other members of the multidisciplinary effort. Particularly important in the latter category have been annual employment and population forecasts by region and for the state as a whole. Coordination with those analyzing community and cultural impacts has also been necessary so that impacts can at a later date be successfully integrated.

The report contains three major sections, in addition to an introductory chapter. First, a present-day baseline (Chapter II) is established by examining for each mode existing routes, carriers, and terminals which could realistically serve freight and passenger traffic generated directly or indirectly by Beaufort Sea OCS activites. Second, impacts for the non-OCS scenario (Chapter III) are developed. Third, additional demands resulting from OCS activities are generated (Chapter IV) and the resulting impacts on the transportation systems assessed. Information contained in the report will be useful in setting priorities for lease/sales and for generating stipulations for the leases.

Introduction

Alaska's basic transportation systems have evolved principally from construction undertaken during the Second World War. Subsequent major projects that have increased the capacity and flexibility of intrastate movement of goods and people include port improvements, particularly for Anchorage and Valdez, the Parks Highway which provides a direct connection between Fairbanks and Anchorage, statewide airport improvements, the state-operated marine highway system in southeastern and southcentral Alaska, paving of and bringing up to design standards the primary and secondary road systems, and the North Slope Haul Road. The only major non-urban facilities under or near construction at the present time are the Skagway-Carcross Road in Southeastern Alaska, and the Copper River Highway. Figure 1 depicts the intercity road network which is currently open to the public and, thus, maintained by the state. Note that the TransAlaska Pipeline

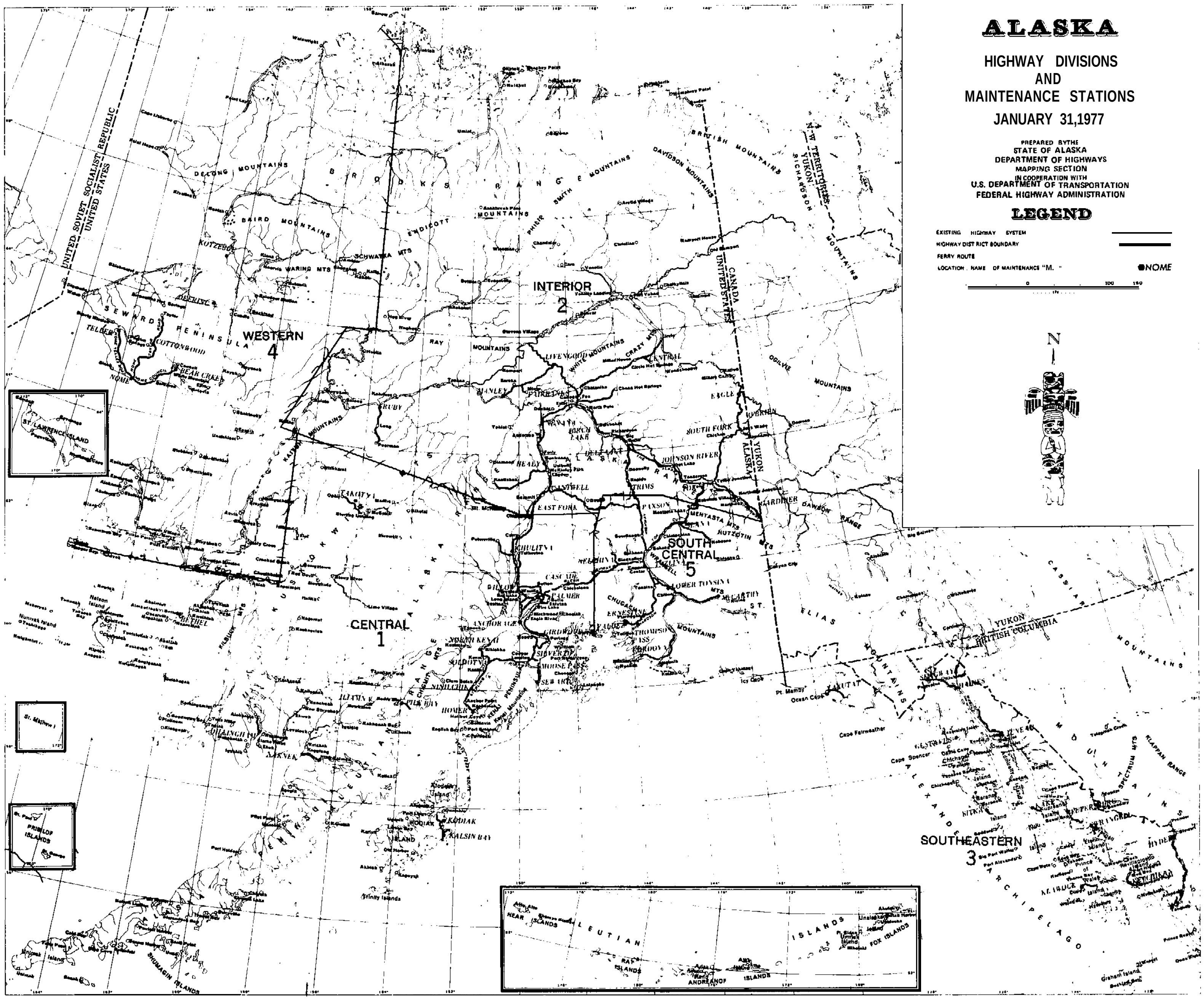


FIGURE 1

SOURCE: ALASKA DEPARTMENT OF HIGHWAYS, 1977

Haul Road is not shown since it is not scheduled to be turned over to the State by Alyeska Pipeline Company, until October, 1978.

The primary emphasis of proposed transportation expenditures for the State of Alaska in the coming years is to meet the transportation requirements for the fast growing urban centers, particularly Anchorage and Fairbanks, as well as reconstructing and upgrading the existing systems. Several proposed corridors such as the Western Access Road, which would connect Nome by road to the Haul Road, and a road between Juneau and Haines are on the Federal Aid System which makes them eligible for funding preliminary engineering studies by the Federal Highway Administration, but their eventual construction is highly problematic.

A study of any transportation requirements for Northeastern Alaska during the next 20 years should consider the feasibility of using available routings through Canada. The Mackenzie River has been an established north-south transportation corridor for many years. The Canadian philosophy for transportation development in the Yukon and Northwest Territory differs somewhat from that of the State of Alaska. Although the present populations in the two territories are small, even in comparison to Alaska, the Canadian Government has expended significant funding to improve land access for remote areas. One purpose has been to promote resource development activities (Roads for Resources program), which is economic in nature, while the other purpose has been to link the area's population centers with existing surface transportation systems, which is more social and political in nature. Figure 2 shows the available transportation routes to and from Northwest Canada that existed in 1973. Since then, the Dempster Highway, which will extend from Dawson to Inuvik is nearing completion, and the Mackenzie Highway now goes to Fort Simpson and plans call for an extension as far as Wrigley.

Methodology

Impacts related to trnasportation can be expected to commence at the time of the lease sale in 1979. The planning horizon of the impact assessment is the year 2000. Depending upon the amount of development that actually occurs, impacts could continue beyond this date. The timing and the magnitude of transportation impacts must be assessed on the basis of material requirements and employment for each of the four OCS development scenarios.

Figure 3 indicates the process by which transportation impacts will be assessed.

Two types of impacts relating to increased demands on transportation systems will primarily be considered: (1) accelerated deterioration of facilities, and (2) capacity restraint, or a decline in the availability or quality of service. Also, a brief comparison of the ability to increase capacities during periods of boom cycles and steady growth will be presented.

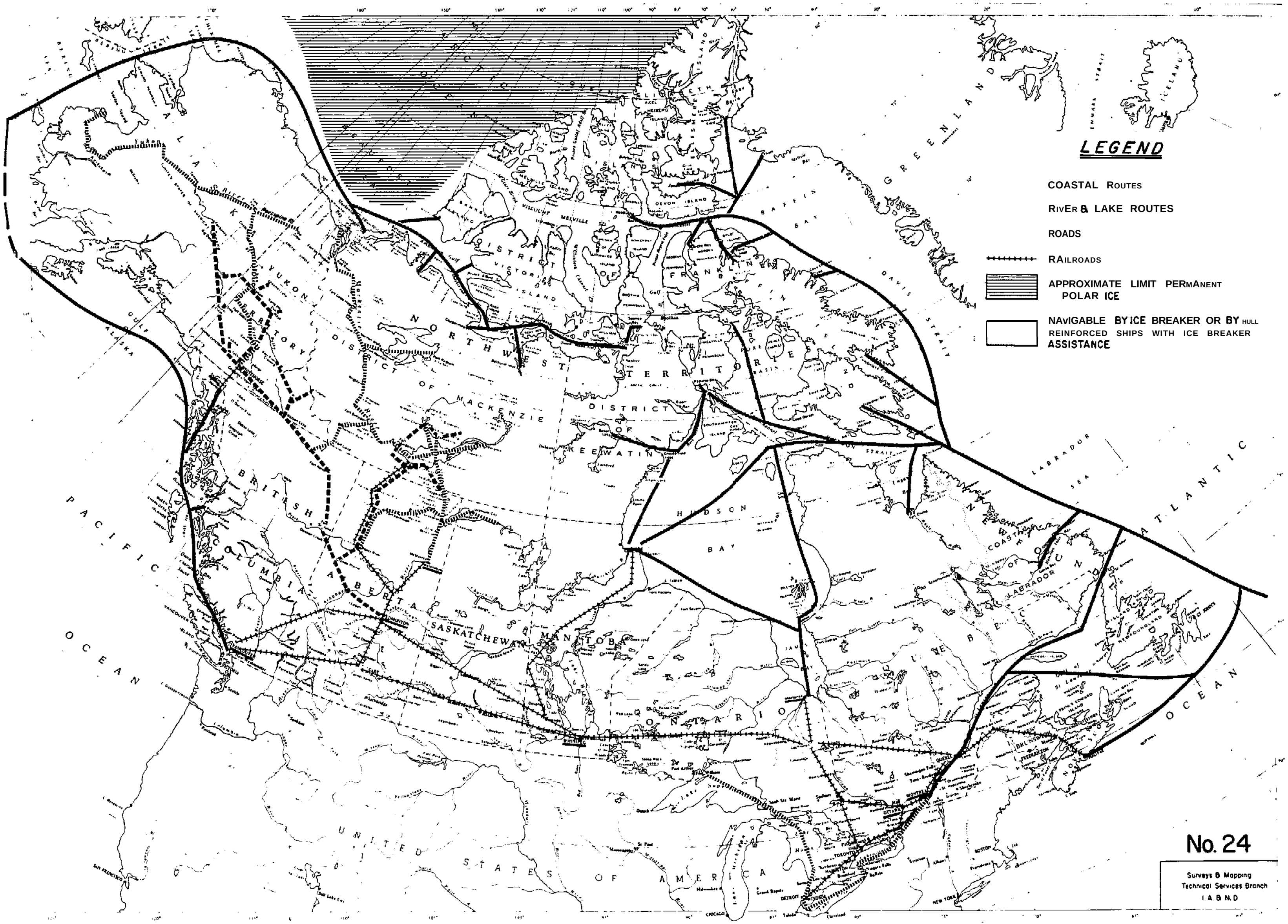
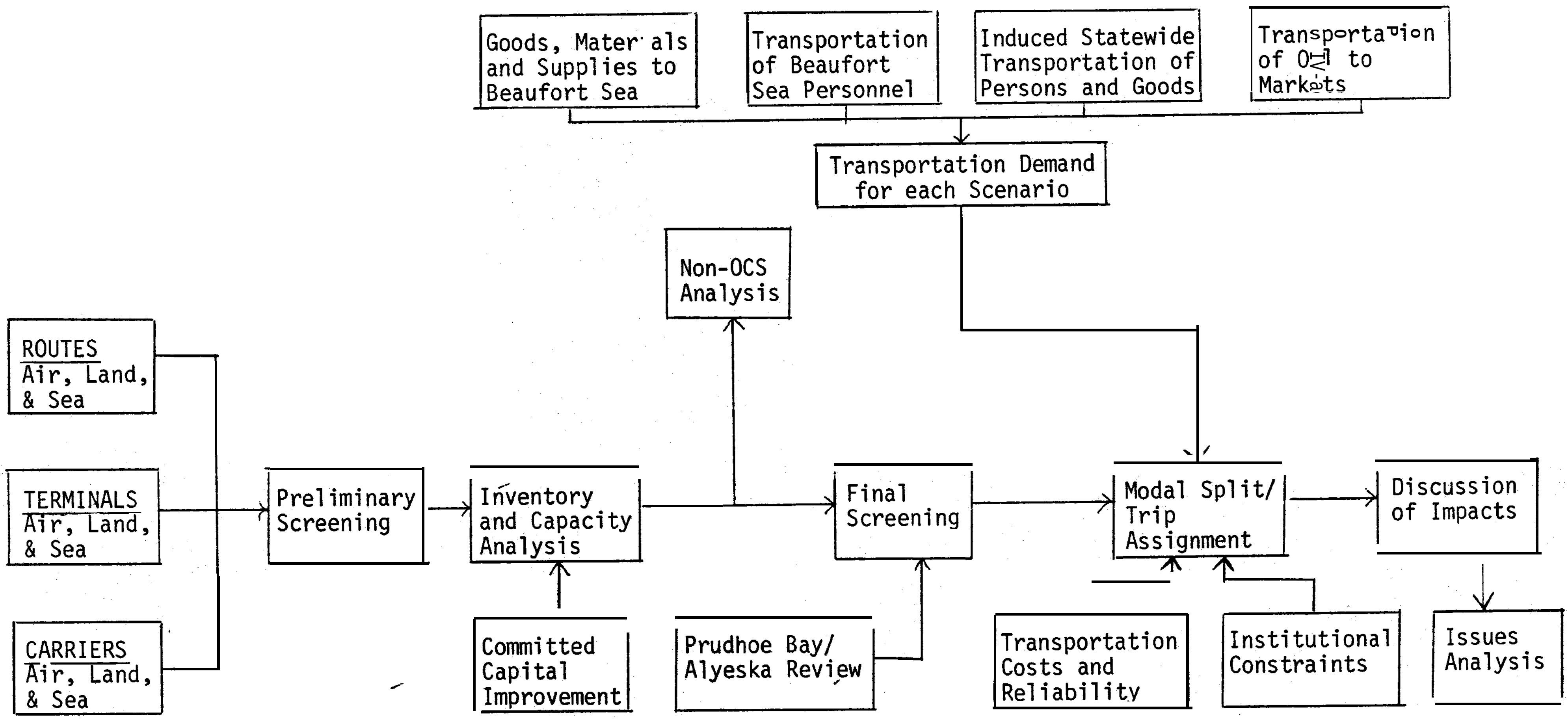


FIGURE 2

SOURCE: CHART NO. 24 IN "NORTH OF 60" - CHARTS, INFORMATION AND ACTIVITY, INDIAN AND NORTHERN AFFAIRS - ONTARIO. CANADA 1973

FIGURE 3

Flow Chart for Beaufort Sea Transportation Impact Analysis



Source: Dennis Dooley and Associates, 1978

The importance of accelerated deterioration or capacity restraint depends principally upon the mode of travel and the design of the system that delivers the service. For intercity highways in Alaska, deterioration considerations usually outweigh those for capacity, particularly for rural sections, while for terminals, the reverse is true. Although accelerated deterioration is self-explanatory, capacity analysis oftentimes is not because of the different contexts that may be used. A distinction is made between service capacities and ultimate capacities. Service capacity is the allowable volume for a given facility and set of operating conditions. For this volume to be exceeded, new operating conditions must be established, and a new service capacity will then exist. New operating conditions that impose time or cost penalties will be less conducive to attracting additional traffic and, thus, introduce a capacity restraint to the system. Ultimate capacity ignores time and cost considerations, and depends only on the facility itself. It represents an unstable flow condition which cannot be maintained for a long period of time and, in fact, can only be reached on rare occasions, if ever. Improvements to facilities can improve either ultimate or service capacities or on occasion both.

The importance of capacity considerations depends upon whether one is discussing routes, terminals, or carriers. For terminals and highway routes, the primary concern is the ultimate capacity of existing facilities. The relationship between existing traffic and ultimate capacity can be relatively low and still justify the construction of fixed facilities. On the other hand, the carriers must operate equipment at relatively high load factors to make operation efficient and, consequently, profitable. Thus, their ability to handle additional traffic using existing equipment is more difficult than for terminals. However, the key question is the ability of carriers to expand their capacity when increased demands occur. The ability to increase capacity usually is easier for carriers than for facilities. In many cases, equipment can be readily leased from other companies or individuals or shifted from other areas of a company's operations. In cases where equipment is specialized or very expensive, a carrier might not be able to meet in timely fashion the change in demand. An uneconomic shift to other modes will then occur until the carrier can acquire additional equipment.

CAPACITY

Volume is generally measured by contents or vehicles per unit time in transportation planning.

- Contents per unit of time. In freight movements, contents can be measured by weight or cubic measures. Because space required per unit weight can vary considerably between commodities, weight measures cannot be used as a consistent measure of capacity; but nevertheless are more widely used. For passenger movements, the problem between weight and volume measures does not exist. The number of passengers has a constant relationship to capacity since the number of seats usually does not change. Load factors, defined as the ratio of volume to capacity, can be established for individual shipments and for various time periods.

- Vehicles per unit of time. This measure depends on a facility's performance characteristics. Careful attention should be given to the use of units of time. For roads and airports, respective capacities for vehicles and plane movements (takeoffs and landings) are based usually on an hour. The relationship between peakhour and longer periods is established through the use of peakhour factors.

The limiting physical characteristics of a system describe an important capacity consideration. Weight restrictions exist for numerous older bridges on the Alaska Railroad, particularly between Anchorage and Fairbanks, and for the state's highway system, particularly during spring freeze/thaw conditions. Aircraft are certified for specified gross takeoff weights. Clearances of bridges and tunnels limit the size of goods that ordinarily could be carried over certain rail and highway lengths.

Each step in Figure 3 is briefly described below:

TRANSPORTATION DEMAND

The analysis of transportation requirements and their consequent impacts will take place for four distinct categories of movements, as follows: (1) movement of equipment, materials, and supplies; (2) movement of on-site (North Slope) employees; (3) movement of induced statewide transportation of goods and persons, and (4) transportation of crude oil to markets. For each category, impacts on appropriate routes, terminals, and carriers are considered.

- Transportation of Equipment, Materials, and Supplies to Beaufort Sea.

  All equipment, materials, and supplies which are needed on the North Slope to explore for, develop, and produce oil fall under this category. In addition to goods produced outside of Alaska, transportation of local materials, supplies, e.g. gravel and water, also are included. For each scenario, the peak demand will be determined by commodity and by year. Commodities will include bulk shipments, such as fuel, drilling mud, and cement; oversized machinery and equipment; housing modules; pipe; construction materials, and miscellaneous.

- Transportation of Beaufort Sea Personnel.

  This category relates to the movement of employees to and from job sites on the North Slope. In cases where ice air fields are constructed, flights directly to job sites are possible. Otherwise, personnel must receive local transportation from primary airports. Included are trips to and from leave stations based on the schedule for crew rotation. For example, drillers work two weeks on followed by one week off.

Because of time considerations, analysis of transportation movements in this category will be limited to the air mode.

- **Induced Statewide Transportation of Goods and Services.** This category includes intercity transportation requirements of the statewide population increase that can be attributed to Beaufort Sea OCS development and in addition the transportation of goods to supply that population. The impacts are based on increased staffing requirements in the petroleum sector of the statewide economy as well as multiplier effects in other sectors of the economy.

- **Transportation of Crude Oil to Markets.** In this category, two options exist, use of the existing TAPS pipeline and an all-water delivery system. Analysis of the TAPS option will focus on shipping activities in the port of Valdez. An all-water delivery system will not be examined in detail because of analyses that indicate adequate pipeline capacity will exist for all scenarios.

TRANSPORTATION SYSTEMS

- **Routes.** In this study, a route is defined as a link or set of links between terminals. Thus, a route comprises only one mode. It is distinguished from a trip, which is the route or routes between an origin and a destination. For example, goods traveling from Seattle by barge to Whittier, then carried to Fairbanks by rail, and finally shipped by truck to Prudue Bay would involve one trip, three routes, and four links as shown on Figure 4. This distinction is necessary so that modal split will not be confused with trip assignment. Each trip to the final destination at Beaufort Sea will generally involve two or three separate modal split decision points.

- Terminals.

  Terminals are trans-shipment points where goods and travelers change from one mode to another.

- Carriers

  For each mode, the ability of common carriers to respond to increasing demands needs to be examined. Data required includes the number of carriers providing appropriate services, extent of their service area, and regulatory and policy constraints under which they operate.

INVENTORY AND CAPACITY ANALYSIS

The capacities of the ports, terminals, and carriers are determined concurrently with the development of inventory data. The use of observed peak flows will complement the use of theoretical analyses. For this study, such figures are particularly useful, because massive

ALTERNATIVE TRANSPORTATION ROUTES FROM U.S. CITIES TO PRUDHOE BAY / BEAUFORT SEA

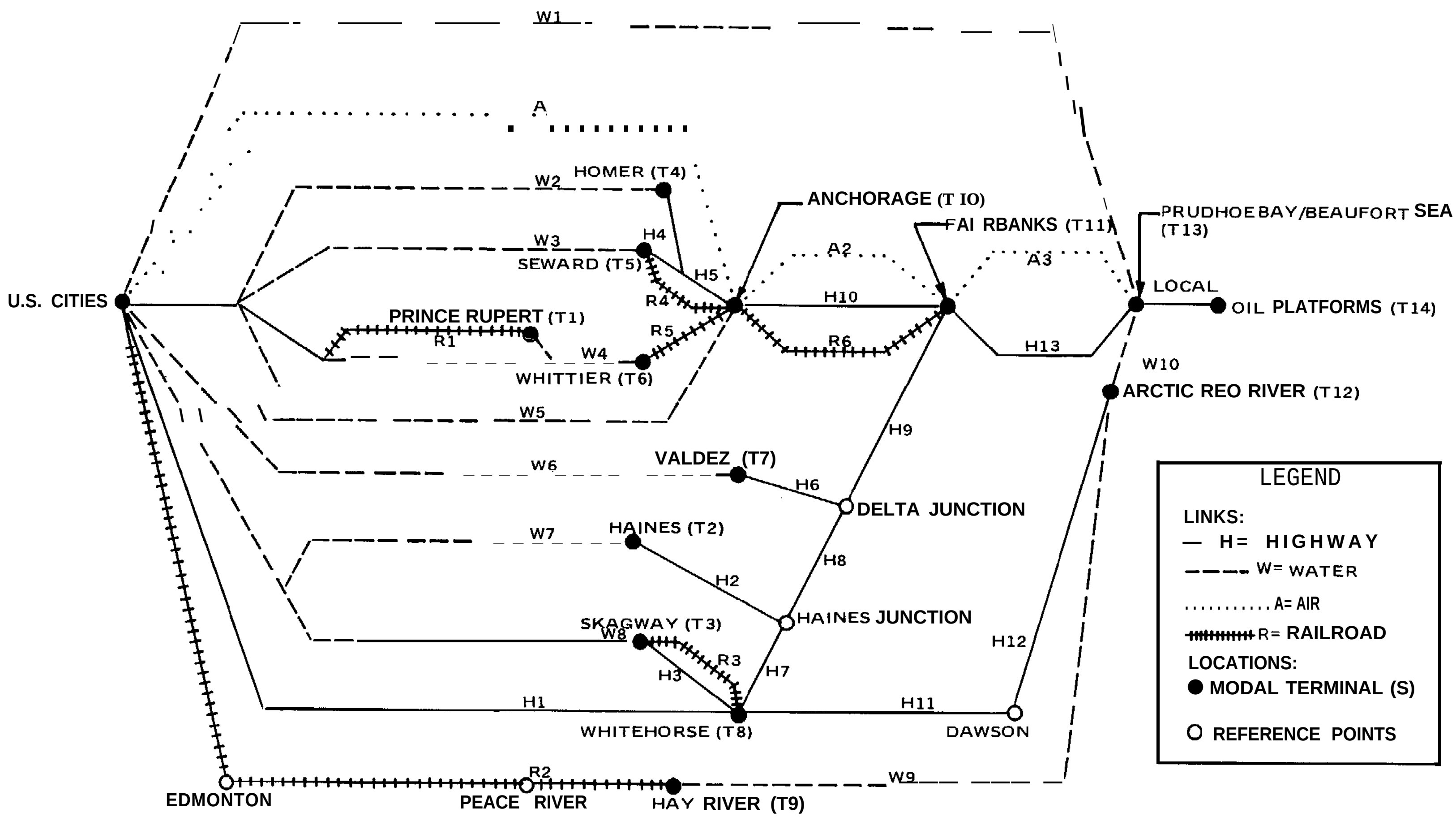


FIGURE 4.

SOURCE: DENNIS DOOLEY AND ASSOCIATES 1978 air and water operations to the North Slope occurred before construction of the Haul Road.

NON-OCS ANALYSIS

Each agency responsible for funding capital improvement projects for transportation makes forecasts of its future needs on a continuing basis. For example, the Municipality of Anchorage has a twenty-year transportation plan, from which it derives annually a six-year implementation plan for each mode. The Alaska Department of Transportation and Public Facilities likewise produces a six-year plan that includes roads, airports, and ferries. The Federal Aviation Administration develops an annual ten-year program. The non-OCS scenario assumes that incremental improvements will occur for all modes to meet normal traffic growth requirements. The non-OCS analysis addresses modes separately and does not consider modal competition, unless it is explicitly considered in the forecast for individual facilities and services. The analysis is basically qualitative in nature because of the lack of data.

SCENARIOS

Five scenarios have been selected for analysis: Camden-Canning, Smith-Dease, Prudhoe-Small, Prudhoe-Large, and Cape Halkett. The scenarios encompass four separate lease sales. Prudhoe-Small and Prudhoe-Large represent different levels of development for the same lease sale. The four categories of transportation demands will be analyzed for each scenario.

MODAL SPLIT AND TRIP ASSIGNMENT

Modal choice decisions are made at terminal locations where change of mode can take place. Trip assignments are the result of successive modal choices made between origin and destination. Specific modal splits will not be forecast for all categories of goods and persons. Instead, a two-step process will be employed. First, all goods which have size or time constraints will be assigned to the mode and route which almost certainly will be utilized. For example, large housing modules certainly will be shipped by an all-water route, and employees will use jets to go to and from Fairbanks and the North Slope. Second, ranges will be established for remaining goods based on modal capacities, source of goods, cost and reliability of transportation services, and institutional constraints.

DISCUSSION OF IMPACTS

The impact analysis wi consider the implications of the modal split and trip assignment task. As indicated earlier, the discussion will center on facility deterioration and capacity restraint.

