CARIBOU WHITE PAPER:

AN EVALUATION OF THE PROPOSED ENDICOTT DEVELOPMENT PROJECT REGARDING POTENTIAL IMPACTS TO CARIBOU

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EXECUTIVE SUMMARY

Sohio Alaska Petroleum Company is proposing to construct the necessary facilities for the development of the hydrocarbon reservoir in the vicinity of the Sagavanirktok River Delta on Alaska's North Slope known as the Endicott Project. The onshore components of the development facilities are within the summer range of the Central Arctic Herd (CAH) caribou. Although the potential impacts to caribou are described in the project Environmental Impact Statement (EIS), pertinent information is compiled within this single document to assist decision-makers, since caribou is such a highlighted concern. Included in this report is specific information regarding the major components necessary to make a responsible evaluation of the Endicott Project's potential impact to caribou. These components are: 1) specific project details, 2) caribou use of the project area, 3) resource agency concerns, and 4) results of recent caribou research. This information is used to present and discuss Sohio's evaluation regarding impacts to caribou, including a description of the mitigative features of the proposed development.

The onshore components of the proposed Endicott Project which are of the most importance in evaluating caribou impacts are the road and pipeline through the delta. There is a 9 mile stretch of new construction before the road and pipeline connect with the existing infrastructure at Prudhoe Bay.

The proposed Endicott Development Project is within the summer range of Central Arctic Herd caribou, currently numbering about 12,700 animals according to the most recent ADF&G estimates. Although on one to a few days as many as 2000 caribou may be found in the delta, typically from 200 to 600 caribou--mostly bull groups--use the delta during the mosquito season (the first three weeks of July)(see Figure 10). Caribou use of the Sagavanirktok River Delta is almost exclusively for mosquito relief and is therefore, directly tied to mosquito levels. When levels are high, caribou move north, downriver using the river channels as movement corridors. River terraces and the coastline south of Foggy Island Bay are regularly used for mosquito relief. These areas are south and/or east of the proposed pipeline/road corridor. Information on major movement corridors and areas of repeated caribou use was obtained in 1983 (Woodward-Clyde 1983) and is shown in Figure 8.

As shown in Figure 14, caribou using the east (main) channel of the river and the two areas of repeated use will not encounter the Endicott proposed pipeline/road corridor. Caribou using the west channel movement corridor continue to do so even though they travel through existing Prudhoe Bay oilfield facilities west of Drill Site 9. The "new" pipeline/road associated with the proposed project will apparently intersect the north-south caribou movement corridor to the immediate east of Drill Site 16 and Drill Site 9.

Resource agencies are concerned with providing for free passage of caribou to habitats important to their life cycle. In the case of the CAH, the concern is for free passage to calving, foraging and insect relief areas. Various stipulations have been and continue to be developed and include requirements on pipeline design, timing of construction activities, and construction of ramps--all to facilitate the free passage of caribou.

A behaviorally-induced "loss" of habitat has been hypothesized as having the potential to affect the productivity, therefore the population, of caribou. There is no documentation of this effect, and its relationship