PRELIMINARY SCREENING OF TRANSPORTATION SYSTEMS

Two screenings of transportation routes and services occur before the final estimation of impacts. A preliminary screening will eliminate from further consideration routes, terminals, and carriers shown on

Figure 4 that have little or no influence on transportation patterns for the developmental activities being studied. Services and facilities that pass this screening will be given a further screening prior to analysis of the four OCS scenarios.

The preliminary screening was based on a review of the following factors: location of routes in relationship to the Beaufort Sea, oil delivery scenarios, seasonal factors, appropriate Federal and State policies, probability of route improvements or new construction up to the year 2000, comparison with logistics requirements for construction of the TransAlaska Pipeline System, the nature of the oil exploration and development industry, and concurrent demands on Alaskan and northern Canadian transportation facilities and services.

- Location of Routes in Relation to Beaufort Sea Lease Sale. The area of the proposed lease sale extends from Point Barrow on the west to Camden Bay on the east. A review of Figures 1 and 2 shows that from strictly a geographical viewpoint, no one surface route has a decided advantage for the entire lease area. The Haul Road is an established land route from the south that intersects the eastern section of the lease sale, while water routes are available from the west and east, via the Bering Straits and the Mackenzie River, respectively. The links that provide convenient access to and along the three main corridors mentioned above have been considered.

Seasonal Factors.

Both the demand for transportation services related to Arctic oil exploration and development and the availability of transportation services show seasonal fluctuations in Alaska. Mater travel to and from the Beaufort Sea depends upon the existence of open water, unless the added expense of ice breaking support equipment is incurred. For highways, winter travel is possible, but bad weather conditions cause delays and increase operating costs. Shippers will seek to overcome the seasonal constraints existing for the various transportation routes to the Beaufort Sea depending upon their demand for services at the time the constraints exist. Available and emerging technologies will enable both offshore exploration and production to occur either during the summer or winter or during both seasons. Since experience with many of the options is limited or nonexistent, the actual mix of operating strategies cannot be accurately forecast at this time. Whatever the actual mix, logistics requirements will show less of a seasonal variation than for onshore exploration activities. The reason for this is that onshore exploration in Arctic regions normally can take place only during the winter months when the tundra is frozen. Seasonal flexibility for the offshore exploration phase will tend to smooth out transportation demand over the years, particularly for the movement of land and air cargo movements. Water transportation, however, will continue to have large seasonal fluctuations because of ice restrictions.

- Oil Delivery Scenarios

Analysis indicates that additional pipelines will not be required, which makes the Beaufort Sea area the final destination for all construction and operational materials. Additional pipelines to augment the capacity of the TransAlaska Pipeline System, should they be required, would significantly increase logistics requirements for Beaufort Sea oil and gas development. Queuing of oil tankers at the Valdez terminal needs to be examined to determine if it might be the critical constraint on the pipeline delivery system. The use of ice-breaking oil tankers remains a possibility; in fact, one study has estimated a per barrel delivery cost of $5.43 by water as compared to requested tariffs for the TransAlaska Pipeline System of over $6.00 (Dames and Moore, 1978). The commitment to provide capabilities for all year shipping to and from the Beaufort Sea would accrue advantages for logistics support for the shore bases and platforms during the production phase of the fields. The normal summer shipping schedule could be extended, with a consequent shift from more expensive land and air travel.

Canada's largest producer of natural gas, Dome Petroleum, Ltd., has made a major commitment to develop oil and gas reserves in the Canadian Beaufort Sea. Without a pipeline to deliver its products to market, it has realized the necessity for eventually developing a year-round, all-water delivery system. Depending on the location of markets, it might maintain traffic lanes west through the Bering Straits or east through the Northwest Passage. As part of its commitment Dome Petroleum is undertaking construction of a $125 million, class 10 -icebreaker, which when built, will be the largest in the world (Business Week, 1978).

Analysis has concentrated on the impacts of goods and passenger movements to the Beaufort Sea. An analysis of the delivery of oil will be done separately and will focus on the tanker handling capacity of the Port of Valdez.

- Federal and State Policies.

Longterm disposition of the Haul Road has not yet been decided upon by the State. Governor Jay Hammond has indicated a desire to have industrial users of the road pay for maintenance costs. The establishment of a toll road north of the Yukon River, would require pay-back of Federal expenses incurred, possibly even the cost of the Yukon River Bridge. The level of maintenance, particularly during the winter, will affect the amount of seasonal traffic. The level of tolls is expected to have a lesser impact on traffic levels. The U.S. Department of Transportation has determined that the Federal Government does not bear any responsibility for damage to the road system produced by truck traffic which was the result of TAPS construction activities (Federal Highway Ad., 1976). This conclusion forces the State to pay more attention to its design philosophy and to enforcement of weight restrictions.

- <u>Comparison with Transportation Impacts of Prudhoe Bay Exploration and TAPS Exploration and Construction</u>

  For early Prudhoe Bay exploration, air service played a key role in meeting logistics requirements. An estimated 340,200 metric tons (375,000 tons) were shipped by air to support North Slope Oil activities between 1968 and October, 1974 when the Haul Road was finally completed (Parker, 1975). For the Beaufort Sea activities, major modal shifts for freight movements will occur from air to both road and barge traffic as compared to movements for Prudhoe Bay. The cause for the shift centers around the existence of the Haul Road and the widespread destinations along approximately 1,125 km. (700 mi.) of coastline in the Beaufort Sea. Also, a modal shift from land to water traffic can be expected because of the absence of intermediate destinations in the case of Beaufort Sea leases. Construction of TAPS produced significant amount of logistics requirements for locations between Prudhoe Bay and Valdez. In addition to intermediate traffic originating outside of Alaska, the movement of gravel from local pits to construction was a significant contributor to impacts and was difficult to monitor by the State (Eakland, 1978d). Finally, the seasonal major transportation demand for Beaufort Sea activities, as previously noted, most likely will differ from those for Prudhoe Bay and TAPS.

- Concurrent Demands on Alaskan and Canadian Transportation Systems.

Construction of the Alcan Gas Line is scheduled to occur between 1979 and 1983. Peak freight movements if this schedule is kept will occur in 1981. During these years, early exploration of the Beaufort Sea Leases is expected. The travel demand during this period will be less than for future years. Gas line construction activity may cause a slight shift from land to other modes for goods destined to the Beaufort Sea. It is not expected to cause delays in the delivery of materials because of adequate alternative routings available and excess capacity.

Oil exploration development is expected to continue in the Canadian portion of the Beaufort Sea, although at a lower level than if the Arctic Gas Proposal had been approved. Arctic Gas had. proposed to build a gas line east from Prudhoe Bay to the Mackenzie River, and then south along that corridor. Canadian and U.S. activities forecast for the Beaufort Sea are expected to produce increased utilization of water travel via the Mackenzie River and the Bering Straits. On the other hand, similarity of operations will ease logistics difficulties by creating the opportunity for joint use of drilling and supply equipment and by providing an economy 'of scale that will tend to increase competition among shippers.

- Transportation construction activities likely to occur before 2000.

  Except for the Dempster Highway and the Skagway-Carcross Road no new land transportation facilities have been considered. Numerous proposals currently exist for new projects. However, feasibility has not been firmly established as yet for any of them. Even if a decision were made to construct any of the projects during the next few years, their magnitude would preclude their completion in time to significantly impact established routings of goods movements to the Beaufort Sea. Proposed improvements to terminals will be treated in the later discussion of capacity for existing systems.

  The most conspicuous proposals are discussed below:

  -- Copper River Highway. The Alaska Department of Transportation and Public Facilities is scheduled to finish by October, 1978 a multi-modal transportation study of Prince William Sound. Until its completion, the State has been unable to improve sections of the Copper River Highway beyond Mile Post 52.

Emergency replacement funds can be used for reconstruction up to this point; but beyond, regular apportionments of Federal Air Highway Funds must be used. If further construction does occur, the most likely project is a new alignment beyond Mile 80 to connect with the Richardson Highway at Tonsina. The costs of the entire project were estimated in the 1974 Alaska Department of Highways Five-Year Plan to be $37,000,000. The current costs would be considerably higher. Even if a road link is eventually established between Cordova and the Richardson Highway, the additional land mileage and the superiority of terminal facilities at Valdez will limit the amount of traffic dest· ned for the interior of Alaska which would shift from Valdez to Cordova.

-- Railroad Link Between Canada and Alaska. The possibility of constructing a rail link between Canada and Alaska has been discussed for several decades, and the proponents have in recent years strengthened their arguments. The British Columbia Government has extended its rail system as far as Dease Lake, and known mineral deposits exist in the Yukon which could be commercially attractive if nearby rail transportation were available. The Alaska Legislature in 1976 appropriated $50,000 to study the feasibility of the project and a year later appropriated $850,000 to perform a local survey. The State is seeking additional funds from interested agencies in Canada and the U.S. to perform a detailed cost-benefit study. For the project to go ahead, funding commitments would have to be secured from the Canadian and U.S. Governments. In the absence of such commitments and detailed studies, prospects for implementation cannot be considered imminent at this time.

-- Additional North Slope Transportation Projects. At the present, no Federal-Aid routes exist in the vicinity of the Beaufort Sea Lease with the exception of the Haul Road. The North Slope Borough has officially supported the philosophy of the State emphasizing improvements to roads within existing cities and villages before spending large sums of money on new intervillage roads. The North Slope Borough's efforts in intervillage travel will focus on the air mode. Efforts are already underway to enable it to directly receive FAA funding for airport planning and construction.

- Nature of the Oil Industry.

Oil exploration and development are highly capital insensitive activities. Large investments in drill rigs and platforms require that they be in use as much as possible. The oil companies strive to move oil to markets as soon as possible so that they can begin recovering the large sums invested in exploration and production facilities unless market prices are depressed. Should capacity restraints exist on preferred routings, oil companies would be willing to shift to secondary routes, even if costs for these routes were higher. The additional transportation costs generally are considerably less than losses that would result from having equipment idle.

o Technology.

The analysis of transportation impacts on Beaufort Sea oil exploration development assumes that no major technological breakthroughs in the area of transportation will exist that will make one mode dominant. Although several concepts exist on drawing boards that would substantially increase the utilization of water travel, these concepts must wait until they have been proven through extensive research and development. The Berger Inquiry into socioeconomic and environmental impacts for the Mackenzie Valley pipeline recognized the inability to predict various kinds of impacts because of the lack of adequate research related to Arctic activities. It is proposed that such research be conducted as soon as possible through a joint effort of nations engaged in development of Arctic Resources. "Canada should propose that research be undertaken jointly by the circumpolar powers into the risks and consequences of oil. and gas exploration, development and transportation activities around the Arctic Ocean (Berger, 1977)."

RESULTS OF PRELIMINARY SCREENING

The results of the preliminary screening are shown in Figure 4. The following is a listing of links and terminals remaining after the preliminary screening

Water Links

W1 - U. S. ports to Prudhoe Bay/BeaufortSea (T13).
Using ocean-going tugs and barges.

W2 - U. S. ports to Homer (T4).

W3 - U. S. ports to Seward (T5).

W4 - U. S. ports and Prince Rupert to Whittier (T6).
By ships/barges carrying rail cars.

W5 - U. S. ports to Anchorage (TIO).

W6 - U. S. ports to Valdez (T7).

W7 - U. S. ports to Haines (T2).

W8 - U. S. ports to Skagway (T3).

W9 - From headwaters of Mackenzie River, specifically Hay River (T9) on Great Slave Lake, to Mackenzie Delta.

W10 - Mackenzie Delta to local destinations.

Air Links

Al - U. S. cities to Anchorage.

A2 - Anchorage to Fairbanks.

A3 - Fairbanks to Prudhoe Bay, which includes airports at Barrow, Deadhorse, Nuiqsut, and Kaktovik.

Rail Links

R1 - Canadian National Railroad to Prince Rupert.

R2 - Northern Alberta and Great Slave Railroads to Hay River (T9).

R3 - Yukon and White Pass Railroad (narrow-gauge) from Skagway to Whitehead (T8).

R4 - Alaska Railroad from Seward (T5) to Anchorage (TIO).

R5 - Alaska Railroad from Whittier (T6) to Anchorage (TIO).

Highway Links

H1 - U. S. cities to Whitehorse via Alaska Highway.

H2 - Haines cut-off from Haines (T2) to Haines Junction.

H3 - Road from Skagway (T3) to Whitehorse (T8).

H4 - Sterling Highway from Homer (T4) to Seward Highway.

H5 - Seward Highway from Seward to Anchorage.

H6 - Richardson Highway from Valdez (T7) to Delta Junction.

H7 - Alaska Highway from Whitehorse to Haines Junction.

H8 - Alaska Highway from Haines Junction to Delta Junction.

H9 - Richardson Highway from Delta Junction to Fairbanks (T11).

H10 - Parks Highway from Anchorage to Fairbanks (T11).

H11 - Klondike Highway from Whitehorse to Dawson.

H12 - Dempster Highway from Dawson to N. W. Territories.

H13 - Prudhoe Bay Highway from Fairbanks to Prudhoe Bay.

Terminals

T1 - Prince Rupert. Intermodal terminal shipping rail cars by barge.

T2 - Haines. Port handling marine highway system traffic and bulk cargo.

T3 - Skagway. Port handling marine highway system traffic and goods to be shipped on railroad.

T4 - Homer. Port handling general cargo.

T5 - Seward. Port handling bulk cargo.

T6 - Whittier. Port handling transfer of rainl cars from sea to land and vice versa.

T7 - Valdez. Ports handling oil tanker traffic and general cargo.

T8 - Whitehorse. Rail terminal.

T9 - Hay River. Terminal moving rail and highway traffic to inland water barge.

TIO - Anchorage. Anchorage International Airport and the Port of Anchorage, which has a POL facility as well as terminals for the handling of containers and roll-on/roll-off trailers.

T11 - Fairbanks. Fairbanks International Airport and rail yards.

T12 - Arctic Red River. Included are nearby N. W. Territory villages of Fort McPherson and Inuvik.

T13 - Prudhoe Bay/Beaufort Sea. Airports at Prudhoe Bay and causeways for tie-up of barges.

T14 - Oil platforms and supply camps (T14). Gravel or ice strips for airplanes. Docks for offshore platforms and artificial islands. No facilities required for lightening.

II. DESCRIPTION OF EXISTING SYSTEMS

Introduction

Evaluation of impacts upon the existing infrastructure during the period 1977-2000 in the absence of Beaufort OCS activity is necessary to determine if additional improvements will be necessary to accommodate additional traffic. Current commitments for oil and gas and mineral developments are part of the scenario, including Prudhoe Bay and nearby fields, upper Cook Inlet, northern Gulf of Alaska OCS, and lower Cook Inlet OCS. The status of existing systems is described in this chapter, and the information will be the baseline for study of the non-OCS and OCS scenarios.

The Alcan Gas Pipeline is the one major construction project to be included in the non-OCS scenario The scheduled project duration for this project is 1979 to 1983. The ability of each statewide mode to handle forecast activities dur ng the period 1977-2000 will be studied separately. Statewide routes and terminals to be studied are those that evolved out of the preliminary screening. For each mode, general information is provided about routes, terminals, and carriers.

Existing Transportation Systems

HIGHWAY MODE

Routes

A total of 13 intercity road links are being studied. Six are exclusively in Alaska, four exclusively in Canada, and the remaining three are in both Canada and Alaska. Table 1 provides general information about the links. Figure 5 shows the location of the Prudhoe Bay Highway, of which the North Slope Haul Road is a segment.

Route Capacity. Route capacities are best described by service volumes, which represent the maximum number of vehicles that can pass a road section in a specified period of time under operating conditions maintained given level of service (Highway Research Board, 1965). Emperical studies have been used to establish criteria for levels of service A through F, which indicate the stability level of the traffic flow. Level of service A is uninterrupted free flow, B and C stable flow, D and E unstable flow, and F forced flow. Decreasing stability is accompanied by lower average operating speeds. The ultimate capacity in both directions of a rural, two-lane highway under ideal physical and traffic conditions is 2,000 passenger cars per hour (Highway Research Board, 1965). This situation would occur at level of service E and an approximate operating speed of 48 km. per hour (30 mi. per hour). Higher levels of service and less than ideal operating conditions make the service volume considerably less than 2,000 vehicles per hour. For level of service C, which is the usual design standard, the service volume is 47% of capacity, or 940 passenger cars per hour in both directions.

The service volume of a given section of a two-lane, rural highway can be computed by using factors that consider the following physical and

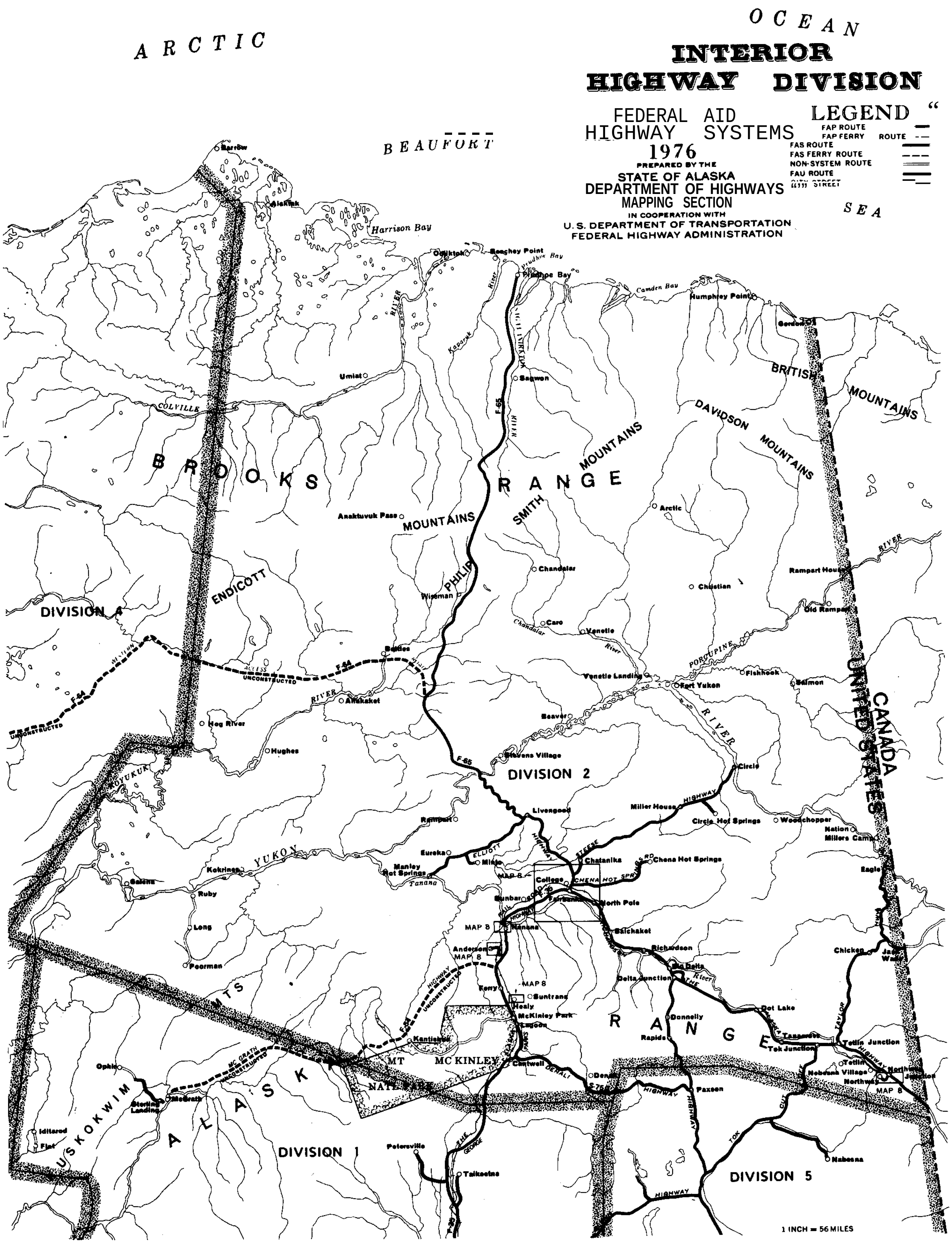


FIGURE 5

SOURCE: ALASKA DEPARTMENT OF HIGHWAYS, 1976

TABLE 1

DESCRIPTION OF ROAD LINKS STUDIED

Road Links	Federal-Aid System (System Designation)	Common Name	Termini		Surface Type	Length
H1	Yukon Territory Highway 1	Alaska Hwy.	--	Whitehorse	Gravel	--
H2	Yukon Territory Highway 4/B. C./ Primary (FAP-95)	Haines Hwy.	Haines	Haines Junction	Canadian: Gravel (to be paved) Alaskan: Paved	Canadian: 185 km (115 mi) Alaskan: 71 km (44 mi)
H3	Primary (FAP-97)	Skagway-Carcross Rd. (to be completed 1978)	Skagway	Whitehorse	Gravel	Canadian: 136 km (84 mi) Alaskan: 24 km (15 mi)
H4	Primary (FAP-21)	Sterling Highway	Homer	Jct. with Seward Highway	Paved	224 km (139 mi)
H5	Primary (FAP-31) Urban (FAU-545)	Seward Hwy. 5th-6th Aves.	Seward	Anchorage	Paved	Primary: 195 km (121 mi) Urban: 11 km (7 mi)
H6	Primary (FAP-71)	Richardson Highway	Valdez	Delta Junction	Paved	436 km (271 mi)
H7	Yukon Territory Highway 1	Alaska Hwy.	Whitehorse	Haines Junction	Gravel	158 km (98 mi)

TABLE 1 - CONTINUED

DESCRIPTION OF ROAD LINKS STUDIED

Road Links	Federal-Aid system (system Designation)	Common Name	Termini		Surface Type	Length
H8	Yukon Territory Highway l/B. C./ Primary (FAP-62)	Alaska Hwy.	Haines Junction	Delta Junction	Canadian: Gravel (to be paved) Alaskan: Paved	Canadian: 331 km (206 mi) Alaskan: 323 km (201 mi)
H9	Primary (FAP-62)	Richardson Highway	Delta Junction	Fairbanks	Paved	155 km (96 mi)
H10	'Primary (FAP-42 and FAP-35)	Glennallen/ Parks Hwy.	Anchorage	Fairbanks	Paved	580 km (360 mi)
H11	Yukon Territory	Klondike Highway	Whitehorse	Dawson	Gravel	538 km (334 mi)
H12	Yukon Territory Highway 11	Dempster Highway (under construction)	Dawson	Inuvik	Gravel	671 km (417 mi)
H13	Primary (FAP-65)	Prudhoe Bay Highway (Steese/ Elliott/ North Slope Haul Road)	Fairbanks	Prudhoe Bay	Paved to approx. 20 miles from Fairbanks, otherwise gravel	813 km (505 mi)

Source: Alaska Department of Transportation and Public Facilities. 1977. 1976 annual traffic volume report, and The Milepost. 1978. Alaska Northwest Publishing Co.

TABLE 2

1976 Traffic Information for Locations of Permanent Counters

Highway Link	Recorder Location (No.)	30th Highest Hour(1)	AADT(2)	PHF(3)	MADT/AADT RATIO Low (Me.) - High (Me.)	Summer % Trucks & Buses	Year 2000 DHV @ 4% Annual Growth(2)(4)
H4	142 km (88 mi) no. of Homer (F-1-21)	320	2,155	0.15	0.55(Jan) - 1.47(Jul)	8.4	820 (5)
H4	69 km (43 mi) no. of Homer (F-2-21)	281	1,285	0.22	0.52(Jan) - 1.69(Jul)	4.6	720 (5)
H5	47 km (29 mi) no. of Seward (F-3-31)	157	771	0.20	0.50(Jan) - 1.74(Aug)	7.3	402
H5	92 km (57 mi) no. of Seward (F-2-31)	298	1,552	0.19	0.40(Jan) - 1.99(Jul)	12.4	764 (5)
H10	126 km (78 mi) no. of Anchorage (F-2-35)	252	1,077	0.23	0.52(Dec) - 2.10(Aug)	9.6	646
H10	311 km (193 mi) no. of Anchorage (F-3-35)	77	452	0.17	0.57(Dec) - 1.69(Jul)	12.0	197
H10	502 km (312 mi) no. of Anchorage (F-3-37)	93	789	0.12	0.66(Dec) - 1.33(Jul)	14.2	238
H8	274 km (170 mi) so. of Delta Junction (F-1-62)	49	292	0.17	0.55(Dec) - 1.82(Jul)	6.7	126
H9	66 km (41 mi) no. of Delta Junction (F-2-62)	85	595	0.29	0.65(Dec) - 1.44(Jul)	10.7	218
H13	11 km (7 mi) no. of Fairbanks (F-5-62)	303	2,429	0.12	0.55(Dec) - 1.39(Jun)	19.7	777 (5)

figure with forecast traffic growth will provide an adequate assessment of which links will be most likely to experience capacity problems during the study period. It takes into account the fact that the state's Capital Improvement Program will emphasize improvements to the existing primary road system, including those items that will increase capacity, such as widening lanes, paving shoulders, and improving alignments. Capacities obviously will vary according to major individual road sections, daily and seasonal variations, the source of congestion, and the area congested.

Table 2 contains traffic data from representative fixed traffic reporters of links being studied (Alaska Department of Highways, 1976). Data from stations close to population centers have not been included. The ratios of monthly average daily traffic to annual average daily traffic indicate the significant seasonal variations that occur on Alaska's intercity road system. Traffic during winter months at most locations is only one-half of the annual average. During the summer months, recreational travel increases for both Alaskan and out-of-state visitors, causing monthly traffic figures to increase to as much as double the average value. The relatively high percentage for trucks and buses was a result of final stages of pipeline construction but will be representative of the Alcan construction period. A high percentageiof camper vehicles, which in some locations even exceeds the percentage of trucks and buses, has a negative impact on capacity because of the vehicles' size and inability to ascend grades as well as passenger vehicles. The Highway

Capacity Manual (1965) at present does not consider the impact of these vehicles on capacity.

Clearance Restrictions. For travel on public roadways, over-size permits must be obtained if the width of a vehicle or its cargo is greater than 2.4 meters (eight feet) or the height from the ground is greater than 4.1 meters (13’6”). For loads wider than 3.1 meters (10 feet), pilot cars must be used. Several through-truss bridges exist on primary state routes and have clearances as low as 4.4 meters (14’6”). They are being-replaced as part of reconstruction projects. The arched ceiling of the Keystone Tunnel has vertical clearances ranging from 5.1 meters (16’7”) in the center to 3.4 meters (11’3”) at the outer edge of the road surface, but a project initiated in 1978 will provide for a tunnel bypass route. Clearance restrictions are assumed not to be a problem in future goods movements.

Accelerated Deterioration. The condition of Alaska’s highways deteriorated significantly during the construction of the TransAlaska Pipeline. Structual failures resulted from a combination of two factors: (1) loading during periods of normal subsurface conditions, and (2) loadings during freeze-thaw conditions when the loading capacity of the road is substantially diminished. Adequate attention to the type and number of trucks in pavement design will address the first factor. Design can assist in addressing the second factor, but more important is an effective monitoring of road conditions and enforcement of load limits during spring breakup.

The state of Alaska in 1976 requested the federal government to provide a total of $300 million of pipeline impact funds so that the state road system could be reconstructed. Of this amount, $70 million was requested for immediate use. In addition to resurfacing, the state desired to improve cross sections and alignments on roads that had been inherited from the Bureau of Public Roads at the time of statehood in 1959. The principal argument advanced by the state was that the construction of the pipeline served a national interest; and, consequently, the federal government should bear responsibility for damages incurred. Congress did not appropriate any of the additional construction funds requested but did agree to study the question of state versus federal liability. The resulting "Alaska Roads Study," which was prepared by the Federal Highway Administration (1976), determined that damage, indeed, had occurred to the Alaska road system as a result of pipeline construction, but that the federal government was not liable for any of the damage. The incremental damage estimated to be caused by pipeline traffic was $49 million. The study cited three reasons why the state must bear sole responsibility for repairing damaged roads.

- State of Alaska Comments on Pipeline EIS. The Department of Highways stated that long-range revenues would far outweigh short-term expenses of maintenance and reconstruction due to pipeline activities.

- Pipeline Legislation. The intent of Congress in the Trans-Alaska Pipeline Act, 1973 was that the federal government should not be held liable for damages related to pipeline construction, although roads are not specifically mentioned.

- State Stewardship of Highways. The state, in accepting federal highway funds, agrees to act as the steward of the funds and of the facilities that are built. The state has the responsibility to plan for, design, and construct roads and to develop regulations for their use.

For future development activities, the first two reasons will have little or no bearing. The state will be wary of making statements that imply assumption of negative impacts, and federal legislation for specific projects will probably be unnecessary. Now aware of the federal outlook on impacts of energy-related development activities, the state must move decisively to fulfill its stewardship responsibilities in design and enforcement.

During the past year in the state of Alaska, procedures have been developed for rational design of flexible pavement surfaces. Equivalent axle loads are compiled from scalehouse data, and a traffic index has been computed which provides for specific pavement thickness. Contrary to past practices, when standard thicknesses of 3.8 to 5.1 cm. (1-1/2 to 2 in.) were specified for all projects, traffic loading characteristics are now being directly utilized in design. For Tudor Road, a heavily traveled arterial road in Anchorage, pavement depth was increased from the original design depth of 3.8 cm. (1-1/2 in.) to 11.4 cm. (4-1/2 in.) after use of rational design techniques. The new design procedures have not as yet been implemented for all projects because of the large additional costs that will eventually be required.

Terminals

Terminals will be mentioned in the discussion for" other modes. Local motor freight terminals, which are now used for change-of-mode operations, are primarily privately-owned warehouse facilities that are used for local distribution. Such facilities are not of primary interest in this study.

Carriers

Common motor carriers engaged in the business of transporting goods for compensation over public streets, roads, and highways in the state of Alaska must have permits issued by the Alaska Transportation Commission (ATC). Each permit issued contains a scope of operating authority related to both commodities authorized to be transported and points which, or areas within which, services are authorized. Five operating zones, which are defined in regulations promulgated by the ATC (see Alaska Administrative Code, 3AAC 64.530), serve as the principal guidelines for defining areas of operating authority. Table 3 relates the principal Alaskan cities to these operating zones.

TABLE 3

Operating Zone	Title	Representative Cities/Areas
1	Southeastern Alaska	Haines, Skagway, Juneau, Ketchikan
2A	Northwestern Alaska	Western North Slope, Barrow, Nome, Kotzebue
2B	Southwestern Alaska	Bethel, Dillingham
3	Kenai Peninsula	Seward, Whittier, Homer
4	North Central Alaska	Fairbanks, Barrow, North Slope
5	South Central Alaska	
5A	Valdez Subzone	Valdez, Cordova
5B	Anchorage Subzone	Anchorage
8	Kodiak-Afognak	Kodiak

Source: Alaska Transportation Commission. 1978. Scopebook directory, Motor Carrier Operating Authority. Anchorage.

Cities have been underlined which provide terminals on highway links being studied or which are in the North Slope region. ATC regulations for motor carriers, including the zonal structure, have several implications for land movement of goods to the Beaufort Sea for OCS activities.

- All zones to varying degrees except 2B and 8 will potentially carry traffic destined for the Beaufort Sea.
- Fairbanks, the North Slope haul road, and the entire Beaufort Sea coastline are all within operating zone 4. The western border of zone 4 is Barrow, which specifically is included as

part of both zones 2A and 4. The boundary creates two operating-zones for the North Slope borough. This situation does not create any problems currently because of the lack of intervillage routes and is not expected to change during the study period.

- The ATC'S responsibilities vis-à-vis the haul road will not change once it is officially turned over to the state. The ATC requires an operating authority if any portion of a freight hauling trip is over a public highway. Thus, all carriers currently using the haul road have been subject to ATC regulations since public roads are used to reach it.
- Carriers utilizing the marine highway system are subject to ATC regulations as if a public land highway was being traveled.

Review of active common motor carrier certificates shows that adequate competition exists for all types of commodities and for all trip end pairs (Alaska Transportation Commission, 1978). If anything, there is perhaps too much competition at the present time. The certificates do not place any restrictions on the quantity of service that can be offered. Companies' service capacity is limited only in their ability to finance the purchase of new equipment or to acquire new equipment through lease arrangements, usually from owner-operators. Operating philosophies of the major freight hauling companies differ markedly. Sealand prefers leasing, while Weaver Brothers is going exclusively to company-owned equipment (Todd, 1978).

A down-turn in motor freight demand occurred after oil pipeline construction and may last several years until construction of the gas line commences. Despite several bankruptcies which have occurred recently, the number of operating authorities will remain constant, and the industry appears to possess the resources to expand as demand requires.

RAIL MODE

Two railroads operate in the state of Alaska, namely the Yukon and White Pass Railway and the Alaska Railroad. Neither are connected to other lines. Both rely on water shipments from west coast ports to provide freight for trans-shipment to interior destinations. The railroads will be discussed separately, since their operations are unrelated and serve different markets.

Yukon and White Pass Railroad

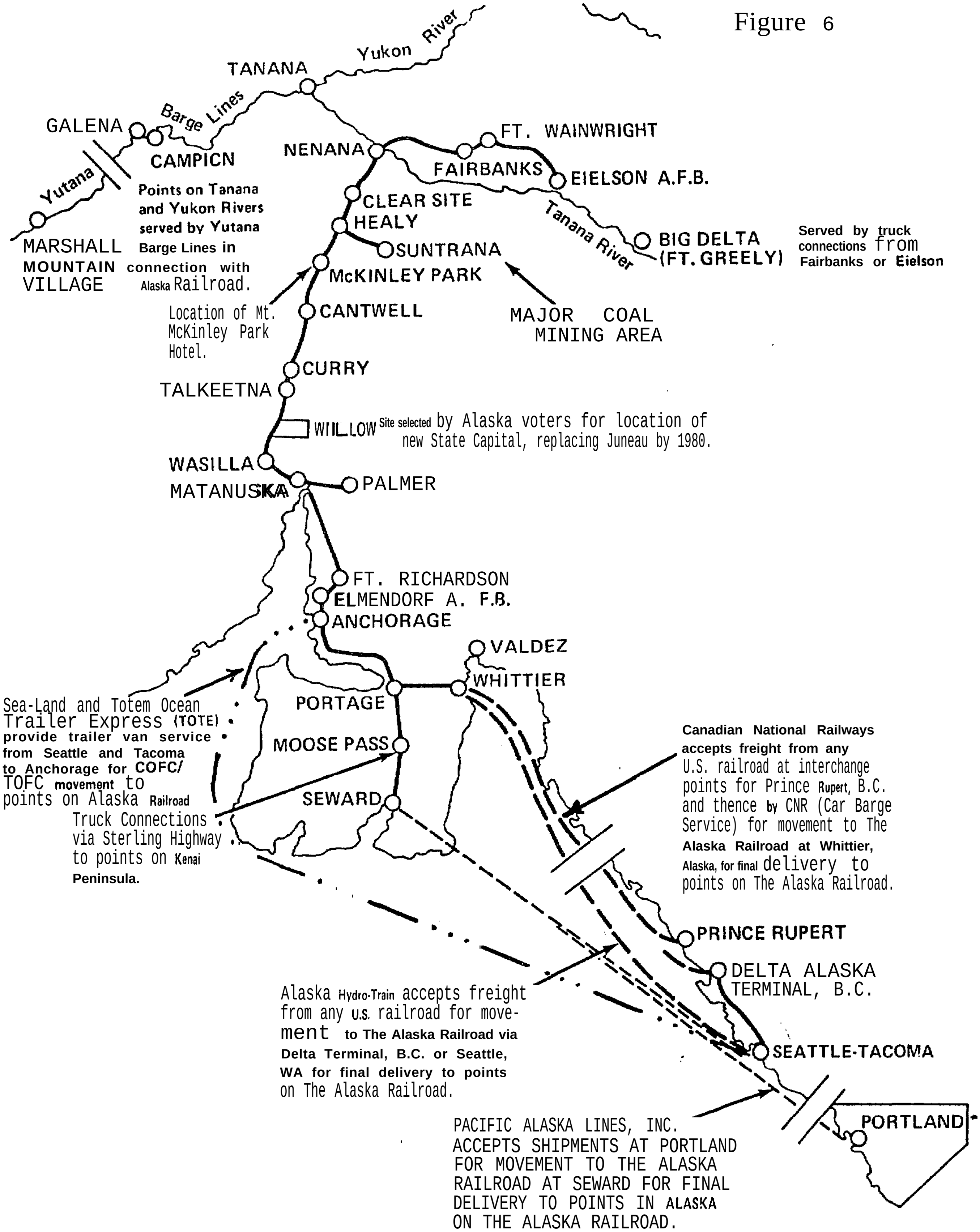
Built in the 1890's during the Klondike gold rush, the Yukon and White Pass Railroad is a privately-owned, narrow-gauge operation connecting the cities of Skagway, Alaska and Whitehorse in the Yukon Territory, which are approximately 161 km. (100 mi.) apart. Its principal source of revenue is hauling ore concentrate that originates at the Cyprus/Anvil Mine in Fare. Trucks carry the ore to Whitehorse, and the railroad then delivers it to port facilities in Skagway. Traffic in the opposite direction includes a substantial percentage of bulk commodities required by Whitehorse. Being an integrated transportation company, the railroad operates a container ship from Vancouver to Skagway.

The railroad has been little used for shipments destined for Alaska. Its short length offers no compensating advantage for the additional change of mode that must occur. Shippers instead have either chosen to drive the entire distance of the Alaska Highway or take a water route as far as Haines and then use the road system.

Alaska Railroad

Routes. The Alaska Railroad is operated by the Federal Railroad Administration. It has a mandate to generate internally its operating expenses, but has in recent years received federal assistance for capital improvements. The 756 km. (470-mi.) system has three single main line lengths. Two connect the ports of Whittier and Seward to Anchorage, and the third links Anchorage with Fairbanks (See Figure 6). From the point of view of Beaufort Sea OCS activities, the system can be viewed as providing Fairbanks with access to three ports--Anchorage, Whittier, and Seward. The differences in mileage from Fairbanks to each of the three ports is insufficient to make the intra-Alaska travel times and tariffs a dominant factor in choosing a port of entry. The choice depends upon whether goods are to be shipped by rail car, container or break-bulk. Whittier, where the railroad operates a roll-on/roll-off rail car facility, has a decided advantage in handling bulk freight but is limited to rail cars. Anchorage, on the other hand, is well equipped to handle containers. Seward offers the advantage of large staging areas if they are needed and adequate transfer facilities for break-bulk cargo.

Figure 6



Source: Alaska Railroad, 1978,

Capacity. During 1976, which was the railroad's peak year of activity, it handled approximately 50,000 car loads of freight (Eakland, 1978e). The railroad estimates that it could comfortably handle as many as 75,000 long haul car loads, which would be an increase of 50% over the 1976 figure, without acquiring additional equipment (Eakland, 1978e).

Capacity constraints exist on the water link of freight movements, particularly for rainl car shipments to Whittier. Delays rarely occur once freight has arrived in Alaska. Unlike the Yukon and White Pass Railroad, the railroad does not have the advantage of operating its own ships. During the TAPS project limitations were imposed upon the marine leg for rail cars. This was primarily due to the fact that Crowley Maritime Corp. diverted a few of its barges from handling rail cars to support the Arctic Sea-Lift operation to Prudhoe Bay.

Presently, new traffic, such as gravel and forest products, produces shorter hauls than traffic which is being lost. Figure 7 portrays the impact of this trend on revenue tons and revenue ton miles.

WATERBORNE MODE

The disparate types of waterborne transportation services that can move goods directly or indirectly to Alaskan destinations require separate discussions. A division into four general route structures, as follows, has been established: (1) Southeast Alaska; (2) Cook Inlet and Prince William Sound; (3) all-water services to the North Slope via the Bering Straits, and (4) the Mackenzie River corridor. Table 4 contains a

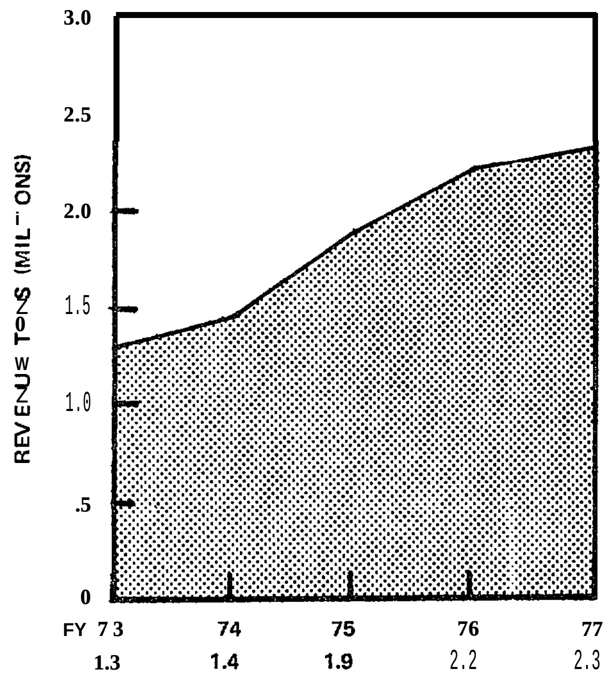


FIGURE : REVENUE TONS CARRIED

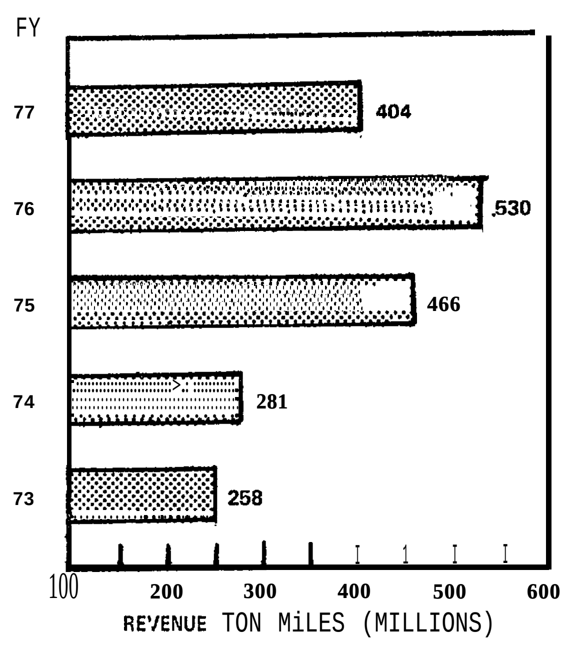


FIGURE : REVENUE TON MILES

Source: Alaska Railroad, 1978.

summary of characteristics for applicable Alaskan ports. Table 5 provides information about road mileages from these ports to Prudhoe Bay.

The relationship between routes, terminals, and carriers for water transportation deserves a brief discussion, because it relates to transportation impacts. Unlike land transportation, where routes beget terminals, in water transportation the converse is true. And unlike land transportation, whose carriers for the most part use similar equipment, water carriers gain competitive advantages by employing specialized equipment designed to maximize the efficiency of handling certain types of goods and/or overcoming given operating conditions. Carriers must be sure that their specialized equipment matches up with port facilities at both origin and destination. Therefore, in the discussions that follow terminals and carriers will be discussed together because of their interrelationship.

Southeast (Haines and Skagway)

Carriers and Terminals. The movement of freight in southeast Alaska consists of two basic systems--a state-operated marine highway system and private barge operators. Foss Alaska is the principal barge operator and maintains its northern base of operations in Juneau, where a container handling facility has been installed. Cargo destined for Haines or Skagway is removed from Foss Alaska barges in Juneau, placed on a wheeled carriage, and then loaded on the marine highway ferry for transit of the remaining distance. Sufficient demand does not currently

TABLE 4

COMPARISON OF ALASKAN PORT AREAS

	PRIMARY PORTS		SECONDARY PORTS			
	Anchorage	Valdez	Whittier	Seward	Haines	Skagway
Deep water harbor	Yes	Yes	Yes	Yes	Yes	Yes
Ice-free year-round	Partly[1]	Yes	Yes	Yes	Yes	Yes
Capable of handling:						
U. S. origin traffic	Yes	Yes	Yes	Yes	Yes	Limited
Break-bulk cargo	Yes	Yes	Yes	Yes	Yes	Yes
Containerized cargo	Yes	No[2]	No[2]	No[2]	No[2]	Yes
Roll-on/roll-off	No	Yes	Yes.	No	No	No
Overland routing options:						
Highway	Yes	Yes	No	Yes	Yes	No
Rail	Yes[3]	No	Yes[3]	Yes[3]	No	Yes[4]
Miles from:						
Glennallen	189	119	2515,	314	665	714[6]
Delta Junction	341	271	#35)	466	634	683[6]
Fairbanks	359	367	421[5]	484	730	779[6]

1) For Sea-Land containerships, not for standard ships or barges.

2) /Vat efficiently in volume; in moderate amounts only.

3) To Fairbanks.

4) To Whitehorse.

5) Rail to Anchorage, then highway mileage.

6) Rail to Whitehorse, then highwa y mileage.

NOTE: *Lift capacities are not included in the comparison because of difficulties of comparability and relative ease of obtaining additional capacity if required.*

Source: Survey of Alaskan Ports and Highways, by Bechtel for Alyeska Pipeline Service Co. , July/August 1974.

TABLE 5

ROAD MILEAGES TO PRUDHOE BAY
VIA NORTH SLOPE HAUL ROAD FROM MAJOR ALASKAN PORTS

Origin	Road Mileage	Additional Road Mileage	Road Surface By Percentage
Anchorage	1,393 km (865 mi)	--	44% paved/56% gravel
Valdez	1,404 km (872 mi)	11 km(7 mi)	44% paved/56% gravel
Seward	1,598 km (993 mi)	205 km (128 mi)	51% paved/49% gravel
Homer	1,761 km (1,094 mi)	368 km (229 mi)	56% paved/44% gravel
Haines	1,877 km (1,166 mi)	484 km (301 mi)	31% paved/69% gravel
Skagway	2,070 km (1,286 mi)	678 km (421 mi)	28% paved/72% gravel

(1) The gravel road surface consists of 516 km. (321 mi.) located in Canada. The Skagway Highway Improvement Project, which is a joint effort of the U. S. and Canadian governments, will provide for paving of this entire mileage over the next ten years.

(2) Mileage between Skagway and Carcross under construction. Estimated completion date, 1979.

Sources: Alaska Highways 1976 Annual Traffic Volume Report by Alaska Department of Transportation and Public Facilities and Shakwak Highway Improvement Environmental Impact Statement, by Department of Public Works, Canada and U. S. Department of Public Works, Federal Highway Administration 1977.

exist to justify dedicated barge service to Haines or Skagway, and only Skagway can handle containers at the present time (Eakland, 1978c). The first phase of improved barge service would be to unload the trailers on the beach at Haines and Skagway. At a later date, container handling facilities on the docks would be added. At present, all Foss trailers going to Skagway or Haines have cargo that is consumed locally in the two communities. Virtually all through trips are limited to household goods. Southeast ports offer the advantage of using a semi-protected waterway, the so-called Inland Passage. Being able to bypass the more adverse weather conditions in the Gulf of Alaska has importance for certain shippers, even though the land mileage to Fairbanks is greater than for northern ports. A significant number of mobile homes were shipped to Fairbanks during the pipeline period, and this shipping practice has been continued.

Capacity. The through-put capacity of the present freight system in Southeast at present is constrained by the vehicle capacity of the marine highway system ferries. The system does not provide preferential treatment to commercial users, and Foss must make its reservations for space several months in advance, especially for summer travel, using the same procedures as private users. Generally, Foss averages 17 trailer shipments north bound in the summer, or approximately five per ferry sailing.

The existing capacity restraint should be solved without difficulty as soon as additional traffic develops. Dock facilities at Skagway and

Haines have large potential capacities.

Cook Inlet and Prince William Sound

Four major ports exist in the Cook Inlet and Prince William Sound areas--Anchorage, Seward, Whittier, Valdez.

Port of Anchorage.

Description

The Port of Anchorage, which is municipally-owned and operated, serves three primary shipping groups year-round, which are able to operate in ice during the winter. They are users of the petroleum, oil, and lubricant (POL) facilities, Sea-Land container ships, and TOTE (Totem Ocean Trailer Express, Inc.) trailer ships. TOTE's ships, 240 meters (786 feet) long, are the largest being handled by the port. After current port improvements have been completed, TOTE's ships will be able to unload at Terminal 3 where they will not interfere with the docking of other ships. Terminal 2 will continue to be used by Sea-Land, and Terminal 1 will be available for unscheduled carriers and general cargo. The POL facility is used by oil companies owning tanks at the port, except that Tesoro ships oil to its tanks through a pipeline from its Nikiski refinery on the Kenai Peninsula.

The port lacks adequate long-term holding or staging areas, and geographical constraints prevent major site expansion. The additional 6.9 hectares (17 acres) which is available will require expensive site improvements because of drainage problems. The Corp of Engineers provides dredging up to the dock face at the present time. This assistance from the federal government enables the port to pay its operating costs and debt charges on capital improvement bonds.

Capacity

The port director has estimated that present traffic could be increased fourfold before capacity constraints would arise (Eakland, 1978f). Severe cost penalties that now exist for work between midnight and 7 a.m. (triple time) will have to be modified when traffic approaches these levels. A combination of efficient ship and dock facilities and high labor productivity create high capacity estimates for the port, although it only has three cargo terminals.

If a capacity constraint does occur in the study period, it will be first in the level of service being offered by carriers serving the port. TOTE's bold entry into the Seattle/Anchorage market in 1975 and the introduction of a second ship in 1977 has proved that additional service was warranted. Both TOTE and Sea-Land, because of their competition and slightly depressed markets after pipeline construction, now have excess capacities within their existing fleets. Should demands warrant, both shippers can be expected to acquire additional ships.

The Port of Anchorage is content at the moment to promote the use of specialized services best suited to its circumstances and to let the ports of Seward and Whittier exert their advantages as natural deep-water, ice-free ports.

Whittier.

The Alaska Railroad owns and operates a roll-on/roll-off, rail car facility at Whittier, which is a small, land-locked community in Prince William Sound. The port was constructed during World War II as an alternative to Seward, which was then the major port for Alaska but was felt to be vulnerable to submarine attacks. The 17.7 km (11 mi.) link which connects Whittier to mainline track at Portage passes through two unlined tunnels. Horizontal clearances do not permit wide mobile homes to pass through the port.

Two carriers operate through Whittier, Canadian National (CN) from Prince Rupert and Crowley Maritime from Seattle. CN makes one shipment a week of approximately twenty cars. Crowley, the primary shipper into Whittier, operates hydro-train rail barges and also owns a train ship, which can provide enclosed shipment of rail cars. Barges used by Crowley are considerably larger than those used by CN and can hold 50 cars. Trips are made at least weekly and consist of a tug pulling two barges in tandem. Although providing a higher level of service, the train ship also requires higher manning levels (33 persons compared to 5 for tugs) and recently has been removed from service by Crowley for economic reasons. The ease with which interline rail shipments can be handled both at origin and destination makes the hydro-train service popular for shippers of bulk commodities to interior points.

Freight passing through the port of Whittier in 1976 accounted for 18% of the railroad system is total tonnage. Proponents of Whittier are hopeful that it will someday handle more tonnage than the Port of Anchorage. Although a natural deepwater port, Whittier lacks road access, is limited by inadequate staging areas, and has heavy snowfalls during the winter.

Capacity

Whittier's capacity is limited not by terminal facilities but by the capacity of equipment dedicated to hydro-train service. Alyeska's comments about logistics for pipeline construction indicate that additional capacity would have been utilized had it been available (Larsen, 1976). Rationing of capacity was used to minimize interference with normal shipping patterns to Alaska. Crowley currently has equipment in reserve; but in periods of large, peak demands its ultimate capacity is reached before that of carriers to other northern ports.

Valdez.

Description

The importance of Valdez as a port predated pipeline activity. The town's old facilities were destroyed by a tidal wave caused by the 1964 earthquake, and new facilities have been located at the new town site. Valdez now has two major port areas--Alyeska's four tanker berths and the facilities that make up the Port of Valdez. The latter includes a 183-meter (600 foot) long dock and crane service, a 91.5 meter (300 foot) wharf for berthing of barges and delivery of petroleum products, the marine highway ferry terminal, a 61 meter (Zoo foot) fuel pier, rail-barge dock, and a small boat harbor.

During p peline construction, all materials for the southern portion of the pipe ine were shipped to Valdez for trans-shipment by truck to work sites. he railyard was little used by the Alyeska project except for the movement of pipe from Valdez to Fairbanks via Whittier; however, local consumption of lumber, brick, liquid gas, and heavy equipment was handled intermittently by this service. Although offering ice-free waters year-round, heavy snowfall complicates freight handling during the winter. Without a through-rail connection, the port has limitations, but road mileage from Valdez to Fairbanks is approximately the same as that from Anchorage to Fairbanks and handling of roll-on/roll-off trailers might become feasible if demand were increased. At present, many Valdez commodities originally enter Alaska through Anchorage.

The City of Va dez has initiated studies to study the technical and market feasibi ities of expanding existing dock facilities.

Capacity

The problem at the Port of Valdez does not relate to capacity considera-tions at the moment but in generating sufficient demand to attract major shippers who would prov de scheduled service. The city has demonstrated the willingness and bonc ing strength to upgrade dock facilities should such projects appear feasible.

When the pipeline reaches full capacity in the late 1980's, a fifth tanker berth probably will have to be constructed.

All-Water Route to Prudhoe Bay via Bering Straits

Oil companies have provided major sea lifts to the North Slope every year since 1970 which was the year after the state lease sales. The shipping season is limited to the time that open waters exist in the summer, which is usually two months but can be considerably shorter as was the case in 1975.

The only port structures that exist on the North Slope are two 463 meter (1 ,520 foot) causeways that were built in 1975 to enable off-loading of iced-in barges to take place (CCC/HOK, 1978). Both causeways are owned by ARCO, which operates one of the two base camps at Prudhoe Bay. A combination of shallow Arctic Ocean waters near shore and the use of ocean-going tugs and barges makes lightening a necessity for getting commodities to land. The ARCO causeways are the only exception to this procedure. Lightening significantly increases the cost of sea lift activities as does their seasonal nature. The once-a-year movement of goods imposes inventory penalties at destinations and requires larger fleets than would be necessary if more frequent shipments were possible.

Capacity

The 1970 sea lift carried more than 169,645 metric tons (187,000 tons) to Prudhoe Bay (CCC/HOK, 1978). The short shipping season creates a severe peaking situation for the use of barges and tugs. Even if equipment can be obtained, shortages are likely to occur in levels of service to other shipping routes to Alaska. Impacts on other services could be minimized if the shipping season could be extended, possibly to even become year-round.

Crowley has available an ice-breaking barge; otherwise no private ice-breaking equipment is available to maintain open waters in the Arctic region. The United States Coast Guard has four ocean-going ice breakers in service at the present time. Two additional inland water ice breakers are stationed permanently in the Great Lakes. The two newest ice breakers form the "Polar Class" that is theoretically able to break 1.8 meters (six feet) of ice continuously at the speed of 5.6 km/kr (three knots). At least two ice breakers, including one in the "Polar Class," are assigned to the Arctic during the summer, but their missions are limited to installing navigational aids (RACONS), scientific research, and emergency search and rescue. Except in the Great Lakes, the Coast Guard does not utilize its ice breakers to promote shipping, since such activities constitute a subsidy of private enterprise (Eakland, 1978e). It also might detract the agency from carrying out its regular missions. In 1975, the Coast Guard did assist the beleaguered sea lift operation but only when President Ford declared such an action to be in the national interest.

The capacity of ocean-going barges ranges from 1,800 to 10,900 metric tons (2,000 to 12,000 tons). An average load of 4,535 metric tons (5,000 tons) has been assumed for this study.

Mackenzie River

Description. The Mackenzie River extends 1,724 km (1,071 mi.)

northwest from its origin at Great Slave Lake to the Beaufort Sea. Its navigability, length, and north-south orientation have made it an important commercial waterway since fur trapping became established in the early 1800's. Alaska lacks a comparable inland waterway to be used to move cargo to the North Slope. The east-west Brooks Range marks the southern limit for rivers emptying into the Arctic Ocean.

The water route north begins at the Great Slave Lake whose south shore is reached by both road and railroad. From Edmonton, Northern Alberta Railways go northwest to Peace River, and from there the Great Slave Lake Railway was built to Hay River. Northern Transportation Company Limited (NTCL), which is a Crown Corporation, provides virtually all tug and barge transportation on the McKenzie and operates out of extensive terminal facilities in Hay River (Eakland, 1978b). A small barge company out of Fort Simpson handles traffic that can be transported by truck. Principal terminal facilities for the Mackenzie Delta are at Inuvik, which is the region's administrative center.

Traffic can begin its northward journey in the middle of June when navigation is first possible in Great Slave Lake. It must end by mid-October when the lake generally freezes over. At the river's mouth, navigable conditions exist from July to late September.

Tugs and barges operating on the Mackenzie River have been especially designed for this purpose. Equipment specifications are intermediate between those required for ocean travel that reach the North Slope via the Bering Straits and those required for lightening. Barge drafts when loaded are 1-1/2 to 2 meters (5 to 6 feet) and some have maximum river loads as high as 1,215 metric tons (1,340 tons). Tugs have comparable drafts, and have sufficient power--up to 4,300 horse power--to move loads at speeds of 18 to 22 km/hr. (10 to 12 knots). For certain offshore activities, the barges will be able to take materials directly to their destinations without the need for lightening.

When completed in 1978, the Dempster Highway will extend from Dawson in the Yukon to the communities of Fort McPherson, Arctic Red River, and Inuvik in the Northwest Territories. The gravel road could over time become an important supply route for the Mackenzie Delta and, using barges, for Beaufort Sea destinations. The road distance from Skagway to Inuvik is 1,432 km. (890 mi.), which is only 40 km. (25 mi.) further than the mileage from Anchorage to Prudhoe Bay. Also, the distance is 444 km. (276 mi.) shorter than the mileage from Haines to Prudhoe Bay.

Capacity. Mackenzie River trave peaked in 1972 at 426,375 metric tons (470,000 tons) (Berger, 1977). " he annual average since then has been 362,870 metric tons (400,000 tons), although the long-term annual growth rate is 9%. North boun traffic includes construction materials, heavy equipment, and fuels. Ore concentrates from mines near Great Bear Lake and oil from Norman Wells are the predominate commodities that are carried southbound. To accommodate the logistics for the proposed Arctic gas pipeline, the number of tugs and barges operating on the Mackenzie would have had to be doubled (Berger, 1977). Total river travel for the project would have been 1.5 million tons for three years. Arctic Gas proposed to provide its own tug and barge fleet so as not to compete for space with existing local demands. To accommodate comparable traffic demands, increased expenses for dredging and navigational aids will be necessary.

AIR MODE

The air mode has proven to be the most flexible and reliable for travel within the state of Alaska, but unfortunately, also the most expensive. For resource development, air activities tend to be statewide for personnel but regional for freight. The value of time requires that entire trips for personnel be made by air, but for commodities the final air link is kept as short as possible.

Routes

Passenger routes impacted would primarily be from Anchorage to Fairbanks and from Fairbanks to Prudhoe Bay and Barrow, since the majority of workers are assumed to live in Anchorage. Impact of freight routes will principally be those from Fairbanks to points north. The 740 km. (460 mi.) air distance from Fairbanks to the North Slope produced an effective compromise between travel costs and time savings before the Haul Road was completed. Greater time savings were not worth additional costs, and lesser time savings were insufficient to justify the use of aircraft. The existence of the Haul Road now changes the parameters, and a greater reliance can be placed on shorter flights distributing freight from Prudhoe Bay. Nevertheless, the lack of North Slope staging areas and the smaller ton-mile cost for shipping freight from Fairbanks suggests that a low to moderate number of flights will occur directly from Fairbanks to base camps and, during the winter, directly to drill sites on the ice.

Facilities

Four major airports were studied for impacts, including Anchorage International Airport, Fairbanks International Airport, Wiley Post/ Will Rogers Memorial Airport (Barrow), and Deadhorse, as well as the secondary airports in the North Slope Borough communities of Nuiqsut and Kaktovik.

Anchorage International Airport. Anchorage International Airport, which is owned and operated by the state, has three asphalt runways. Their headings and dimensions are as follows: 6L-24R, 3,230 meters long by 61 meters wide (10,600 feet long by 200 feet wide); 13-31, 1,445 meters long by 46 meters wide (4,742 feet long by 150 feet wide), 6R-24L (10,897 feet long by 150 wide) (FAA, 1977).

Operations (take-offs and landings) at the Anchorage International Airport totaled 236,000 in 1976, which is 77% of the facility's capacity as estimated in the 1971 Master Plan (Quinton-Budlong, 1971).

Visual operations take place 93% of the time (Quinton-Budlong, 1971). Strong cross winds create operational difficulties and are the primary reason for the proposed North-South runway.

Fairbanks International Airport. The airport is owned and operated by the state of Alaska. Its two parallel asphalt runways having the following designations and dimensions: 1L-19R, 3,139 meters long by 46 meters wide (10,300 feet long by 150 wide), 1R-19L, 975 meters long by 18 meters wide (3,200 feet long by 60 wide). The 1972 Master Plan estimates the current capacity of the airport to be 265,000 annual operations (R. D. Speas, 1972). Total 1976 operations were 191,000 or 72% of capacity. Commercial operations represent 29% of the total figure, general aviation 26%, and touch-and-gos 25%. The higher percentage for training operations in Fairbanks compared to Anchorage reflects the existence in the latter city of a well-developed training air field. However, a private air field does exist in the Fairbanks area and is used exclusively by general aviation, and the airport at Wainwright Army Base is a reserve capacity that was used by Alyeska to support pipeline activities.

Visual operations at the Fairbanks International Airport are possible 93.3% of the time. Cross winds are not seen as a significant problem (R. D. Speas, 1972).

Deadhorse. Deadhorse which serves the Prudhoe Bay industrial community, has a single gravel runway (4-22) which measures 1,981 meters by 46 meters (6,500 feet by 150 feet). Operations totaled 15,000 in 1976, and a 33% increase is expected by FAA over the next ten years.

The oil companies operate a separate private air field in the Prudhoe

Bay area that can accommodate Hercules aircraft and which provides reserve capacity.

Barrow (Wiley Post/Will Rogers Memorial). The Barrow airport, which is state operated, had 8,000 operations in 1976. A single asphalt runway (6-24) measures 1,981 meters long by 46 meters wide (6,500 feet long by 150 feet wide). No capacity problems exist. Heavy fog limits operations at certain times of the year.

Kaktovik and Nuiqsut. Kaktovik is served by a single gravel runway, which is also used by the Barter Island DEW Station for logistics support.

Nuiqsut, a small community located in the Colville River Delta, has a gravel airstrip that is 762 meters long by 15 meters wide (2,500 feet long by 50 feet wide).

Carriers

The Alaska Transportation Commission (ATC) regulates all common air carriers operating within the state. It cooperates with the Civil Aeronautics Board (CAB) in regulating carriers that operate interstate. ATC issues permits in three categories--air taxi operators, scheduled carriers, and contract carriers. Different operating rights oftentimes are established for fixed wing and rotary wing (helicopters) and for certified gross takeoff weights above and below 5,670 kg. (12,500 pounds). The largest aircraft weighing less than 5,670 kg. (12,500 pounds) are the Twin Otter and Lear Jet, which have typical seating capacities of 15 persons.

Air taxi carriers are issued operating authorities that specify bases of operation. Operators must provide "safe, adequate, efficient, and continuous service from and maintain bases of operation at listed locations" (Alaska Transportation Commission, 1978). The latest ATC directory, issued in February, 1978, lists 10 air taxi carriers having bases on the North Slope. All may operate fixed-wing aircraft, and three may operate rotary-wing aircraft. Only two may have certified gross takeoff weights above 5,670 kg. (12,500 pounds) using fixed-wing aircraft, only one using rotary-wing aircraft. Three have their North Slope operations based at Barrow, four at Deadhorse, and one each at Kaktovik, Colville River, and Bettles Field.

Scheduled carriers are issued authorities based on specific routes and stops. Implicit in their authority is the right to engage in contract operations where the origin is on a scheduled route. For example, even though Alaska Airlines does not have authority as a contract carrier, it is able to provide contract services direct to North Slope locations from Anchorage or Fairbanks.

The primary scheduled airlines from Fairbanks to the North Slope is Wien which offers twice daily jet (737) service to Barrow and Deadhorse. Carriers using small equipment are Frontier Flying Service, Inc. which soon will operate from Fairbanks to Barrow via Anaktuvuk Pass. Sea

Airmotive operates a coastal schedule on the North Slope which currently includes destinations at Barrow, Deadhorse, and Nuiqsut. Both carriers also have air taxi authority.

Contract carriers generally are not restricted by location in their operating authorities. Principal contract carriers for the state include Cocal Aviation, Inc., Northern Air Cargo, Inc., Munz Northern Airlines, Inc., and Alaska International Air, Inc.

Unlike the situation for motor carriers, the number and extent of operating authorities for air carriers in interior Alaska appears to be in line with normal demand requirements. One reason is that permits for air taxi and scheduled carriers are more finely tuned by site and area than for motor carriers. Another has been the unwillingness of the ATC to approve permanent authorities for what are obviously short-term, peak periods of activity. Temporary permits were issued for the 1969 air lift to the North Slope which saw take-offs and landings average 1,000 per day. They were revoked the following year when traffic demand returned to more normal levels (Eakland, 1978g).

Aircraft

The Hercules C-130 is the primary aircraft used in Alaska for large cargo shipments. It has a maximum payload of 21,130 kg. (46,583 pounds) and a range in excess of 3,220 km. (2,000 mi.)(Taylor, 1977). Its rear ramp enables it to carry vehicles and other bulky cargo.

The Boeing 737, which has been called the world's largest bush plane, serves a dual passenger-cargo carrying role in interior Alaska. The planes, operated by Wien Consolidated Air, have a sideloading freight door through which containers can be loaded. Operating in all-passenger configuration, 115 passengers can be accommodated. Mixed passenger-cargo configurations are possible which carry 26, 56 or 74 passengers behind a cargo compartment. Maximum payload for the 737-200 is 15,875 kg. (35,000 pounds). Aircraft carrying this load have a range of 3,815 km. (2,370 mi.)(Taylor, 1977).

The DeHavilland Twin Otter (DHC-6), which has 20 passenger seats, serves several markets in Alaska that do not have sufficient demand to justify large capacity jets. The plane has a maximum payload of 1,941 kg. (4,280 pounds) and a range of 1,450 to 1770 km. (900 to 1,100 mi.) (Taylor, 1977).

NORTH SLOPE LOCAL TRANSPORTATION SYSTEMS

The absence of an inland surface transportation network, either water or land, means that transportation demands for villages and developments adjacent to the proposed state/federal Beaufort Sea leasing areas are primarily met on an individual basis and not through a North Slope distribution system. Developers derive no benefits from using existing community infrastructures and instead create enclaves such as Prudhoe Bay. Negative social impacts of developments in the region are minimized, but on the other hand so are positive economic impacts, such as reducing transportation costs to existing communities. From a transportation viewpoint, a better balance between decentralization and centralization for surface logistics would produce better efficiency.

III. TRANSPORTATION IMPACT ASSESSMENT FOR NON-OCS SCENARIO

Introduction

Impacts on local, regional, and state-wide transportation systems resulting from the non-OCS scenario have two principal components -- (1) normal incremental growth acti vi ties, and (2) major development activities, principally construction of the Alcan gas pipeline and possibly construction of a new State capital city near Willow.

The non-OCS assessment parallels the analysis of existing facilities in the previous chapter. Figure 4 in that chapter shows the potential transportation routes.

Table 6 shows the changes in employment that have been forecast by the University of Alaska's Institute of Social and Economic Research for the cities of Fairbanks and Anchorage and for the entire state. Year-by-year forecasts for the Anchorage, Fairbanks, and North Slope areas are shown in Tables 8, 9 and 10, respectively in Chapter IV on page 99-101. Impacts of the Alcan gas line construction and operation were taken into account in developing these forecasts. As opposed to the large increases in population and employment that occurred in Alaska during the mid-1970's -- the population increase from 1974 to 1975 alone was 15.2% -- a small but steady growth is forecast for the state from 1977 to 2000. As shown in Table 6, the growth rate for Anchorage is approximately 50% greater than that for the state as a whole. Fairbanks, on the other hand, is forecast to have a lower than average growth rate during the study period.

TABLE 6. NON-OCS EMPLOYMENT FORECASTS

Location	Time Period	Compounded Annual Growth Rate
Statewide	1977-1987	2.27%
	1987-2000	2.59%
	1977-2000	1.89%
Anchorage	1977-1987	3.03%
	1987-2000	3.22%
	1977-2000	3. 13%
Fairbanks	1977-1987	-0.39%
	1987-2000	0.94%
	1977-2000	0. 36%

Source: Dennis Dooley and Associates, 1978.

Discussion of Non-OCS Impacts

HIGHWAY MODE

Capacity

Table 2 in Chapter II lists existing traffic volume conditions at thirteen permanent counter locations on routes that will be potentially impacted by Beaufort Sea OCS activities. In recent years, traffic growth has exceeded that of the population, particularly in urban areas. For intercity travel, a compounded annual growth rate of 4% is assumed for the non-OCS case, which is more than double the state-wide figure but only less than a percentage point above that for Anchorage. Results are shown in the last column of Table 2 in Chapter II on page 37.

Four of the thirteen traffic stations are forecast to have design hourly volumes exceeding the average capacity of 667 vehicles per hour derived in Chapter II. Three of the locations are on the Kenai Peninsula on the route between Anchorage and Homer. The Kenai Peninsula is a favorite recreational area for Anchorage residents and tourists. Traffic congestion is expected to be limited to summer weekends. Improvements in roadway alignment and width for this route will be accomplished during the study period once road sections damaged during pipeline construction have been improved. The fourth location is 113 km. (7 mi.) north of Fairbanks. It was chosen because no permanent counter exists that is further north along the Prudhoe Bay Highway. The proximity of the location to Fairbanks suggests that any congestion will be due primarily to local rather than intercity traffic. The low growth rate forecast for Fairbanks suggests that the assumed 4% compounded annual growth rate might be high in this case. Of these four locations, only the latter is expected to receive any significant traffic related to gas pipeline construction.

A fifth location located 126 km. (78 mi.) north of Anchorage has a forecast design hourly volume approaching 667 vehicles per hour, but the high monthly average daily traffic in July indicates that traffic congestion, should it occur, would be related to recreational traffic originating in Anchorage.

Without a doubt, the gas pipeline will place a heavy burden on the state's highway system. Figure 8 dramatically shows the increase in truck traffic that occurred for 1975 over 1970 and 1973 at weigh scale

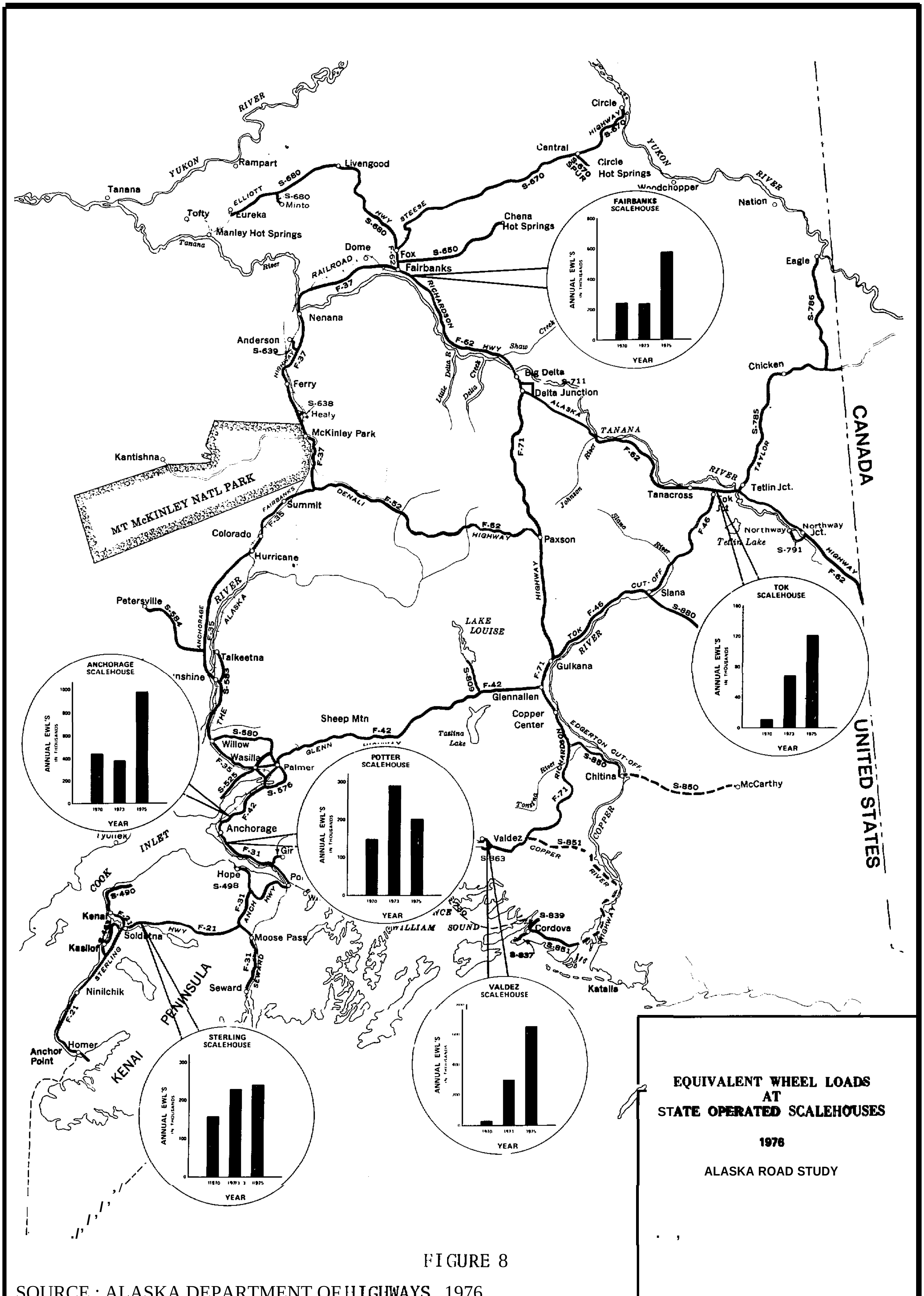


FIGURE 8

SOURCE : ALASKA DEPARTMENT OF HIGHWAYS , 1976 stations near Tok, Valdez, Anchorage, and Fairbanks (Federal Highway Administration, 1977). Most of the increase, except perhaps for Anchorage, can be attributed to pipeline construction. The negative impact should be less in some respects than for the oil pipeline, because the state's reconstruction program will have enabled the roads to better handle the traffic. Also lessons were learned during TAPS construction, and better monitoring of traffic can be expected. On the other hand, the longer length of the line means that impacts will be felt to a greater extent in Skagway and Haines. Competition for available transportation services between Beaufort Sea OCS leaseholders and Alcan should not pose any problems. Capacity of roads receiving the heaviest usage during construction have been shown to be adequate, and carriers will be able to respond to virtually any demand that exists. One possible exception is the haul road, which may be used extensively by both developments. Alcan has indicated that it intends to use the road as a work pad. It is expected that routine provisions for minimizing disruption of through traffic will be implemented.

Carriers

Based on pipeline experiences, the trucking industry will be able to respond to any demands that might exist in the non-OCS scenario. As previously noted, excess capacity in the industry exists at present; and in collective bargaining, unions are focusing more on job protection than on wage increases.

RAIL MODE

The Yukon and White Pass Railroad can be expected to carry significant shipments of construction materials related to construction of the gas pipeline. The closing in June, 1978 of the Cassiar Asbestos Corporation's operation at Clinton Creek has cast a shadow over the future financial prospects for the railroad, and subsidies may be required until substitute revenues can be generated. Conceivably, by the year 2000, traffic on the railroad could diminish to such an extent that the Skagway-Carcross road could supplant it for moving goods inland to Whitehorse from the coast of Southeast Alaska.

The Alaska Railroad will be able to satisfy all foreseeable traffic demands during the study period. Expected peaking of demand for the Alcan project is offset by the loss of petroleum products that in the past have been shipped from Anchorage to Fairbanks. The new North Pole refinery in Fairbanks has eliminated the need for such shipments. Thus, from a capacity viewpoint, the Alaska Railroad will be better able to handle the gas project than the oil pipeline, although it had few problems with the latter. The prospects are for ton-miles to decrease faster than tons carried in the near future.

WATERBORNE MODE

Southeast

The Alcan project will certainly generate additional traffic to Haines and Skagway. Carriers must be able to offer through barge service to these cities to be able to capture that traffic, which means that existing operations 'will not suffice. Additional tonnage requirements can be met by major shippers utilizing contract carriage to meet their unique requirements. Improvements to dock facilities at Haines and Skagway are a likely result of the Alcan project, whether they are done by public agencies or shipping companies. However, normal growth in southeast Alaska by itself will not lead to any major changes in service levels. The regional annual growth rate is forecast to be approximately only 1-1/2 percent for the next twenty years.

Cook Inlet and Prince William Sound

Anchorage

Both Sea-Land and TOTE will gain significant shares in the movement of materials and supplies for the Alcan pipeline. These shares will come principally at the expense of shipments that would have previously gone over the Alaska highway. TOTE's transit time of 2-1/2 days between Tacoma and Anchorage enables it to compete effectively with any over-the-road travel through Canada. The steady growth of the Anchorage population and economy during the study period suggests the primary shippers will eventually increase their capacities. Because of the times required to obtain specialized ships needed by the shippers, it is possible that demand during the pipeline period will exceed capacity and some freight may have to use alternate routings through Seward.

No major improvements will be needed for the foreseeable future, although several are in the talking stages, such as a fourth cargo terminal and a joint project between the Port of Anchorage and the Alaska Railroad for roll-on-roll-off, rail car facilities. The Port currently generates sufficient revenues to pay off its bonded indebtedness on schedule as well as operating expenses. A study will soon be undertaken to perform a long-range study of port operations.

Seward

The railroad is promoting the use of Seward port facilities for OCS-related activities in the northern Gulf of Alaska. The advantages are attractive. An area of 30 acres would be made available for staging as well as a dock for servicing supply ships. Seward will also be attractive to the Alcan group because the dock will have few competing users with the possible exception of OCS developers. Both the State of Alaska and the railroad have programmed funds for use at Seward dock facilities but they will be used for repairs rather than expanding facilities.

Whittier

Whittier will continue to be a major port for freight entering Alaska. The inability of Crowley to expand its barge service sufficiently during peak periods will lead to capacity pressures when large development activities occur. Developers will be forced to ship excess demand on contract barges to other ports, particularly Seward. As in Seward, except on a larger scale, the Alaska Railroad is repairing and renovating existing facilities.

Valdez

The Port of Valdez will be an important port for the Alcan project but less so than for the TAPS pipeline because of the long hauls that will be required from the city to work sites. Projects of a more long-term nature, such as refinery proposals and exporting of fish and mineral resources, offer more promise to the growth prospects of the port. As facilities improve and population of the area continues to grow, Valdez should develop into a strong regional distribution center for the eastern Prince William Sound area and small communities along the southern portion of the Richardson Highway.

All-Water Route via Bering Straits

Traffic for the non-OCS case will consist of four categories, as follows: (1) cargo for NPR-A exploration activities; (2) cargo for North Slope Borough Communities, particularly fuel and building materials; (3) support materials for oil company activities at Prudhoe Bay, and (4) logistics support for oil and gas exploration in the Canadian Arctic. Total traffic for these activities will be considerably less than that experienced during the height of exploration and development activities at Prudhoe Bay during the early 1970's. A rough estimate would be 8-15 barges. No new port facilities are planned.

Support of NPR-A exploration is expected to require annual shipments of 18,145 metric tons (20,000 tons) to Barrow until the year 1982 (CCC/HOK, 1977). Much of the cargo will be fuel, which can be delivered considerably cheaper by water than by air. For areas that cannot be served by Prudhoe Bay and, thus, by land transportation via the Haul Road, water travel will continue to be an important life-line despite its seasonality

Employment forecasts by the University of Alaska's Institute of Social and Economic Research predict a steady state economy for Fairbanks during the non-OCS Scenario, except for a pronounced peak during construction of the gas pipeline. Nevertheless, the airport should show a small but steady increase because of resource exploration and development activities on the North Slope and in the interior and also because of continued growth in tourism. Capacity problems will probably occur somewhat later than forecast, probably in the late 1980's or early 1990's. A new master plan, which is being prepared, will examine how the additional traffic can be accommodated.

North Slope Aviation Facilities. Capacity problems are not foreseeable at Deadhorse. In 1979, which was the peak period for air logistics to the North Slope, take-offs and landings averaged 1,000 per day. The existence of the Haul Road precludes such intense activity in the future. From a revenue standpoint, the Alaska Department of Transportation Public Facilities encourages additional traffic at this airport.

Air taxi and scheduled carriers with operations within the North Slope Borough should show steady growth because of exploration in NPR-A, which will be administered from Barrow, and construction of the Alcan gas pipeline. Contract and scheduled services from Barrow will be able to expand to meet peak seasonal and annual demands during study period. Increased activity could lead to several new permits for air taxi and scheduled operators.

Improvements will occur to air facilities at Kaktovik and Nuiqsut which will improve safety and operations, but they will not induce a noticeably higher level of service for the communities.

Non-OCS Summary

Of the four modes analyzed, two of them - rail and waterborne -- are not expected to experience any problems along routes that potentially would carry goods and passengers to and from oil and gas activities in the Beaufort Sea. For the air mode, capacity problems will be experienced at the international airports in Anchorage and Fairbanks due to the steady growth of the Alaskan economy, the continued reliance of Alaskans on air travel for intercity trips, and the increase in international travel. Traffic congestion will appear on several highway routes close to urban centers or which are heavily used by weekend recreational travelers. Incremental improvements, such as resurfacing, widening of the road surface, and improving vertical and horizontal curves will provide for a small increase in capacity and greater safety. For the most part, traffic will be able travel at a level of service C, which is a free-flow condition, at all times. Impacts due to heavy loads will result from construction of the Alcan gas pipeline, but an extensive reconstruction program accomplished during recent years will enable the road system to withstand heavy loads to a greater degree than occurred during TransAlaska Pipeline construction. Gas pipeline construction will cause some competition for existing transportation services with the State's normal freight and passenger requirements, particularly for rail car barges to Whittier and shipments to southeastern ports of Skagway and Haines, but the availability of alternative routings will enable both types of traffic to be accommodated without substantial delays or cost penalties.

IV. BEAUFORT SEA OCS TRANSPORTATION IMPACTS

Introduction

This chapter discusses the transportation impacts of the four OCS Scenarios. The analysis is based on an examination of annual transportation demands for each scenario. As a preliminary topic, a description of logistics experiences encountered in the exploration and development of Prudhoe Bay and the construction of the oil pipeline is presented. Second, a final screening of transportation routes and services is made. The criteria for selection are similar to those used in the preliminary screening, but additional information provided in Chapter 2 is utilized. Finally, impact assessments are made for each of the four different types of transportation demands for each scenario.

PRUDHOE BAY/ALYESKA PIPELINE EXPERIENCES

Logistics patterns that evolved to supply materials for Prudhoe Bay oil exploration, development, and production as well as construction of the TransAlaska Pipeline provide valuable lessons for the planning of any future development activities in Alaska's interior. The two activities, however, must be analyzed separately, for each offers different lessons. Given the Beaufort Sea OCS scenarios, the Prudhoe Bay case has greater similarities regarding types of shipments and their origins and destinations. TAPS construction for its part offers a situation where available routes more closely resemble those that will be available for the Beaufort Sea scenarios.

In the early days of Prudhoe Bay, transportation choices were limited to either cheaper, seasonal water transportation or more expensive, but all year-round air transportation. These limitations produced peaks for both loads following the 1969 lease sales, first for air in the winter of 1969 and then for water the following summer (CCC/HOC, 1978).

Traffic patterns supporting Alyeska and Prudhoe Bay activities changed from year to year, according to the amounts and immediacy of transport requirements, institutional and weather constraints, and availability of new routes and services. The last item is particularly interesting to trace; the year 1975 represents a watershed for several reasons. The haul road was completed, including the Yukon River Bridge. Also, construction that year of a causeway extension at Prudhoe Bay eliminated the need for lightening. And finally, TOTE instituted its service for express delivery to Anchorage of roll-on, roll-off trailers.

For the Alyeska review, operations out of Seattle and north of the Yukon River will be examined separately for they represent the two key points at which modal choice decisions were made.

SEATTLE

Listed below is information concerning shipments and costs for modes of travel to reach Alaska from Alyeska's Seattle support facility (Alyeska Pipeline Service Co., 1978).

TABLE 7. ALYESKA SHIPMENTS FROM SEATTLE BY MODE

Mode	Shipments (Short Tons)	Percent	Cost/Short Ton
Charter Barge	241,177	65%	$134.59
Rail Barge	60,088	16%	88.62
Truck	37,121	10%	253.24
Container Ship	27,993	7%	164.59
Commercial Barge	5,819	2%	240.05
Air	1,051		651.42

Source: Alyeska Pipeline Service Co. memorandum, H. Larsen to W. Brodie, Historical Summary/Seattle support facility, 1976.

The data lacks consistency since intermediate destinations and, thus, mileage differs for each mode; but the figures, nevertheless, are representative and valid for general discussion purposes. It should be noted that the figures cover a three-year span, 1974-1976.

Inexact correspondence between the cost of shipping by mode and the actual amounts shipped suggests that factors other than cost entered into decision-making. One would have expected considerably more tonnage to have traveled by rail and less by truck. Hydro-train capacity was limited, and Alyeska received a rationing of approximately one-third of the rail car space. Similarly, Sea-Land container ships to Anchorage had limited available space until TOTE started services in late 1975. Thus, tonnage transported by truck is more than the high cost would suggest because of the mode's flexibility and pressing time demands by Alyeska for certain goods. Time savings, however, never became such an important factor that air freight was a serious contender for freight traffic originating from Northwest states. Although costs for trucks were almost twice as expensive as those for charter barges, they were only 40% of air freight costs. Truck tonnage was 15% of the total 1974 tonnage shipped from Seattle. The percentage declined when TOTE instituted its service from Seattle to Anchorage the following year. Its 2-1/2 day travel time for ships enables TOTE to compete effectively with over-the-road travel to interior Alaska.

From Seattle, water traffic went to a variety of Alaskan ports. All rail traffic was unloaded at Whittier, which has the only roll-on, roll-off facilities in Alaska for through traffic. Otherwise, Alyeska favored Seward, which has modern freight-handling facilities for break-bulk cargo, a rail connection, and adequate staging areas. Anchorage was used primarily for container shippings. Pipeline location required the port of Valdez to be used extensively, but goods were shipped to other ports whenever possible to minimize congestion along the construction corridor.

Goods that arrived in Seward or Anchorage for the most part were switched to rail for transport to Fairbanks. In 1975, approximately only 1,500 truck loads originated from both Seward and Anchorage compared to over 32,000 from Fairbanks.

NORTH OF FAIRBANKS

Goods sh· pments north of Fairbanks for pipeline construction had two distinct phases--before and after construction of the haul road. Until the Yukon River Bridge was completed in October, 1975, the river was crossed with the use of an ice bridge in winter and an air-cushion transporter in the summer. Before the haul road existed, cargo and fuel requirements for the northern portion of the pipeline were met by air and water carriers. The C-130 Hercules was the work horse during this period for the air mode. Tonnage transported in 1974 by air amounted to 79,689 metric tons (87,843 tons) when truck loads traveling north bound across the Yukon numbered less than 1,000 (Alyeska Pipeline Service Co., 1975). During this year, barges sent directly to Prudhoe Bay accounted for an additional 19,958 metric tons (22,000 tons). A year later in 1975, a slight dip in air traffic resulted in metric tonnage of 76,532 (84,363 tons), but truck traffic dramatically rose to 30,000 loads as the haul road became operational. During the following year, travel on the haul road became the dominant mode, and Hercules flights were used only during spring break-up when weight restrictions were in effect on the highways (Alyeska, 1977).

FINAL SCREENING

An inventory and capacity analysis of transportation facilities that are potentially impacted by Beaufort Sea OCS activities has been performed by mode. The final screening, drawing heavily on this information, includes backward-seeking routes from both Prudhoe Bay/Beaufort Sea and Fairbanks as shown in Figure 9. The general routings that will be examined include four that converge on Prudhoe Bay/Beaufort Sea and three on Fairbanks. They are as follows:

DIAGRAM FOR FINAL SCREENING OF TRANSPORTATION ROUTES

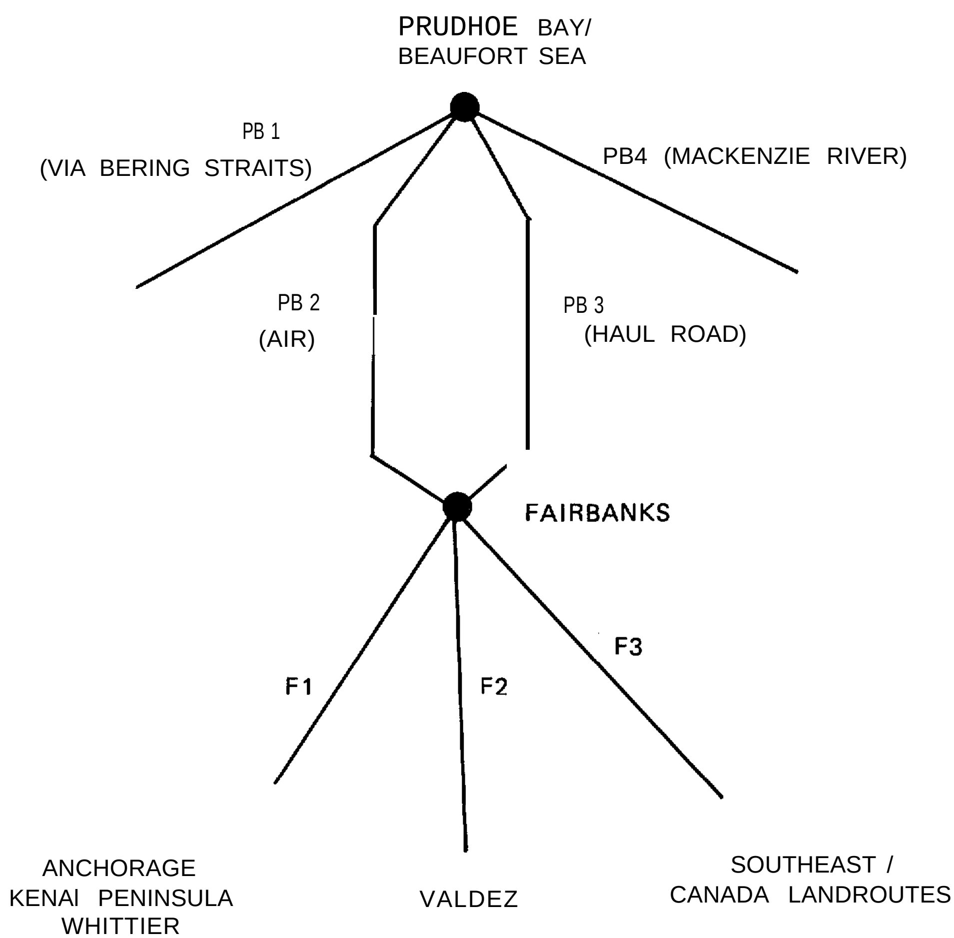


FIGURE 9.
SOURCE: DENNIS DOOLEY AND ASSOCIATES, 1978

Routes to Prudhoe Bay

PB1. All-water route via the Bering Straits

PB2. Air mode from Fairbanks

PB3. Prudhoe Bay Highway (Haul Road)

PB4. Mackenzie River

Routes to Fairbanks

F1. Anchorage/Kenai Peninsula/Whittier

F2. Valdez

F3. Southeast/Alaskan Highway

PB.1 ALL-WATER ROUTE VIA THE BERING STRAITS

This tug and barge route has been used each summer since the mid-1960's to support exploration and development activities on the North Slope and will definitely play a continuing role in transporting over-sized equipment and bulk commodities that originate outside of Alaska. The coastal and off-shore destinations in the Beaufort Sea OCS Scenarios favor this route, as do operating improvements that have occurred and will continue to occur such as the causeway extensions constructed by ARCO.

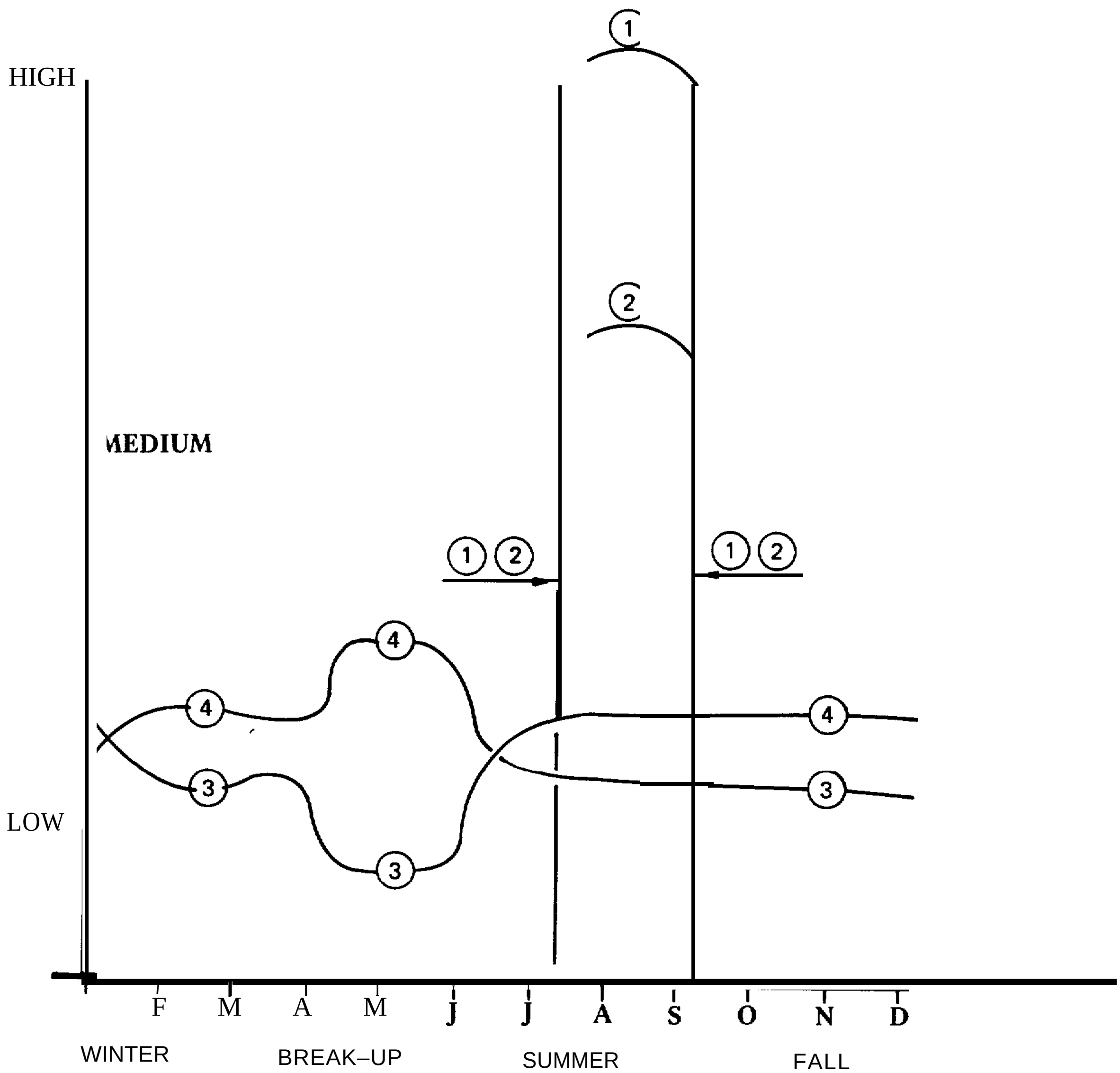
PB.2 AIR MODE

Air travel from Fairbanks will never regain the extreme levels that were reached before construction of the Haul Road but, nevertheless, will remain an important mode for the movement of passengers and certain goods to the North Slope. For personnel movements, it is assumed to be the sole carrier. For freight movements, no large shipments will originate south of Fairbanks. Four types of air freight service complement that available from other modes. First, the air mode provides a basic level of service to base camps and Prudhoe Bay for time-sensitive and high value, low weight commodities. Second, it increases its level of service to these destinations during spring break-up when Haul Road traffic is limited. Third is a one-time-only role of short duration; the mode will supply base camps until a connecting haul road is constructed. Air strips, it is estimated, can be constructed in 1-1/2 months, while a road may take more than a year to build (Dames & Moore, 1978). This role applies specifically to Camden-Canning, which will require road links of 103 and 24 km. (64 and 15 mi.). Fourth, air travel can be used to transport supplies directly to off-shore facilities when the ice is of sufficient thickness. This time period commences in January and lasts approximately two months.

PB .3 PRUDHOE BAY HIGHWAY (HAUL ROAD)

The Haul Road, except when weight limits are imposed on traffic leaving Fairbanks during spring break-up, is a year-round facility that offers reliability and flexibility to shippers at a moderate price. It will continue in importance as a carrier of a wide variety of commodities, irrespective of the utilization scheme that is finally decided upon by the state administration. Currently all alternatives addressed by the state assume that the road will be open to industrial traffic, although some involve the imposition of tolls. During pipeline and field construction, an average of 2,722 metric tons (3,000 tons) per month was

MODAL SPLIT ORDER OF MAGNITUDES AND SEASONAL VARIATIONS



ROUTES

1. OCEAN WATER ROUTE (BERING STRAITS)
2. INLAND WATER ROUTE (MACKENZIE RIVER)
3. NORTH SLOPE HAUL ROAD
4. AIR FRAIGHT FROM FAIRBANKS

FIGURE 10.

SOURCE : DENNIS DOOLEY AND ASSOCIATES , 1978 transported over the Haul Road (Dames and Moore, 1978).

PB.4 MACKENZIE RIVER

The Mackenzie River provides an inland waterway shipping route that for the most part can provide the same services as the ocean route. It has advantages for freight originating in the eastern and mid-western states that can be shipped by rail, such as steel products; and available shallow-draft equipment oftentimes can deliver goods to the final destination without the need for lightening. Use of the Dempster Highway to provide a connection to the Mackenzie River is assumed to be insignificant. The Jones Act requires that each tug and barge make only one stop once they have entered U. S. waters.

Beaufort Sea Modal Split Order of Magnitude. Figure 10 shows probable order of magnitude relationships between the four final links to the Beaufort Sea for goods shipments. The figure should not be construed as a working diagram but only as a means of portraying general shipping patterns. The figure shows that water shipping by both routes has a short duration; but considerable tonnage is carried, nevertheless. The Mackenzie route is expected to carry less tonnage than the Bering Straits route, principally because of the larger barges available for the latter. The air and land modes are more constant in their shipping patterns. Haul Road traffic will be more significant in the summer and fall months but will fall off during the winter when planes can land on off-shore ice and during the spring break-up. The downturn in truck shipments during break-up is a result of the 50% and 75% load limits imposed by the state. The number of trucks on the road during this period most likely will not significantly decrease.

F.1 ANCHORAGE/KENAI PENINSULA/WHITTIER

All personnel are assumed to travel to Fairbanks by air, and all freight by surface modes, either railroad or truck. Homer was eliminated as a potential port because of its lack of adequate dock facilities and long road mileage. Whittier will be the preferred port of entry for bulk commodities, and Anchorage for other commodities, particularly perishables and dry stores. Seward will serve as an important secondary port receiving freight that is not shipped in special-handling equipment, such as trailers, containers, or rail cars. Rail, whether from Anchorage, Whittier, or Seward, will be the dominant mode for moving commodities to Fairbanks. Despite the favorable rates for rail shipments, motor carriers will carry a certain amount of freight directly from Anchorage to the North Slope.

F.2 VALDEZ

This port will be of minor significance for Beaufort Sea OCS operations because it does not handle on a regular basis specialized equipment as do Anchorage and Whittier and lacks a through rail connection. The approximately equal driving distance to Fairbanks from Anchorage and Valdez means that some truck traffic will originate here, but less than from Anchorage. Anchorage-based carriers have the advantage of a tie-in with TOTE.

F.3 SOUTHEAST/ALASKA HIGHWAY

The entry of TOTE into the Alaskan shipping market reduced the need for freight movements through Canada. Certain types of freight destined for the interior, which are prone to damage on the open seas, such as mobile homes, will continue to be shipped via the Inland Passage; but Beaufort Sea housing modules will almost certainly be shipped by water routes. No significant activity in Southeast is expected for Beaufort Sea OCS logistics.

Fairbanks Modal Split Order of Magnitude. Goods reaching Fairbanks for the most part will enter the ports of Whittier, Anchorage, and Seward. Most tonnage will then travel by rail to Fairbanks, although some Anchorage to Fairbanks traffic will also occur.

Discussion of Impacts

Four separate types of transportation demands will be analyzed to determine the impacts of each OCS scenario. These demands are as follows: (1) goods, materials, and supplies to Beaufort Sea; (2) transportation of Beaufort Sea personnel; (3) induced statewide transportation of persons and goods, and (4) transportation of oil to markets. Each is discussed below:

GOODS, MATERIALS, AND SUPPLIES TO BEAUFORT SEA

The scenarios provide data that can be translated into approximate tonnage values by year. Estimates of the tonnage to be carried by air, trucks, ocean barges, and river barges will be made based on costs, availability of services, and the type and origin of cargo. The impact assessment will be based principally on the additional transportation demands resulting from each of the OCS scenarios. Although traffic forecasts were possible for some transportation facilities in the analysis of the non-OCS scenario, for the most part only a qualitative assessment was possible, which precluded the development of base figures to which those for the OCS scenario could be added.

TRANSPORTATION OF BEAUFORT SEA PERSONNEL

Employee figures are included as part of the scenario developments and permit a quantitative assessment of impacts similar to that for the previous category. These figures, in conjunction with assumptions about manning philosophies, were used to forecast air travel demands.

INDUCED STATE-WIDE TRANSPORTATION OF PERSONS AND GOODS

Induced transportation requirements depend on the location of permanent residences of employees hired directly or indirectly as a result of OCS development. The North Slope work camps are assumed to house only transients.

Induced transportation demand has two components, as follows: (1) freight needed to supply the induced households, including among other items building materials, household goods, and food, and (2) passenger transportation for recreational and business purposes. The latter category for Anchorage and Fairbanks will include frequent trips by automobile of short duration to nearby destinations and for all regions will include long, but infrequent trips by airplane.

Data does not exist to assess induced transportation demand directly; therefore, it is assessed qualitatively using as an indicator employment figures for the Anchorage, Fairbanks, and North Slope regions. Employment was chosen because data exists for both the non-OCS and OCS scenarios and because it relates closely to households, which is a basic trip-generating unit. Employment figures developed by ISER have been used for the analysis (Institute of Social and Economic Research, 1978a-d). For Anchorage and Fairbanks, the forecast employment increases for each scenario have been used directly. For the North Slope region, OCS on-site employment has been subtracted from that region's employment increases to eliminate the double-counting that occurs in regional totals. Tables 8-10 contain employment information for each of the regions.

TRANSPORTATION OF OIL TO MARKETS

It may be reasonably expected that substantial increases in volume throughput above 1.2 million barrels per day at the Alyeska terminal in Port Valdez will necessitate additional storage and berth capacity to be constructed. This conclusion is premised upon the notion that for a given fixed number of berths there exists a finite limit to the amount of time the berth can be occupied without suffering adverse economic impacts upon marine shipping due to delays incurred in arriving, loading and departing the Port of Valdez as a consequence of congestion. When a vessel arrives at Port Valdez, it may not be able to proceed directly to

TABLE 8

ANCHORAGE EMPLOYMENT FORECASTS BY SCENARIO
(Thousands of Persons)

Year	(1) Non-OCS (Annual Change)	(2) Camden-Canning (Annual Change)	(3) Prudhoe-Large (Annual Change)	(4) Prudhoe-Small (Annual Change)	(5) Cape Halkett (Annual Change)
1977	82.8	0.0	0.0	0.0	0.0
1978	83.2 (+0.4)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1979	86.7 (+3.5)	0.0 (0.0)	0.1 (+0.1)	0.0 (0.0)	0.0 (0.0)
1980	94.2 (+7.5)	0.0 (0.0)	0.2 (+0.1)	0.1 (+0.1)	0.0 (0.0)
1981	98.4 (+4.2)	0.1 (+0.1)	0.3 (+0.1)	0.3 (+0.2)	0.0 (0.0)
1982	97.3 (-1.1)	0.3 (+0.2)	0.4 (+0.1)	0.4 (+0.1)	0.0 (0.0)
1983	99.8 (+2.5)	0.4 (+0.1)	0.5 (+0.1)	0.5 (+0.1)	0.0 (0.0)
1984	103.0 (+3.2)	0.5 (+0.1)	0.5 (0.0)	0.5 (0.0)	0.0 (0.0)
1985	106.9 (+3.9)	0.5 (0.0)	0.7 (+0.2)	0.5 (0.0)	0.1 (+0.[illegible])
1986	109.8 (+2.9)	0.7 (+0.2)	3.1 (+2.4)	0.7 (+0.2)	0.2 (+0.2)
1987	111.5 (+1.7)	1.5 (+0.8)	3.6 (+0.5)	2.1 (+1.4)	0.1 (-0.6)
1988	112.6 (+1.1)	2.9 (+1.4)	3.8 (+0.2)	2.4 (+.3)	0.3 (+0.2)
1989	114.7 (+2.1)	3.0 (+0.1)	5.0 (+1.2)	2.8 (+0.4)	0.9 (+0.2)
1990	117.5 (+2.8)	4.0 (+1.0)	5.5 (+0.5)	2.6 (-0.2)	2.1 (+0.3)
1991	120.8 (+3.3)	4.4 (+0.4)	6.1 (+0.6)	3.0 (+0.4)	1.9 (-0.1)
1992	124.1 (+3.3)	4.9 (+0.5)	7.1 (+1.0)	3.1 (+0.1)	2.2 (+0.3)
1993	128.1 (+4.0)	5.2 (+0.3)	7.6 (+0.5)	3.5 (+0.4)	2.3 (+0.3)
1994	132.1 (+4.0)	6.0 (+0.8)	8.0 (+0.4)	4.0 (+0.5)	2.6 (+0.3)
1995	136.7 (+4.6)	6.6 (0.6)	8.7 (+0.7)	4.4 (+0.4)	2.9 (+0.[illegible])
1996	141.6 (+4.9)	6.5 (-0.1)	9.4 (+0.7)	4.6 (+0.2)	3.2 (+0.2)
1997	147.2 (+5.6)	7.2 (+0.7)	10.3 (+0.9)	4.9 (+0.3)	3.4 (+0.[illegible])
1998	153.2 (+6.[illegible])	7.4 (+.2)	11.3 (+1.0)	5.3 (+0.4)	3.8 (+.4)
1999	160.3 (7.[illegible])	7.9 (+0.5)	12.6 (+1.3)	[illegible] (+0.1)	4.0 (+.2)
2000	168.3 (+8.0)	8.8 (+0.9)	14.2 (+1.6)	[illegible] (+0.5)	4.4 (+0.4)

Note: Column (1) lists the tota employment in thousands for the non-OCS scenario in the g ven year. the figure in parenthesis represents the change in thousands from the previous year.

Columns (2) through (5) contain the employment n thousands for each scenario above the non-OCS case and, in parenthesis, the annua changes.

Source: Institute of Social and Economic Research, University of Alaska, 1978.

TABLE 9

FAIRBANKS EMPLOYMENT FORECASTS BY SCENARIO
(Thousands of Persons)

Year	(1) Non-OCS (Annual Change)	(2) Camden-Canning (Annual Change)	(3) Prudhoe-Large (Annual Change)	(4) Prudhoe-Small (Annual Change)	(5) Cape Halkett (Annual Change)
1977	33.9	0.0	0.0	0.0	0.0
1978	28.3 (-5.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1979	32.1 (-3.8)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1980	39.8 (+7.7)	0.0 (0.0)	0.1 (+0.1)	0.0 (0.0)	0.0 (0.0)
1981	39.2 (-0.6)	0.0 (0.0)	0.1 (0.0)	0.1 (+0.1)	0.0 (0.0)
1982	30.8 (-8.4)	0.1 (+0.1)	0.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1983	30.8 (0.0)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1984	31.4 (+0.6)	0.1 (0.0)	0.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1985	32.0 (+0.6)	0.1 (0.0)	.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1986	32.4 (+0.4)	0.1 (0.0)	0.3 (+0.2)	0.1 (0.0)	0.0 (0.0)
1987	32.6 (+0.2)	0.2 (+0.1)	0.4 (+0.1)	0.3 (+0.2)	0.0 (0.0)
1988	32.4 (-0.2)	0.3 (+0.1)	0.7 (+0.3)	0.4 (+0.1)	0.0 (+0.1)
1989	32.6 (+0.2)	0.4 (+0.1)	1.0 (+0.3)	0.5 (+0.1)	0.1 (0.1)
1990	32.8 (+0.2)	0.5 (+0.2)	1.0 (0.0)	0.5 (0.0)	0.2 (0.0)
1991	33.2 (+0.4)	0.7 (+0.1)	1.1 (+0.1)	0.5 (0.0)	0.2 (0.2)
1992	33.4 (+0.2)	0.8 (+0.1)	1.2 (+0.1)	0.5 (0.0)	0.4 (0.0)
1993	33.8 (+0.4)	0.9 (+0.1)	1.3 (+0.1)	0.6 (+0.1)	0.4 (0.0)
1994	34.1 (+0.3)	0.9 (0.0)	1.3 (0.0)	0.6 (0.0)	0.4 (0.0)
1995	34.5 (+0.4)	0.0 (+0.1)	1.3 (0.0)	0.7 (+0.1)	0.4 (-0.0)
1996	34.9 (+0.4)	.9 (-0.1)	1.4 (+0.1)	0.7 (0.0)	.5 (0.1)
1997	35.3 (+0.4)	1.0 (+0.1)	1.4 (0.0)	0.7 (0.0)	0.5 (0.0)
1998	35.8 (+0.5)	0.9 (-0.1)	1.5 (+0.1)	0.7 (0.0)	0.5 (0.0)
1999	36.3 (+0.5)	0.9 (0.0)	1.5 (0.0)	0.6 (-0.1)	0.5 (0.0)
2000	36.8 (+0.5)	1.0 (+1.0)	1.6 (+0.1)	0.7 (+0.1)	0.5 (0.0)

Note: Column (1) lists the tota' employement in thousands for the non-OCS scenario in the given year. The figure in parenthesis represents the change in thousands from the previous year.

Columns (2) through (5) conta n the employment in thousands for each scenar o above the non-OCS case and, in parenthesis, the annua change.

Source: Institute of Social and Economic Research, University of Alaska, 1978.

TABLE ○

NORTH SLOPE INDUCED EMPLOYMENT FORECASTS BY SCENARIO
(Thousands of Persons)

Year	(1) Non-OCS (Annual Change)	(2) Camden-Canning (Annual Change)	(3) Prudhoe-Large (Annual Change)	(4) Prudhoe-Small (Annual Change)	(5) Cape Halkett (Annual Change)
1977	6.5	0.0	0.0	0.0	0.0
1978	5.0 (-1.5)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1979	6.6 (+1.6)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1980	8.3 (+1.7)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
1981	8.9 (+0.6)	0.0 (0.0)	0.1 (+0.1)	0.1 (+0.1)	0.0 (0.0)
1982	6.8 (-2.1)	0.0 (0.0)	0.1 (0.0)	0.1 (0.0)	0.0 (0.0)
1983	6.7 (-0.1)	0.1 (+0.1)	0.2 (+0.1)	0.2 (+0.1)	0.0 (0.0)
1984	6.9 (+0.2)	0.1 (0.0)	0.2 (0.0)	0.2 (0.0)	0.0 (0.0)
1985	7.0 (+0.1)	0.1 (0.0)	0.3 (+0.1)	0.1 (-0.1)	0.0 (0.0)
1986	7.3 (+0.3)	0.3 (+0.2)	2.7 (+2.4)	.4 (+0.3)	0.1 (+0.1)
1987	7.0 (-0.3)	1.0 (+0.7)	2.4 (-0.3)	.4 (+1.0)	0.1 (0.5)
1988	6.1 (-0.9)	.9 (+0.9)	.4 (-2.0)	0.0 (-0.4)	0.2 (+0.8)
1989	5.8 (-0.3)	.5 (-0.4)	0.4 (0.0)	0.7 (-0.3)	.7 (+0.[illegible])
1990	5.8 (0.0)	.3 (-0.2)	0.4 (0.0)	0.4 (-0.3)	.5 (+0.5)
1991	5.9 (+0.1)	0.9 (-0.4)	0.5 (+0.1)	0.4 (0.0)	0.0 (-0.7)
1992	6.0 (+0.1)	0.7 (-0.2)	0.5 (+0.1)	0.3 (-0.1)	0.3 (-0.1)
1993	6.2 (+0.2)	0.4 (-0.3)	0.5 (+0.1)	0.4 (+0.1)	0.2 (-0.0)
1994	6.3 (+0.1)	0.6 (+0.2)	0.5 (+0.1)	0.4 (0.0)	0.2 (0.1)
1995	6.5 (+0.2)	0.7 (+0.1)	0.6 (+0.1)	0.3 (-0.1)	0.3 (+0.0)
1996	6.7 (+0.2)	0.4 (-0.3)	0.6 (0.0)	.4 (+0.1)	.3 (0.1)
1997	6.8 (+0.1)	0.6 (+0.2)	6 (0.0)	0.4 (0.0)	0.2 (-0.1)
1998	7.0 (+0.2)	0.4 (0.0)	0.7 (+0.1)	0.4 (0.0)	0.3 (+0.0)
1999	7.3 (+0.3)	0.4 (0.0)	0.7 (0.0)	0.4 (0.0)	0.3 (0.0)
2000	7.5 (+0.2)	0.6 (+0.2)	0.8 (+0.1)	0.4 (0.0)	0.3 (0.[illegible])

Note: Column (1) lists the total employment in thousands for the non-OCS scenario in the given year. The figure in parenthesis represents the change in thousands from the previous year.

Column (2) through (5) contain the employment in thousands for each scenario above the non-OCS case and, in parenthesis, the annual change.

Source: Institute of Social and Economic Research, University of Alaska, 1978.

a berth and immediately begin cargo operations. This delay may be due to port congestion, lack of sufficient berths to handle forecast throughput, delays resulting from inclement weather, or a number of other factors.

Robert J. Nathan Associates, Inc., developed design criteria for the U. S. Army Corps of Engineers to be applied to crude oil terminals, which can handle large vessels. These criteria are as follows:

Number of Berths	Berth Occupancy Factor (%)
1	27
2	51
3	62
4	70
5	74
6 and over	75

Further analysis suggests that the current facilities of the Alyeska terminal (four berths) would provide sufficient berths to accommodate 680 vessel callings per year assuming a 1.5 day service time per vessel. If it is assumed that the average size vessel calling at Port Valdez is 108,862 DWMT (120,000 DWT), daily throughput is estimated to be approximately 1,600,000 barrels. The first year that flow from the TransAlaska Pipeline has been projected to exceed this figure is 1981 (Dames and Moore, 1978).

An expansion of the crude oil facility of Port Valdez by one additional berth would allow the facility to serve approximately 900 vessel callings per year. This would increase the potential daily throughput to greater than 2,000,000 barrels per day.

TRANSPORTATION IMPACTS

Transportation impacts can be of three types. First, there are impacts on the level of service when a capacity restraint situation exists. The discussion of the non-OCS scenario concluded that except for local road traffic and airports in the major urban cities of Fairbanks and Anchorage no significant level of service impacts would occur. The reasons center on the existence of excess capacity, the ability of shippers to use alternative modes or ports of entry without incurring significant penalties, and the relative ease of carriers to increase capacities. A second type is accelerated damage to facilities, which was found to be limited to roadways, especially during break-up. The third type, which has not been previously discussed is the rollercoaster effect of large fluctuating demands. Given the large, short-term impacts of gas line construction, this type of impact deserves consideration. To the extent that transportation demands related to Beaufort Sea OCS tend to counter a rollercoaster effect or enforce a steady increase, transportation groups will be willing to respond in advance to forecasted increases in demand. Conversely, to the extent that OCS demands create or accentuate a rollercoaster effect, they may not be willing to do so.

Transportation Requirements for OCS Development Scenarios

INTRODUCTION

The types of transportation impacts as well as the considerations that go into determining the mode and location of impacts have been described in the previous section. This section concentrates on developing the extent of transportation demands for passenger and freight movements. The resulting data then " cads to specifics about modal split and impacts by taking into account. the previous discussions.

For passenger movements to and from Beaufort Sea activities, a simple one-step process is involved, since such movements will all be carried by the air mode and passengers will use Fairbanks as an intermediate or final destination except for those workers residing permanently on the North Slope. For freight, the process is more complex, since three modes are invo' ved and a total of four links ending at the Beaufort Sea are involved, as shown in Figure 9. Once total tonnages have been established, seasonal considerations and the breakdown of freight categories are used to establish peak and annual tonnage figures by year for each mode. For the air and road modes, only one link exists to the North Slope, so that a further breakdown is unnecessary. For the waterborne mode, however, a further split is estimated for the two available routings -- via the Bering Straits and via the Mackenzie River.

Previous chapters have confirmed that adequate capacity exists for al 1 transportation facilities studied, with the exception of airports at Anchorage and Fairbanks and severs' road sections that experience heavy recreational traffic in the summer, The low modal split for air and highway modes that is projected means that the contribution of OCS activities to congestion of these facilities will be marginal. For example, no scenario is expected to produce more than four daily emplanings (two round-trips per day).

A detailed discussion of assumptions and methodology is presented for the Camden-Canning scenario. Briefer discussions appear for the other scenarios, since the same basic assumptions and methodology apply.

CAMDEN-CANNING SCENARIO

The Camden-Canning Scenario assumes that 18 exploratory wells will be drilled between 1980 and 1987, with no more than three wells to be drilled in any one year. An additional 520 development and production wells are slated with a maximum of 64 in any one year (Dames and Moore, 1978). It is further assumed that drilling operations will require a maximum of 10 drilling rigs. Table 11 shows the year-by-year scheduling of the 538 wells.

Pipeline requirements were developed assuming that pipe for underwater development purposes arrives coated and will have the following quantities and weights: 148 km. (92 mi.) of 30.5 cm. (12 in.) connecting pipes at 144 metric tons (159 short tons) per mile, and 19 km. (12 mi.) of 61 cm. (24 in.) underwater trunk lines at 491 metric tons (541 short tons) per mile. It was further assumed that the 86 cm (34 in.) onshore trunk line tonnage requirement would be 429 metric tons (473 tons) per mile. The total weight to be transported is equal to 65,502 metric tons (72,204 tons) to be delivered in three annual shipments averaging 21,825 metric tons (24,068 tons) each commencing in 1988. Insulation requirements for the above-ground portion of the pipe and for road and/or work

TABLE 11

CAMDEN-CANNING SCENARIO

Year	Wells	Rigs	Tonnage Short Tons	Fuel Tonnage Short Tons	Goods Tonnage Short Tons	Pipe Tonnage Short Tons	Total Tonnage Short Tons
1980	1	(1)	1,840	1,380	1,665		4,885
1981	2	(1)	1,840	2,760	3,330		7,930
1982	3	(1)	1,840	4,140	4,995		10,975
1983	3			4,140	4,995		9,135
1984	3			4,140	4,995		9,135
1985	19			26,220	31,635		57,855
1986	34	(1)	1,840	46,920	56,610	24,068	129,438
1987	49	(2)	3,680	67,620	81,585	24,068	176,953
1988	64	(4)	7,360	88,320	106,560	24,068	226,308
1989	64			88,320	106,560		194,880
1990	64			88,320	106,560		194,880
1991	64			88,320	106,560		194,880
1992	48			66,240	80,240		146,160
1993	32			44,160	53,280		97,440
1994	32			44,160	53,280		97,440
1995	24			33,240	39,960		73,200
1996	16			22,080	26,960		49,040
1997	8			11,040	13,320		24,360
1998	8			11,040	13,320		24,360
1999							
2000							

Note: Short ton figures are readily converted to metric tons using the conversion factor 0.907

Source: Dennis Dooley and Associates, 1978.

pad requirements were assumed to be transported in loads which needed to be cubed out.

For purposes of arriving at relative orders of magnitude for the shipping requirements, Table 11 illustrates the industrial tonnage requirements associated with the scenario development plan. Note that tonnage requirements associated with road, pipeline, and camp construction are not included. Standards associated with various design parameters as they affect construction practices and attendant requirements for equipment and life support systems (sewage, fuel, maintenance, etc.) vary so widely as to be of little utility in this discussion. It should be remembered that these support requirements, although important, are of little relative significance when compared to the major requirements associated with field development.

The following assumptions were used to develop comparative values for shipping requirements during the development of each scenario: all wells (exploratory and production) would require 272 metric tons (300 tons) of casing, 1,225 metric tons (1350 tons) of dry bulk (barite, cement, bentonite), 1,089 metric tons (1200 tons) of fuel and approximately 14 metric tons (30 tons) of miscellaneous consumable goods of which approximately 15 tons would arrive periodically throughout a well's drilling program; an additional fuel allowance of 15% was included to represent requirements for ancillary support (helicopter, camp fuel, etc.); drilling rigs were assumed to weigh approximately 1,669 metric tons (1840 tons) each (no distinction was made between an exploratory drilling rig and a production drilling rig).

Modal split requirements for delivery of the major industrial goods to the field are primarily predicated upon the following assumptions:

- Fuel distribution requirements to service the various exploration and development platforms and staging areas are not expected to be dependent upon tanker, truck or plane delivery systems as the onshore drilling technology does today. Limited durations of sufficient sea-ice strength to accommodate truck loads and/or aircraft landings in close proximity to the drill rigs suggest that annual fuel stores be provided during the summer months. Such a system may be reasonably provided by delivery of fuel by tanker(s) and/or barge(s) during an annual sea-lift which would then lighter to shallow draft barges that are dedicated to a platform's annual storage requirements. Such a strategy, however, may be limited due to insufficient tonnage of such vessels available in the certificated Jones Act tank vessel fleet. In that event, it is possible that fuel could be transported from Hay River in foreign vessels under a year-round charter which could relieve some requirements for U. S. barge capacity. A fuel storage fleet would, during the heaviest requirements (1987-1994), would require at least 15 fuel vessels (13 platform and 2 staging areas) with an average capacity of 4,872 DWMT (5,370 DWT) per platform storage and 5,443 DWMT (6,000 DWT) for each staging area for support requirements (diesel, aviation gas, jet fuel, etc.).

- Industrial goods tonnage are also expected to be shipped principally by the marine sea-lift. Of the assumed 1,510 metric tons (1,665 tons) of goods required for development of each well, it is expected that only approximately 14 metric tons (15 tons) are composed of miscellaneous consumption goods (parts stores, etc.) that would require frequency of delivery to be greater than once per year. These deliveries would be accomplished chiefly by truck except during the annual break-up period when support by air service from Fairbanks is expected.

- The remaining transportation services are expected to be performed by the trucking and air modes. The principal requirements are assumed to be functions of man-power levels; namely, consumable camp stocks and transportation for labor force from oil field camps to principle places of residence. Consumable camp stocks are estimated to be approximately 190 kg. (420 lbs.) per man-month, which is based on 6.4 kg. (14 lbs.) per man-day, with peak requirements estimated to be 1.5 times the average man-month requirements (Dames & Moore, 1978).

Air Transportation

Table 12 illustrates the passenger requirements associated with air transportation. The air distribution of men and goods between work camps (staging areas) and work sites (rigs) is solely an oil field transportation support service. Variations in a platform's design, living quarters, stage of development, season, etc., limit seriously any general assumptions to be made regarding service requirements by helicopters or light planes. In any event such usage would be entirely within the oil field of operations and would not impose limitations upon the existing transportation infrastructure.

Direct transportation requirements to the work force between primary areas of residence and the Arctic are expected to occur entirely by air. The figures in Table 12 are developed by utilizing industry labor practices man-month requirements developed for the various scenarios (Dames and Moore, 1978). The number of required round trips to serve the labor force in each year were approximated by dividing a typical crew member's work cycle into the number of man-months projected for a particular activity. An example is that construction employment is assumed to be nine weeks work with one week off, for a total of 10 weeks or 2-1/2 man-months. Thus, 2.5 divided into an estimate of 25 man-months for a construction activity would yield a demand for approximately 10 round trips. The seating required to serve these round trips was further expanded by 100% to reflect three separate factors as follows: (1) man-month figures used for petroleum and construction include support staff that have smaller work cycles (generally one-week on, one-week off) than those discussed above; (2) a certain amount of excess seats must be provided so that all passengers can be accommodated, even when slight imbalances in demand exist, and (3) the large number of short-term travelers to work sites, e.g. inspectors, repairmen, design

TABLE 12

CAMDEN-CANNING
AIR PASSENGER SEAT REQUIREMENTS

Year	Annual Round Trips	Peak Monthly Seat Demand (1)	Passenger Seat Demand Per Day	737 Flights (2)
1980	2,514	314	10	0.1
1981	3,445	431	14	0.1
1982	3,239	405	13	0.1
1983	2,140	268	9	0.1
1984	3,693	462	15	0.1
1985	7,795	974	32	0.3
1986	16,774	2,097	70	0.6
1987	16,206	2,026	68	0.6
1988	27,654	3,457	115	1.0
1989	29,210	3,651	122	1.1
1990	32,920	4,115	137	1.2
1991	32,320	4,040	135	1.2
1992	33,112	4,139	138	1.2
1993	32,309	4,039	135	1.2
1994	27,776	3,472	116	1.0
1995	28,568	3,571	119	1.0
1996	26,096	3,262	109	0.9
1997	24,176	3,022	101	0.9
1998	22,256	2,782	93	0.8
1999	22,256	2,782	93	0.8
2000	20,336	2,542	85	0.7

Notes : (1) Peak monthly demand equals 1.5 times average monthly demand.
(2) 737 flights based on seating capacity of 115.

Source: Dennis Dooley and Associates, 1978.

engineers, etc. who are unaccounted for in manpower charts. Peak activities were developed by assuming that peak activity would be approximately 1-1/2 times the average monthly man-months (12-1/2% of the annual man-months)(Dames and Moore, 1978).

In addition, the assumption is made that demand is constant during the month and therefore the resulting number of passenger seats were divided by 30 to arrive at an average seat demand to transport workers during the peak months of oil field activity. Flights per week assumes use of a Boeing 737 in an all-passenger configuration (115 seats).

Peak air requirements for consumable commodities were developed by assuming that the major demand upon the air system would be imposed during the annual spring break-up period (duration of approximately six weeks). In addition, it was further assumed that consumption of industrial commodities and camp consumables is in direct proportion to manpower schedules. Peak periods for man-power availability occur in the fall and winter months necessitating that an assumption be made of the relative proportion of man-power being utilized during the spring. The air demands for spring break-up were developed with the assumption that average man-month utilization during this period was appropriate. Tables 13 and Table 14 illustrate the proportionate flight demands, assuming a 20,865 kg. (46,000 lb.) net weight allowance per plane load, generated by consumption of camp consumables and industrial consumables. The two separate demands (industrial and camp) are combined in Table 15 to illustrate the total air freight requirements which would take place

TABLE 13

CAMDEN-CANNING
PEAK AIR REQUIREMENTS FOR CAMP CONSUMABLES

Year	Monthly Average Employment (Man-Months)	Average Monthly Consumption (Pounds)	Spring Breakup 6-weeks (Pounds)	Spring Breakup Flights	Spring Breakup Flights Per Week (1)
1980		35,700	53,550	1.16	.2
1981	1::	60,480	90,720	1.97	.3
1982	138	57,960	86,940	1.89	.3
1983	110	46,200	69,300	1.51	.3
1984	273	114,660	171,990	3.74	.6
1985	698	293,160	439,740	9.56	1.6
1986	1,365	573,300	859,950	18.56	3.1
1987	1,034	434,280	651,420	14.16	2.4
1988	1,271	533,400	800,100	17.39	2.9
1989	1,125	472,500	708,750	15.41	2.6
1990	1,087	456,540	684,810	14.89	2.5
1991	1,010	424,200	636,300	13.83	2.3
1992	1,093	459,060	688,590	14.97	2.5
1993	1,089	457,383	686,070	4.91	2.5
1994	868	364,560	546,840	1.89	2.0
1995	951	399,420	599,130	3.02	2.2
1996	819	343,980	515,970	1.22	1.9
1997	759	318,780	478,170	0.40	T*7
1998	699	293,580	440,370	9.57	1.6
1999	699	293,580	440,370	9.57	1.6
2000	639	268,380	402,570	8.75	1.5

Notes: (1) Spring breakup flights/week = (monthly avg. empl.) x $\frac{\text{(420 lbs. /man-month)}}{\text{(46 ,0001 bs/aircraft)}}$ x $\frac{\text{(1.5 months/peak)}}{\text{(6 weeks/peak)}}$

Source: Dennis Dooley and Associates, 1978.

TABLE 14

CAMDEN-CANNING
CONSUMABLE INDUSTRIAL COMMODITY REQUIREMENTS BY MODE

Year	Wells	Annual Consumable Commodities @15 Short Tons/Well	Average Monthly Consumable (Short Tons)	Peak Flights per Week (1)	Peak Truck Loads per Month(2)
1980	1	15	1.25	neg.	.1
1981	2	30	2.5	neg.	.1
1982	3	45	3.75	neq.	.2
1983	3	45	3.75	nea.	.2
1984	3	45	3.75	neg.	.2
1985	19	285	23.75	.3	1.3
1986	34	510	42.50	.5	2.3
1987	49	735	61.25	.7	3.3
1988	64	960	80.00	.9	4.3
1989	64	960	80.00	.9	4.3
1990	64	960	80,00	.9	4.3
1991	64	960	80,00	.9	4.3
1992	48	720	60.00	.7	3.2
1993	32	480	40.00	.4	2.1
1994	32	480	40.00	.4	2.1
1995	24	360	30.00	.3	1.6
1996	16	240	20.00	.2	1.1
1997	8	120	10.00	.1	.5
1998					
1999					
2000					

Notes: (1) Peak flights per week = $\frac{\text{(Avg. Monthly Consumables)}}{\text{(23 short tons/aircraft)}} \times \frac{1}{\text{(4 weeks/month)}}$

(2) Peak truck loads per month = $\frac{\text{(Avg. Monthly Consumables)}}{\text{(28 short tons/semi -truck)}} \times$ (1.5 Avg. months/peakmonth)

Source: Dennis Dooley and Associates, 1978.

*

TABLE 15

CAMDEN-CANNING SCENARIO
PEAK AIR FLIGHTS PER WEEK
(Goods Transport)

Year	Industrial	Camp	Total
1980	neg.	.2	.2
1981	neg.	.3	.3
1982	neg.	.3	.3
1983	neg.	.3	.3
1984	neg.	.6	.6
1985	.3	1.6	1.9
1986	.5	3.1	3.6
1987	.7	2.4	3.1
1988	.9	2.9	3.8
1989	.9	2.6	3.5
1990	.9	2.5	3.4
1991	.9	2.3	3.2
1992	.7	2.5	3.2
1993	.4	2.5	2.9
1994	.4	2.0	2.4
1995	.3	2.2	2.5
1996	.2	1.9	2.1
1997	.1	1.7	1.8
1998	.1	1.6	1.7
1999		1.6	1.6
2000		1.5	1.5

Note: Peak for air flights is expected to occur during spring breakup, a period of six weeks.

Source: Dennis Dooley and Associates, 1978.

during spring break-up peak demand periods.

Truck Transportation

Peak truck requirements for consumable commodities were developed by assuming that major demands upon the road system would be of a year-round nature with the exception of six weeks during the spring break-up period.

Total tonnage requirements for camp consumables were developed as a function of average man-month for the scenario, minus the tonnage delivered by air. This gross annual truck tonnage was further adjusted by a factor of .143 (for 10-1/2 months, 0.095, multipled by 1.5) to develop estimates of monthly peak trucking demands measured in terms of fully utilized semi-truck loads 25,400 kg. (56,000 lbs.). Results are shown in Table 16.

Industrial commodity trucking requirements were developed assuming' that 13.6 metric tons (15 tons) per well represented industrial consumption requirements. Average monthly requirements were multiplied by 1.5 to reflect seasonal peak usage during the fall and winter months and adjusted to remeasured in terms of fully utilized semi-truck loads, 25,400 kg. (56,000 lbs.). Results are shown in Table 14. Total truck requirements for industrial and camp supplies are shown in Table 17.

Marine Transportation

Previous discussions have established the dominance that the marine mode is expected to have in the movement of industrial goods to the Beaufort

TABLE 16

CAMDEN-CANNING
TRUCK REQUIREMENTS FOR CAMP CONSUMABLES

Year	Annual Monthly Average Employment (Man-Months)	Annual Consumption (Pounds)	Truck Requirements (minus Herc. Supplies) (Pounds)	Annual Number of Truck Loads	Peak Truck Loads Per Month (1)
1980		428,400	374,850	6.7	1.0
1981	1::	725,760	635,040	11.3	1.6
1982	138	695,520	608,580	10.9	1.6
1983	110	554,400	467,460	8,3	1,2
1984	273	1,375,920	1,203,930	21.5	3.1
1985	698	3,517,920	3,078,180	55.0	7.9
1986	1,365	6,879,600	6,019,650	107.0	15.3
1987	1,034	5,211,360	4,559,940	81.4	11.6
1988	1,271	6,405,840	5,605,740	100.1	14.3
1989	1,125	5,670,000	4,961,250	88.6	12.7
1990	1,087	5,478,480	4,793,670	85.6	12.2
1991	1,010	5,090,400	4,454,100	79.5	11.4
1992	1,093	5,508,720	4,820,130	86.1	12.3
1993	1,089	5,488,560	4,802,490	85.8	12.3
1994	868	4,374,720	3,827,880	68.4	9.8
1995	951	4,793,040	4,193,910	74.9	10.7
1996	819	4,127,760	3,611,790	64.5	9.2
1997	759	3,825,360	3,309,390	59.1	8.5
1998	699	3,522,960	3,044,790	54.4	7.8
1999	699	3,522,960	3,044,790	54.4	7.8
2000	639	3,220,560	2,780,190	49.6	7.1

Notes: (1) Peak truck loads per month = $\frac{\text{(annual truck loads)}}{\text{(10.5 months truck traffic)}}$ x (1.5 months/peak month)

Source: Dennis Dooley and Associates, 1978.

TABLE 17

CAMDEN-CANNING
PEAK TRUCK SERVICE REQUIREMENTS PER MONTH

Year	Industrial	Camp	Total
1980	.1	1.0	1.1
1981	.1	1.6	1.7
1982	.2	1.6	1.8
1983	.2	1.2	1.4
1984	.2	3.1	.3
1985	1.3	7.9	9.2
1986	2.3	15.3	17.6
1987	3.3	11.6	14.9
1988	4.3	14.3	18.6
1989	4.3	12.7	17.0
1990	4.3	12.2	16.5
1991	4.3	11.4	15.7
1992	3.2	12.3	15.5
1993	2.1	12.3	14.4
1994	2.1	9.8	11.9
1995	1.6	10.7	12.3
1996	1.1	9.2	9.3
1997	0.5	8.5	9.3
1998	0.5	7.8	8.3
1999		7.8	7.8
2000		7.1	7.1

Note: Peak truck demand is expected to occur in the fall and winter months, coinciding with peak employment.

Source: Dennis Dooley and Associates, 1978.

Sea. The cost per ton of charter barges, as shown in Table 7, is almost one-half that of the trucking mode and one-fifth that of the air mode. Table 18 shows that the marine mode, on a tonnage basis, will likely account for 92-98% of material movements for the Camden-Canning Scenario.

Two marine routes will be utilized. Ocean-going tugs and barges will reach the Beaufort Sea via the Bering Straits, and inland water tugs and barges will use the Mackenzie River. The exact breakdown of traffic between these routes depends upon several factors which can only be estimated at this time. They include the source of goods and materials, the availability of barges, and the extent of other resource development activities in the Canadian and Alaskan Arctic regions.

Fuel, which represents approximately 45% of the total tonnage (see Table 11), will most likely come from western ports on ocean barges. Large structures for use at drilling sites and for onshore support facilities that can be prefabricated will be constructed on the west coast where practicable and shipped via ocean barges. Materials that are likely to be purchased in the Midwest, such as steel pipe and cement, will make up most of the Mackenzie River traffic.

Overall, 80% of the tonnage is assumed to go on ocean barges, and the remaining 20% by river barges. Average barge sizes of 907 metric tons (1,000 tons) and 4,536 metric tons (5,000 tons) have been assumed, respectively, for the river and ocean barges. The significantly smaller capacities of river barges result in a larger number of river than ocean barges, despite four times as much tonnage for the latter. The 1978 sea-lift to Prudhoe Bay from Puget Sound consisted of 10 barges carrying 34,473 metric tons (38,000 tons), or approximately 3,629 metric tons (4,oOO tons) per barge (Associated Press, 1978). The cargo was principal ly pre-fabricated modules as opposed to bulk goods.

The total marine tonnage estimated for the Camden-Canning Scenario exceeds in four years (1988-1991) the tonnage carried on the 1970 Prudhoe Bay sea-lift, which was the largest movement of marine cargo since World War II and amounted to 169,645 metric tons (187,000 tons) (CCC/HOK, 1978). The largest annual tonnage (1988) is approximately 20% greater than the 1970 figure. Tug and barge companies have a decade to build the necessary equipment to handle the traffic. This lead time, combined with the incremental nature of the increase above the peak flow to date, indicates that the industry should be able to adequately respond to transportation demands for this scenario.

The excess capacity that will be available in the air and truck modes and their proven ability to respond to sudden shifts in demand will insure that materials will reach their destination in a timely manner even if Arctic Ocean ice conditions severely limit tug and barge traffic. Time delays are costly to capital intensive activities, such as oil and gas exploration and development. Companies will make extensive use of trucks from Anchorage and Fairbanks to keep work on schedule if the demand for the marine can not be satisfied for one reason or another.

Combined peak usage demands by year are shown in Table 18.

Induced Statewide Transportation Demand

Induced transportation impacts will be examined separately for the Anchorage, Fairbanks, and North Slope Borough regions. The impact of induced demand depends upon the individual annual demand indicators, the sequence of annual changes, and the percentage change compared to the non-OCS scenario. These figures can be found on Tables 8-10.

For the non-OCS case in Anchorage, a steady increase in employment occurs except for two anomalies related to construction of the gas line, a sharp increase of 7,500 from 1979 to 1980 and a decrease of 1,100 from 1981 to 1982. That annual decrease is the only one forecast for Anchorage during the 1977-2000 study period.

The Camden-Canning Scenario shows a steadily increasing induced employment beginning at approximately 100 in 1981 and reaching 8,800 in 2000. Until 1987, its impact on the annual growth in Anchorage is insignificant, but thereafter the effect is to double the increase in demand that would otherwise have occurred. In other words, the induced employment for this later period is forecasted to be greater than the non-OCS annual change. Because of the induced demand, the road systems will be less able to accommodate traffic; but the impact on intercity, routes, termina"ls, and carriers will be more limited. Induced

TABLE 18
CAMDEN-CANNING
SUMMARY OF GOODS SHIPMENTS

	Annual Truck and Air Tonnage (3)			Annual Marine Tonnage (3)			
Year	Industrial Consumables	camp Consumables	Modal Split	Industrial	Modal Split	Ocean Barges(1)	River Barges(2)
1980	15	214	4%	4,870	96%	1	1
1981	30	363	5%	7,900	95%	1	2
1982	45	348	3%	10,930	97%	2	2
1983	45	277	3%	9,090	97%	2	2
1984	45	688	7%	9,090	93%	2	2
1985	285	1,759	3%	57,570	97%	9	12
1986	510	3,440	3%	128,928	97%	21	26
1987	735	2,606	2%	176,218	98%	28	35
1988	960	3,203	2%	225,348	98%	36	45
1989	960	2,835	2%	193,920	98%	31	39
1990	960	2,739	2%	193,920	98%	31	39
1991	960	2,545	2%	193,920	98%	31	39
1997	720	2,755	2%	145,440	98%	23	29
1993	480	2,745	3%	96,960	97%	16	19
1994	480	2,188	3%	96,960	97%	16	19
1995	360	2,397	4%	72,840	96%	12	15
1996	240	2,064	5%	48,800	95%	8	10
1997	120	1,912	8%	24,240	92%	4	5
1998	120	1,761	7%	24,240	93%	4	5
1999	0	1,761	100%	0	0%	0	0
2000	0	1,610	100%	0	0%	0	0

Notes: (1) Ocean barges = (annual marine tonnage) x O. 80/5,000 tons/barge.
(2) River barges = (annual marine tonnage) x O. 20/1,000 tons/barge.
(3) Tonnage figures given in short tons, which are converted to metric tons using the conversion figure 0.907.

Source: Dennis Dooley and Associates, 1978.

intercity travel will be a smaller percentage of total traffic because of the large amount of visitors or in-transit passengers that pass through Anchorage. A similar argument can be advanced for induced freight demand. The induced demand during the study period reinforces the need for additional transportation facilities.

In Fairbanks, numerous inflection points occur in the non-OCS scenario between 1978 and 1983; but, thereafter, annual employment increases between 200 and 600 persons are the norm. Employment induced by Camden-Canning does not begin early enough to smooth out the erratic changes. Similar to Anchorage, scenario employment steadily increases and exceeds the non-OCS annual change beginning in 1988, but it never exceeds 1,000 employees during the study period. Induced employment throughout is roughly 15-20% of that for Anchorage. The build-up in transportation facilities that will occur for the gas line construction, even if inadequate, will be sufficient to accommodate subsequent increases, including that for the Camden-Canning Scenario.

The analysis of induced transportation demand in the North Slope Borough must consider that most workers will have permanent residences outside of the region. To estimate induced employment, actual on-site employment for the Camden-Canning Scenario was subtracted from the regional totals. The resulting numbers (Table 10) will slightly underestimate demand, since local residents certainly will perform some of the on-site tasks. This subtraction was not performed for the non-OCS control numbers because the appropriate figures were unavailable. For the North Slope

Borough, induced transportation demands, given the use of induced employment as an indicator, follows a different pattern than that for the major urban regions. Induced employment figures are lower than for the other regions which should make them easier to accommodate, but as a percentage of total non-OCS employment they are higher. Also, whereas induced demand increases throughout the study period in other regions, in the North Slope it more closely follows on-site employment levels, reaching a peak in the late 1980's and then declining. The timing of the peak for this scenario, however, has the effect of reducing employment losses that would otherwise occur, except for those occurring in the early 1980's. The impact of induced employment in the transportation sector principally will be to increase the demand for air passenger service between Barrow and Fairbanks and to a lesser extent points further south. In conjunction with the demand for Beaufort OCS on-site employees, an additional scheduled flight per day might be warranted. A larger base of demand might reduce the need for oil companies to engage in charter operations.

Summary

The Camden-Canning scenario, having the largest number of total wells (538) and the largest number per year (64), produces the largest impacts due to freight transportation. It is the only scenario to have projected annual tonnage greater than that for the 1970 sea-lift. During the years of largest tonnage, the modal split for waterborne commerce is expected to be 98%. Competition with existing demands for waterborne transportation should be minimal. Northern Transportation Co. Ltd. can be expected to expand as necessary its fleet of tugs and barges to accommodate increased development activities in the Northwest Territories and the Beaufort Sea. Oil companies will obtain the services of ocean-going tugs and barges on a charter basis and, thus, will minimize competition with existing scheduled services. Deployment of ocean-going equipment by large shipping companies, such as Crowley Maritime, occurs on a world-wide rather than a state-wide basis. Equipment used in the Middle East for part of a year could be used for Alaska trade the rest of the year. Exceptions are equipment designed especially for Arctic conditions.

The small amount of tonnage that will be transshipped through major Alaskan ports indicates that only slight competition will exist for such services as rail barges between Seattle and Whittier. The largest estimated tonnage in one year which will enter by water and then eventually travel by air or road from Fairbanks to the Beaufort Sea is expected to be less than 3,500 tons, or 3% of the total tonnage in that year (see Table 18).

Peak truck loads are expected when manpower is greatest in late fall and to reach a maximum of 19 per month in 1988. C-130 flights, which will occur during the spring breakup, peak at approximately four flights per week in the same year. Passenger flights will peak at approximately eight per week (1.2 per day) in 1990. Peak freight and passenger flight figures are not additive, since the peak demands occur at different times of the year, freight in the spring and passengers in the late fall.

PRUDHOE-SMALL SCENARIO

The Prudhoe-Small Scenario slates 12 exploration wells to be drilled between 1981 and 1987, with three wells the first year, two wells in each of the following three years, and one well during each of the next three years. In addition, 328 development and production wells are slated for field development with a maximum of 32 in any one year (Dames and Moore, 1978). It is further assumed that drilling will require five drilling rigs. Table 19 shows the year-by-year scheduling of the 340 wells.

Pipeline requirements were developed assuming that pipe for underwater development purposes arrived coated for displacement at the following rates: 113 km. (70 mi.) of 30.5 cm. (12 in.) connecting pipe at 144 metric tons (159 tons) per mile; 13 km. (8 mi.) of 4.6 cm (18 in.) underwater trunk line at 279 metric tons ('308 tons) per mile. It was further assumed that the 46 cm. (18 in.) onshore trunk line tonnage requirement was 225 metric tons (248 tons) per mile. The total weight of pipe to be transported is equal to 16,614 metric tons (18,314 tons) to be delivered in three annual shipments averaging 5,538 metric tons (6,105 tons) each, commencing in 1986. Insulation requirements for the above-ground portions of the pipe and for road and/or work pad requirements were assumed to be transported in loads which needed to be cubed out.

TABLE 19

PRUDHOE-SMALL
MAJOR INDUSTRIAL REQUIREMENTS

Year	Wells	Rigs	Tonnage (Short Tons)	Fuel Tonnage (Short Tons)	Goods Tonnage (Short Tons)	Pipe Tonnage (Short Tons)	Total Tonnage (Short Tons)
1980							
1981	3	(3)	1,840	4,140	4,995		10,975
1982	2			2,760	3,330		6,060
1983	2			2,760	3,330		6,090
1984	2			2,760	3,330		6,090
1985	1			1,380	1,665		3,055
1986	1			1,380	1,665	6,105	9,150
1987	17	(1)	1,840	23,460	28,305	6,105	59,710
1988	32	(1)	1,840	44,160	53,280	6,105	105,385
1989	32			44,160	53,280		97,440
1990	32			44,160	53,280		97,440
1991	32			44,160	53,280		97,440
1992	32			44,160	53,280		97,440
1993	32			44,160	53,280		97,440
1994	32			44,160	53,280		97,440
1995	24			33,120	39,960		73,080
1996	16			22,080	26,640		48,720
1997	16			22,080	26,640		48.720
1998							
1999							
2000							

Note: Short ton figures are readily converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

For the purposes of arriving at relative orders of magnitude for shipping requirements, Table 19 illustrates the industrial tonnage requirements associated with the scenario development plan. It is noted that tonnage requirements associated with road and pipeline construction are not stated. Standards associated with various design parameters as they affect construction requirements vary so widely as to be of little utility in this discussion. It should be remembered that these support requirements, although important, are of little relative significance when compared to major requirements associated with field development.

Modal-split assumptions are fully described in previous Camden-Canning Scenario.

Air Transportation

Air freight requirements for the Prudhoe-Small Scenario are most noticeable during the period 1987-1994 when work activity and man-power numbers are the highest. Passenger requirements peak in 1994-1995 with peak load equivalent to 80% of the carrying capacity of a 737 jet. Air support for industrial goods from Fairbanks appears to peak in the spring break-up periods 1988-90 with demands equivalent to approximately five Hercules cargo trips per month.

Truck Transportation

The truck transportation requirements to support the Prudhoe-Small Scenario peak during the years 1988-91 and approach approximately 10-14 truck loads per month during the fall and winter months.

Marine Transportation

Marine transportation requirements for the Prudhoe-Small Scenario requires a maximum sea-lift of approximately 95,254 metric tons (105,000 short tons) of which approximately 40,061 metric tons (44,160 tons) are fuel requirements. The number of ocean barges for this demand is expected to be approximately 16. Total marine shipping capacity would require approximately 36,423 DWMT (40,150 DWT) for fuel transport and approximately 50,167 DWMT (55,300 DWT) for goods transport.

Induced Statewide Transportation of Goods and Passengers

Induced transportation demand for this scenario in Anchorage and Fairbanks, given the use of employment as a primary indicator, will closely resemble the Camden-Canning Scenario until 1987 and after that its impacts will be approximately 30% less.

In the North Slope region, peak employment and subsequent decreases occur at the same time as for Prudhoe-Large; but peak employment is considerably less--2,700 compared to 1,400--and the decrease is spread out over a longer period of time.

Summary

Peak freight tonnage is approximately 60% of the figure reached by the 1970 sea-lift. Peak truck loads are approximately 14 per month, and peak air freight flights less than three per week. Peak passenger flights are approximately one per day. All demands, being less than

TABLE 20

PRUDHOE-SMALL
AIR PASSENGER SEAT REQUIREMENTS

Year	Annual Round Trips	Peak Monthly Seat Demand (1)	Passenger Seat Demand Per Day	737 Flights (2)
1980				
1981	1,909	239	8	0.1
1982	4,193	524	17	0.2
1983	1,957	245	8	0.1
1984	1,957	245	8	0.1
1985	1,208	151	5	0.0
1986	2,936	367	12	0.1
1987	12,992	1,624	54	0.5
1988	14,130	1,766	59	0.5
1989	20,390	2,549	85	0.7
1990	18,648	2,331	78	0.7
1991	18,840	2,355	79	0.7
1992	18,333	2,292	76	0.7
1993	19,224	2,403	80	0.7
1994	21,232	2,654	88	0.8
1995	21,232	2,654	88	0.8
1996	19,312	2,414	80	0.7
1997	17,392	2,174	72	0.6
1998	17,392	2,174	72	0.6
1999	13,552	1,694	56	0.5
2000	13,552	1,694	56	0.5

Notes: (1) Peak monthly demand equals 1.5 times average monthly demand.
(2) 737 flights based on seating capacity of 115.

Source: Dennis Dooley and Associates, 1978.

TABLE 21

PRUDHOE-SMALL
PEAK AIR REQUIREMENTS FOR CAMP CONSUMABLES

Year	Monthly Average Employment (Man-Months)	Average Monthly Consumption (Pounds)	Spring Breakup 6 weeks (Pounds)	Total Spring Breakup Flights	Spring Breakup Flights Per Week(1)
1980					
1981		25,200	37,800	.82	.14
1982	1!:	72,660	108,990	2.37	.39
1983	113	47,460	71,190	1.55	.26
1984	121	50,820	76,230	1.66	.28
1985	121	50,820	76,230	1.66	.28
1986	85	35,700	53,550	1.16	.19
1987	265	111,300	166,950	3.63	.60
1988	1,005	422,100	633,150	13.76	2.29
1989	856	359,520	539,280	11.72	1.95
1990	822	345,240	517,860	11.26	1.88
1991	641	269,220	403,830	8.78	1.46
1992	647	271,740	407,610	8.86	1.48
1993	600	252,000	378,000	8.22	1.37
1994	659	276,780	415,170	9.03	1.50
1995	667	280,140	420,210	9.14	1.52
1996	667	280,140	420,210	9.14	1.52
1997	607	254,940	382,410	8.31	1.39
1998	547 “	229,740	344,610	7.49	1.25
1999	547	229,740	344,610	7.49	1.25
2000	427	179,340	269,010	5.85	.97

Notes: (1) Spring Breakup Flights/week = (monthly avg. empl.) x $\frac{\text{(420 lbs. /man-month)}}{\text{(46,000 lbs. aircraft)}}$ x $\frac{\text{(1.5 months/peak)}}{\text{(6 weeks/peak)}}$

Source: Dennis Dooley and Associates, 1978.

TABLE 22

PRUDHOE-SMALL
INDUSTRIAL COMMODITIES

Year	Wel 1s	Annual Consumable Commodities @15 Short Tons/Well	Average Monthly Consumables (Short, Tons)	Peak Flights per Week (1)	Peak Truck Loads per Month (2)
1980					
1981	3	45	3.75	neg.	.2
1982	2	30	2.5	neg.	.1
1983	2	30	2.5	neg.	.1
1984	2	30	2.5	neg.	.1
1985	1	15	1.25	neg.	.1
1986	1	15	1.25	neg.	.1
1987	17	255	21.25	.2	1.1
1988	32	480	40.00	.4	2.1
1989	32	480	40.00	.4	2.1
1990	32	480	40.00	.4	2.1
1991	32	480	40.00	.4	2.1
1992	32	480	40.00	.4	2.1
1993	32	480	40.00	.4	2.1
1994	32	480	40 ,00	.4	2.1
1995	24	360	30.00	,3	1.6
1996	16	240	20.00	.2	1.1
1997	16	240	20.00	.2	1.1
1998					
1999					
2000					

Notes: (1) Peak flights per week = $\frac{\text{(Avg. Monthly Consumables)}}{\text{(23 Short Tons/Aircraft)}} \times \frac{\text{(1.5 months/peak period)}}{\text{(6 weeks/peak period)}}$

(2) Peak truckloads per week = $\frac{\text{(Avg. Monthly Consumables)}}{\text{(28 Short tons/semi-truck)}} \times \text{(1.5 Avg. months/peak month)}$

Source: Dennis Dooley and Associates, 1978.

TABLE 23

PRUDHOE-SMALL
PEAK AIR FLIGHTS PER WEEK
(Goods Transport)

Year	Industrial	Camp	Total
1980			
1981	neg.	.14	.14
1982	neg.	.39	.39
1983	neg.	.26	.26
1984	neg.	.28	.28
1985	neg.	.28	.28
1986	.2	.19	.21
1987	.4	.60	1.00
1988	.4	2.29	2.69
1989	.4	1.95	2.35
1990	.4	1.88	2.28
1991	.4	1.46	1.86
1992	.4	1.48	1.86
1993	.4	1.37	1.77
1994	.4	1.50	1.90
1995	.3	1.52	1.82
1996	.2	1.52	1.72
1997	.2	1.39	1.59
1998		1.25	1.25
1999		1.25	1.25
2000		.97	.97

Note: Peak for air flights is expected to occur during spring breakup, a period of six weeks.

Source: Dennis Dooley and Associates, 1978.

TABLE 24

PRUDHOE-SMALL
TRUCK REQUIREMENTS FOR CAMP CONSUMABLES

Year	Annual Monthly Average Employment (Man-Months)	Annual Consumption (Pounds)	Truck Requirements (minus Here. supplies) (Pounds)	Annual Number of Truck Loads	Peak Truck Loads Per Month (1)
1980					
1981	60	302,400	264,600	4.7	.7
1982	173	871,920	762,930	13.6	1.9
1983	113	569,520	498,330	8.9	1.3
1984	121	609,840	533,610	9.5	1.4
1985	121	609,840	533,610	9.5	1.4
1986	85	428,400	374,850	6.7	1.0
1987	265	1,335,600	1,168,650	20.9	3.0
1988	1,005	5,065,200	4,432,050	79.1	11.3
1989	856	4,314,240	3,774,960	67.4	9.6
1990	822	4,142,880	3,625,020	64.7	9.3
1991	641	3,230,640	2,826,810	50.5	7.2
1992	647	3,260,880	2,853,270	51.0	7.3
1993	600	3,024,000	2,646,000	47.2	6.8
1994	659	3,321,360	2,906,190	51*9	7.4
1995	667	3,361,680	2,941,470	52.5	7.5
1996	667	3,361,680	2,941,470	52.5	7.5
1997	607	3,059,280	2,676,870	47.8	6.8
1998	547	2,756,880	2,412,270	43.1	6.2
1999	547	2,756,880	2,412,270	43.1	6.2
2000	427	2,152,080	1,883,070	33.6	4.8

Notes: (1) Peak truck loads/month = $\frac{\text{(annual truck loads)}}{\text{(10.5 months truck traffic)}}$ x (1.5 months/peak month)

Source: Dennis Dooley and Associates, 1978.

TABLE 25

PRUDHOE-SMALL
TRUCK SERVICE REQUIREMENTS

Year	Industrial	Camp	Total
1980			
1981	.2	.7	.9
1982	.1	1.9	2.0
1983	.1	1.3	1.4
1984	.1	1.4	1.5
1985	.1	1.4	1.5
1986	.1	1.0	1.1
1987	1.1	3.0	4.1
1988	2.1	11.3	13.4
1989	2.1	9.6	11.7
1990	2.1	9.3	11.4
1991	2.1	7.2	9.3
1992	2.1	7.3	9.4
1993	2.1	6.8	8.9
1994	2.1	7.4	9.5
1995	1.6	7.5	9.1
1996	1.1	7.5	8.6
1997	1.1	6.8	7.9
1998		6.2	6.2
1999		6.2	6.2
2000		4.8	4.8

Note: Peak truck demand is expected to occur in the fall and winter months, coinciding with peak employment.

Source: Dennis Dooley and Associates, 1978.

TABLE 26

PRUDHOE-SMALL
SUMMARY OF GOODS SHIPMENTS

Year	Annual Truck and Air Tonnage (3)			Annual Marine Tonnage (3)			
	Industrial Consumables	Camp Consumables	Modal Split	Industrial	Modal Split	Ocean Barges(1)	River Barges(2)
1980	0	0	0%	0	0%	0	0
1981	45	151	1%	14,479	99%	3	3
1982	30	436	8%	5,594	92%	1	1
1983	30	228	4%	5,832	96%	1	1
1984	30	305	6%	5,755	94%	1	1
1985	15	305	10%	2,735	90%	1	0
1986	15	214	3%	8,921	97%	1	2
1987	255	668	2%	58,787	98%	9	12
2988	480	2,533	3%	102,372	97%	16	20
1989	480	2,157	3%	94,803	97%	15	19
1990	480	2,071	3%	94,889	97%	15	19
1991	480	1,615	2%	95,345	98%	15	19
1992	480	1,630	2%	95,330	98%	15	19
1993	480	1,512	2%	95,448	98%	15	19
1994	480	1,667	2%	95,293	98%	15	19
1995	360	1,681	3%	71,039	97%	11	14
1996	240	1,681	4%	46,799	96%	7	9
1997	240	1,530	4%	46,950	96%	8	9
1998	0	1,378	100%	0	0%	0	0
1999	0	1,378	100%	0	0%	0	0
2000	0	1,076	100%	0	0%	0	0

Notes: (1) Ocean barges = (annual marine tonnage) x 0. 80/(5,000 tons/barge).
(2) River barges = (annual marine tonnage) x 0. 20/(1,000 tons/barge).
(3) Tonnage figures given in short tons, which are converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

what has been accomplished during recent years, should be met with little difficulty by shippers.

CAPE HALKETT SCENARIO

The Cape Halkett Scenario has eight exploration wells which will be drilled between 1985 and 1989 and 160 additional wells associated with field development (Dames and Moore, 1978). Two exploratory wells are to be drilled in 1985 with three wells the following year and one well each year for the subsequent three years. Production drilling commences in 1990 and proceeds to 1998 with a total of 160 wells drilled for field development. It is expected that the maximum number of wells drilled will not exceed 24 in any one year.

Pipeline tonnage requirements were developed assuming that pipe for underwater development purposes arrived sufficiently coated to neutralize the pipe's buoyancy. Tonnages were developed with the following assumptions: 6.8 km. (42. mi.) of 30.5 cm. (12 in.) connecting pipe at 144 metric tons (159 short tons) per mile; 66 km. (41 mi.) of underwater trunk line at 429 metric tons (473 short tons) per mile. It was further assumed that the onshore trunk line tonnage requirement was 144 metric tons (159 short tons) per mile. The total weight of pipe to be transported is equal to 29,025 metric tons (31,995 short tons) to be delivered in three annual shipments averaging' 9,675 metric tons (10,665 tons) each, commencing in 1989. Insulation requirements for the above-ground portions of the pipe and for road and/or work pad requirements were assumed to be transported in loads which need to be cubed out.

Table 27 illustrates the industrial tonnage requirements associated with the scenario development plan. Assumptions for passenger air service are described in Camden-Canning Scenario.

Air Transportation

Air transportation requirements are most noticeable during the 1993-99 time period. Passenger seat requirements peak with a demand of approximately 67 seats per day. This demand is expected to recur during peak periods of employment

Air support for industrial and camp goods routed through Fairbanks are expected to peak during the period of high employment and construction activity in the late fall and early winter months. Cape Halkett's major camp location removed from an over-land road coupled with distance of approximately 150 km. (93 mi.) from Prudhoe Bay suggests that air support will be the major mode by which consumable industrial and camp goods will be transported. It is expected that during the peak period of 1991 a service level equivalent to three-four Hercules flights per week will be adequate to service the demand generated in this scenario.

Truck Transportation

The truck transportation requirements to support the Cape Halkett Scenario appear to be negligible. The distance from the Prudhoe complex, lack of an over-land road system, low tonnage requirements--all combine to encourage an operator to utilize air service rather than attempt to maintain an over-ice route for three-four months per year.

TABLE 27

CAPE HALKETT
MAJOR INDUSTRIAL REQUIREMENTS

Year	Wells	Rigs	Tonnage (Short Tons)	Fuel Tonnage (Short Tons)	Goods Tonnage (Short Tons)	Pipe Tonnage (Short Tons)	Total Tonnage (Short Tons)
1980							
1981							
1982							
1983							
1984							
1985	2	(2)	3,680	2,760	3,330		9,770
1986	3	(1)	1,840	4,140	4,995		10,975
1987	1			1,380	1,665		3,045
1988	1			1,380	1.665		3,045
1989	1			7,380	1,665	10,665	13,710
1990	8			11,040	13,320	10,665	35,025
1991	16			22,080	26,640	10,665	59,385
1992	24			33,120	39,960		73,080
1993	24			33,120	39,960		73,080
1994	24			33,120	39,960		73,080
1995	24			33,120	39,960		73,080
1996	24			33,120	39,960		73,080
1997	8			11,040	13,320		24,360
1998	8			11,040	13,320		24,360
1999							
2000							

Note: Short ton figures are readily converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

Marine Transportation

Marine transportation requirements for the Cape Halkett Scenario require sea-lift operations which would peak during the period 1992-96 in the order of 66,210 metric tons (73,00 tons) of which approximately 30,040 metric tons (33,120 tons) are fuel requirements. During this period, twelve ocean barges have been forecast and 14 river barges. Total marine shipping capacity at peak would require approximately 27,215 DWMT (30,000 DWT) for fuel transport and approximately 32,658 DWMT (36,000 DWT) for goods transport.

Induced Statewide Transportation of Goods and Passengers

This scenario in Fairbanks and Anchorage for any given year will have less of an impact from induced transportation demands than for any of the other three scenarios (see Tables 8-10).

In the North Slope region, peak induced employment is forecast to be 1,500, or slightly more than that for Prudhoe-Small. However, this peak occurs in 1990, three years later than that for Prudhoe-Small, with the result that Cape Halkett trends tend to cancel out fluctuations appearing in the non-OCS scenario at that time.

Summary

The Cape Halkett scenario has the lowest number of total wells (340) and wells in any one year (24) and, consequently, its impacts are less than those of the other scenarios. Total freight tonnage does not exceed 66,224 metric tons (73,380 tons) in any one year. Peak air freight slights do not exceed four per week, despite the fact that road travel

TABLE 28

CAPE HALKETT
AIR PASSENGER SEAT REQUIREMENTS

Year	Annual Round Trips	Peak Monthly Seat Demand (1)	Passenger Seat Demand Per Day	737 Flights (2)
1980				
1981				
1982				
1983				
1984				
1985	955	119	4	0.0
1986	2,199	275	9	0.1
1987	2,839	355	12	0.1
1988	640	80	3	0.0
1989	1,654	207	7	0.1
1990	4,511	564	19	0.2
1991	9,963	1,245	42	0.4
1992	8,774	1,097	37	0.3
1993	16,077	2,010	67	0.6
1994	15,792	1,974	66	0.6
1995	15,984	1,998	67	0.6
1996	15,984	1,998	67	0.6
1997	15,984	1,998	67	0.6
1998	14,704	1,838	61	0.5
1999	14,704	1,838	61	0.5
2000	12,784	1,598	53	0.5

Notes: (1) Peak monthly demand equals 1.5 times average monthly demand.
(2) 737 flights based on seating capacity of 115.

Source: Dennis Dooley and Associates, 1978.

TABLE 29

CAPE HALKETT
PEAK AIR REQUIREMENTS FOR CAMP CONSUMABLES

Year	Monthly Average Employment Man-Months	Average Monthly Consumption (Pounds)	Peak Monthly Consumption (Pounds)	Peak Flights Per Month	Peak Flights Per Week
1980					
1981					
1982					
1983					
1984					
1985	30	12,600	18,900	.41	.10
1986	83	34,860	52,290	1.14	.29
1987	113	47,460	71,190	1.55	.39
1988	29	12,180	18,270	.40	.10
1989	135	56,700	85,050	1.85	.46
1990	432	181,446	272,160	5.92	1.48
1991	884	371,280	556,920	12.11	3.03
1992	606	254,520	381,780	8.30	2.08
1993	527	221,340	332,010	7.22	1.81
1994	497	208,740	313,110	6.81	1.70
1995	503	211,260	316,890	6.89	1.72
1996	503	211,260	316,890	6.89	1.72
1997	503	211,260	316,890	6.89	1.72
1998	463	194,460	291,690	6.34	1.59
1999	.463	194,460	291,690	6.34	1.59
2000	403	169,260	253,890	5.52	1.38

Notes: (1) Spring breakup flights/week = (Monthly Avg. Empl.) x $\frac{\text{(420 lbs./man-month)}}{\text{(46,000 lbs/aircraft)}}$ x $\frac{\text{(1.5 months/peak month)}}{\text{(4 weeks/month)}}$

Source: Dennis Dooley and Associates, 1978.

TABLE 30

CAPE HALKETT
INDUSTRIAL COMMODITIES

Year	Wells	Annual Consumable Commodities @15 Short Tons/Well	Average Monthly Consumption (Short Tons)	Peak Flights Per Week (1)
1980				
1981				
1982				
1983				
1984				
1985	2	30	2.50	.03
1986	3	45	3.75	.04
1987	1	15	1.25	.01
1988	1		1.25	.01
1989	8	1;;	10.00	.11
1990	16	240	20.00	.22
1991	24	360	30.00	.33
1992	24	360	30.00	.33
1993	24	360	30.00	.33
1994	24	360	30.00	.33
1995	24	360	30.00	.33
1996	24	360	30.00	.33
1997	8	120	10.00	.11
1998	8	120	10.00	.11
1999				
2000				

Notes: (1) Peak Flights per week $= \frac{\text{(Avg. Monthly Consumables)}}{\text{(23 Short Tons/aircraft)}} \times \frac{1}{\text{(4 weeks/month)}}$

Source: Dennis Dooley and Associates, 1978.

TABLE 31

CAPE HALKETT
PEAK AIR FLIGHTS PER WEEK
(Goods Transport)

Year	Industrial	Camp	Total
1980			
1981			
1982			
1983			
1984			
1985	.03	.10	.13
1986	.04	.29	.33
1987	.01	.39	.40
1988	.01	.10	.11
1989	.11	.46	.57
1990	.22	1.48	1.70
1991	.33	3.03	3.36
1992	.33	2.08	2.41
1993	.33	1.81	2.14
1994	.33	1.70	2.03
1995	.33	1.72	2.05
1996	.33	1.72	2.05
1997	.11	1.72	1.83
1998	.11	1.59	1.70
1999		1.59	1.59
2000		1.38	1.38

Note: Peak for air flights is expected to occur during spring breakup, a period of six weeks.

Source: Dennis Dooley and Associates, 1978.

TABLE 32

CAPE HALKETT
SUMMARY OF GOODS SHIPMENTS

	Annual Truck and Air Tonnage (3)			Annual Marine Tonnage (3)			
Year	Industrial Consumables	Camp Consumables	Modal Split	Industrial	Modal Split	Ocean Barges(1)	River Barges(2)
1980							
1981							
1982							
1983							
1984							
1985	30	76	1%	9,664	99%	2	2
1986	45	209	2%	10,721	98%	2	2
1987	15	285	10%	2,745	90%	1	1
1988	15	73	3%	2,957	97%	1	1
1989	120	340	3%	13,250	97%	2	3
1990	240	1,089	4%	33,696	96%	5	7
1991	360	2,228	4%	56,797	96%	9	12
1992	360	1,527	3%	71,193	97%	12	14
1993	360	1,328	2%	71,392	98%	12	14
1994	360	1,252	2%	71,468	98%	12	14
1995	360	1,268	2%	71,452	98%	12	14
1996	360	1,268	2%	71,452	98%	12	14
1997	120	1,268	6%	22,852	94%	4	5
1998	120	1,167	100%	0	0%	0	0
1999	0	1,167	100%	0	0%	0	0
2000	0	1,016	100%	0	0%	0	0

Notes: (1) Ocean barges = (annual marine tonnage) x 0.80/(5,000 tons/barge).
(2) River barges = (annual marine tonnage) x 0. 20/(1,000 tons/barge).
(3) Tonnage figures given in short tons, which are converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

is considered negligible due to the expense that would be required to construct and maintain a road to the nearest shoreline.

PRUDHOE-LARGE SCENARIO

The Prudhoe-Large Scenario has 14 exploration wells to be drilled between 1981 and 1987 and an additional 290 development wells during the period 1986-1995. It is expected that the maximum number of wells drilled will not exceed 48 in any one year.

Pipeline tonnage requirements were developed assuming that pipe for underwater development purposes arrived sufficiently coated to neutralize the pipe's buoyancy during construction. Tonnages were developed with the following assumptions: 116 km. (72 mi.) of 30.5 cm. (12 in.) connecting pipe at 144 metric tons (159 short tons) per mile; 13 km. (8 mi.) of underwater trunk line at 862 metric tons (950 short tons) per mile. It was further assumed that the onshore trunk line tonnage requirement was 406 metric tons (447 short tons) per mile. The total weight of pipe to be transported in equal to 24,215 metric tons (26,700 tons) to be delivered in three annual shipments averaging 8,072 metric tons (8,900 tons) each commencing in 1989. Insulation requirements for the above-ground portions of the pipe and for road and/or work pad requirements were assumed to be transported in loads which need to be cubed out.

Table 33 illustrates the industrial tonnage requirements associated with the scenario development plan. Assumptions for modal split and air passenger service are described in Camden-Canning Scenario.

Marine Transportation

Marine transportation requirements for the Prudhoe-Large Scenario require maximum sea-lift operations which would peak during the period 1988-1991 in the order of 134,260 metric tons (148,000 tons) of which approximately 59,875 metric tons (66,000 tons) are fuel requirements. Total marine shipping capacity at peak demand would require approximately 54,431 DWMT (60,000 DWT) for fuel transport and approximately 65,317 DWMT (72,000 DWT) for goods transport.

Air Transportation

Air transportation requirements are most noticeable during the 1989-92 time period. Passenger seat requirements peak with a demand of approximately 146 seats per day.

Air support for industrial and camp goods routed through Fairbanks are expected to peak during periods of spring break-up in the years 1987 and 1988 with demands equivalent to approximately nine Hercules cargo trips per month.

Truck Transportation

Truck transportation requirements to support the Prudhoe-Large scenario peak during the years 1988-89 approaching approximately 24 truck loads per month during the fall and winter months.

Induced Statewide Transportation of Goods and Passengers

The trends for induced transportation demands that were observed for Camden-Canning largely hold true in the Prudhoe-Large Scenario. The principal difference between the impacts is that the higher employment figures for this scenario accentuate the trends.

For the Anchorage region, induced employment steadily increases. After 1985, it not only exceeds the non-OCS annual change but in many cases is approximately twice the change. In 2000, the induced employment represents an 8.4% increase over the base figure for that year.

The situation in Fairbanks similarly resembles that for the Camden-Canning Scenario. A slightly higher, steady increase occurs which should be easily accommodated.

In the North Slope region, this scenario accentuates an existing roller-coaster pattern that Camden-Canning helped reduce. The reason is that peak employment for this scenario occurs two years before that for Camden-Canning. From 1987 to 1988, induced employment drops from 2,400 to 400 at the same time that employment for the non-OCS scenario is also decreasing. Peak induced employment is expected to occur in 1986 and be 2,700 persons, which is 50% of the total non-OCS employment. Freight requirements will be increased substantially since much of the induced employment will be used for local public works projects. Regional carriers will be able to absorb this demand on top of requirements for Beaufort Sea activities. Local carriers will be able to get increased

TABLE 33

PRUDHOE BAY-LARGE
MAJOR INDUSTRIAL REQUIREMENTS

Year	Wells	Rigs	Tonnage (Short Tons)	Fuel Tonnage (Short Tons)	Goods Tonnage (Short Tons)	Pipe Tonnage (Short Tons)	Total Tonnage (Short Tons)
1980							
1981	3	(3)	4,520	4,140	4,995		13,655
1982	2			2,760	3,330		6,060
1983	2			2,760	3,330		6,060
1984	2			2,760	3,330		6,060
1985	2			2,760	3,330	8,900	6,060
1986	17	(1)	1,840	23,460	28,305	8,900	62,505
1987	34	(2)	3,680	46,920	56,610	8,900	116,110
1988	48	(1)	1,840	66,240	79,920		147,990
1989	48			66,240	79,920		146,150
1990	48			66,240	79,920		146,150
1991	48			66,240	79,920		146,150
1992	48			66,240	79,920		146,150
1993	32			44,160	53,280		97,440
1994	16			22,080	26,640		48,720
1995	2			2,760	3,330		6,060
1996							
1997							
1998							
1999							
2000							

Note: Short ton figures are readily converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

TABLE 34

PRUDHOE BAY-LARGE
AIR PASSENGER SEAT REQUIREMENTS

Year	Annual Round Trips	Peak Monthly Seat Demand (1)	Passenger Seat Demand Per Day	737 Flights (2)
1980	91	11	0	0.0
1981	4,049	506	17	0.1
1982	3,119	390	13	0.1
1983	1,861	233	8	0.1
1984	1,861	233	8	0.1
1985	1,954	244	8	0.1
1986	2,824	353	12	0.1
1987	21,278	2,660	89	0.8
1988	22,103	2,763	92	0.8
1989	35,120	4,390	146	1.3
1990	35,120	4,390	146	1.3
1991	35,120	4,390	146	1.3
1992	35,120	4,390	146	1.3
1993	31,280	3,910	130	1.1
1994	30,000	3,750	125	1.1
1995	26,640	3,330	111	1.0
1996	26,640	3,330	111	1.0
1997	26,640	3,330	111	1.0
1998	26,640	3,330	111	1.0
1999	26,640	3,330	111	1.0
2000	26,640	3,330	111	1.0

Notes: (1) Peak monthly demand equals 1.5 times average monthly demand.
(2) 737 flights based on seating capacity of 115.

Source: Dennis Dooley and Associates, 1978.

TABLE 35

PRUDHOE BAY-LARGE
PEAK AIR REQUIREMENTS FOR CAMP CONSUMABLES

Year	Monthly Average Employment (Man-Months)	Average Monthly Consumption (Pounds)	Spring Breakup 6-weeks (Pounds)	Spring Breakup Flights	Spring Breakup Flights Per Week
1980	60	25,200	37,800	.82	.14
1981	168	70,560	105,840	2.3	.38
1982	110	46,200	69,300	1.51	.25
1983	119	49,980	74,970	1.63	.27
1984	119	49,980	74,970	1.63	.27
1985	132	55,440	83,160	1.81	.30
1986	256	107,520	161,280	3.51	.58
1987	1,833	769,860	1,154,790	25.10	4.18
1988	1,686	708,120	1,062,180	23.09	3.85
1989	1,101	462,420	693,630	15.08	2.51
1990	1,101	462,420	693,630	15.08	2.51
1991	1,101	462,420	693,630	15.08	2.51
1992	1,101	462,420	693,630	15.08	2.51
1993	981	412,020	618,030	13.44	2.24
1994	941	395,220	592,830	12.89	2.15
1995	836	351,120	526,680	11.45	1.91
1996	821	344,820	517,230	11.24	1.87
1997	821	344,820	517,230	11.24	1.87
1998	821	344,820	517,230	11.24	1.87
1999	821	344,820	517,230	11.24	1.87
2000	821	344,820	517,230	11.24	1.87

Notes: Pounds' are converted into metric tons using the conversion factor 0.000456.

Source: Dennis Dooley and Associates, 1978.

TABLE 36

PRUDHOE BAY-LARGE
CONSUMABLE INDUSTRIAL COMMODITY REQUIREMENTS BY MODE

Year	Wells	Consumable Commodities @ 15 Short Tons/Well	Average Monthly Consumable (Short Tons)	Peak Flights Per Week (1)	Peak Truck Loads Per Month (2)
1980					
1981	3	45	3.75	neg.	.2
1982	2	30	2.5	neg.	.1
1983	2	30	2.5	neg.	.1
1984	2	30	2.5	neg.	.1
1985	2	30	2.5	neg.	.1
1986	17	255	21.25	.2	1.1
1987	34	510	42.5	.4	3.2
1988	48	720	60.00	.7	3.2
1989	48	720	60.00	.7	3.2
1990	48	720	60.00	.7	3.2
1991	48	720	60.00	.7	3.2
1992	32	480	40.00	.4	2.1
1993	16	240	20.00	.3	1.6
1994	2	30	2.5	neg.	.1
1995					
1996					
1997					
1998					
1999					
2000					

Notes: (1) Peak flights per week = (Avg. Monthly Consumables x 1) / (23 Short tons/aircraft) (4 weeks/month)

(2) Peak truck loads per month = (Avg. Monthly Consumables) / (28 short tons/semi-truck) x (1.5 Avg. months/peak month)

TABLE 37

PRUDHOE BAY-LARGE
PEAK AIR FLIGHTS PER WEEK
(Goods Transport)

Year	Industrial	Camp	Total
1980	neg.	.14	.14
1981	neg.	.38	.38
1982	neg.	.25	.25
1983	neg.	.27	.27
1984	neg.	.27	.27
1985	neg.	.30	.30
1986	.2	.58	.78
1987	.4	4.18	4.58
1988	.7	3.85	4.55
1989	.7	2.51	3.21
1990	.7	2.51	3.21
1991	.7	2.51	3.21
1992	.4	2.51	2.91
1993	.3	2.24	2.54
1994	neg.	2.15	2.15
1995		1.91	1.91
1996		1.87	1.87
1997		1.87	1.87
1998		1.87	1.87
1999		1.87	1.87
2000		1.87	1.87

Note: Peak for air flights is expected to occur during spring breakup, a period of six weeks.

Source: Dennis Dooley and Associates, 1978.

TABLE 38

PRUDHOE BAY-LARGE
TRUCK REQUIREMENTS FOR CAMP CONSUMABLES

Year	Annual Monthly Average Employment (Man-Months)	Annual Consumption (Pounds)	Truck Requirements (Minus Here. Supplies) (Pounds)	Annual Number of - Truck Loads	Peak Truck Loads Per Month (1)
1980	60	302,400	37,800	4.7	.7
1981	168	846,720	105,840	13.2	1.9
1982	110	554,400	69,300	8.7	1.2
1983	119	599,760	74,970	9.4	1.3
1,984	119	599,760	74,970	9.4	1.3
1985	132	665,280	83,160	10.4	1.5
1986	256	1,290,240	161,280	20.2	2.9
1987	1,833	9,238,320	1,154,790	144.3	20.6
1988	1,686	8,497,440	1,062,180	132.8	19.0
1989	1,101	5,549,040	693,630	86.7	12.4
1990	1,101	5,549,040	693,630	86.7	12.4
1991	1,101	5,549,040	693,630	86.7	12.4
1992	1,101	5,549,040	693,630	86.7	12.4
1993	981	4,944,240	618,030	77.3	11.0
1994	941	4,742,640	592,830	74.1	10.6
1995	836	4,213,440	526,680	65.8	9*4
1996	821	4,137,840	517,230	64.7	9.2
1997	821	4,137,840	517,230	64.7	9.2
1998	821	4,137,840	517,230	64.7	9.2
1999	821	4,137,840	517,230	64.7	9.2
2000	821	4,137,840	517,230	64.7	9.2

Notes: (1) Peak truck 1 oads/month = (annual truck loads) x (1.5 months/peak month)
(10. 5 months truck traffic)

Source: Dennis Dooley and Associates, 1978.

TABLE 39

PRUDHOE BAY-LARGE
TRUCK SERVICE REQUIREMENTS

Year	Industrial	Camp	Total
1980			
1981	.2	.7	.9
1982	.1	1.9	2.0
1983	.1	1.2	1.3
1984	.1	1.3	1.4
1985	.1	1.3	1.4
1986	1.1	1.5	2.6
1987	2.2	2.9	5.1
1988	3.2	20.6	23.8
1989	3.2	19.0	22.2
1990	3.2	12.4	15.6
1991	3.2	12.4	15.6
1992	2.1	12.4	14.5
1993	1.6	12.4	14.0
1994	.1	11.0	11.1
1995		10.6	10.6
1996		9.4	9.4
1997		9.2	9.2
1998		9.2	9.2
1999		9.2	9.2
2000		9.2	9.2

Note: Peak truck demand is expected to occur in the fall and winter months, coinciding with peak employment.

Source: Dennis Dooley and Associates, 1978.

TABLE 40

PRUDHOE BAY-LARGE
SUMMARY OF GOODS SHIPMENTS

Year	Annual Truck and Air Tonnage (3)			Annual Marine Tonnage (3)			
	Industrial Consumables	Camp Consumables	Modal split	Industrial	Modal Split	Ocean Barges(1)	River Barges(2)
1980	0	151	100%	0	0%	0	0
1981	45	423	3%	13,187	97%	2	3
1982	30	277	5%	5,753	95%	1	1
1983	30	300	5%	5,730	95%	1	1
1984	30	300	5%	5,730	95%	1	1
1985	30	333	6%	5,697	94%	1	1
1986	255	645	1%	61,605	99%	10	12
1987	510	4,619	4%	110.981	96%	18	22
1988	720	4,249	3%	143; 021	97%	23	29
1989	720	2,775	.2%	142,655	98%	23	29
1990	720	2,775	2%	142,655	98%	23	29
1991	720	2,775	2%	142,655	98%	23	29
1992	480	2,775	3%	94,185	97%	15	19
1993	240	2,472	6%	46,008	94%	8	9
1994	30	2,371	40%	3,659	60%	1	1
1995	0	2, 107	100%	0	0%	0	0
1996	0	2,069	100%	0	0%	0	0
1997	0	2,069	100%	0	0%	0	0
1998	0	2,069	100%	0	0%	0	0
1999	0	2,069	100%	0	0%	0	0
2000	0	2,069	100%	0	0%	0	0
1996	0	2,069	100%	0	0%	0	0

Notes: (1) Ocean barges = (annual marine tonnage) x 0.80/(5,000 tons/barge).
(2) River barges = (annual marine tonnage) x O. 20/(1,000 tons/barge).
(3) Tonnage figures given in short tons, which are converted to metric tons using the conversion factor 0.907.

Source: Dennis Dooley and Associates, 1978.

utilization of existing aircraft but may be unwilling to acquire new equipment to meet forecast peak passenger and freight flows because of the lean times that will soon follow.

Summary

The total freight requirements for the development of the field are less than for Prudhoe-Small but the more intense development produces greater peak annual demands. The maximum number of wells to be drilled in any one year is 48, greater than all scenarios except Camden-Canning. The largest annual freight requirements approach 80% of the figure achieved during the 1970 sea-lift. Passenger flights per day are the greatest for any scenario, 1.3 which is slightly higher than the figure for Camden-Canning. Peak period truck loads are approximately 24 per month, and peak air freight flights approximately five per week.

ISSUES ANALYSIS

Transportation impacts forecast for the Beaufort Sea OCS scenarios, can be handled by the State's transportation facilities and services given assumptions of the analysis. During the course of the analysis, two issues emerged which could significantly affect the nature and extent of transportation impacts, namely the timing of other resource development activities and the use of ice-breaking vessels, including tankers.

Should the Alcan gas line be constructed as scheduled, the peak uses of transportation systems for its construction and for Beaufort Sea OCS activities will not overlap. But should it slip several years and

Beaufort Sea remain on schedule, conflicts could arise. The potential for other major construction projects to produce overlaps, particularly the building of a new capital city in Willow, could also produce problems that cannot be assessed at the present time.

The forthcoming results of oil and gas exploration in the Canadian Beaufort Sea may influence the oil companies' outlook towards all-water transportation of oil. Dome Petroleum Co. of Canada has taken preliminary steps towards constructing a large icebreaker (Class 10) that within a decade might assist LNG and oil tankers in reaching the east coast by an Arctic water route. Cape Halkett in particular may be made more economically attractive with the possibility of transporting its resources by tanker rather than relying upon the existing pipeline system.

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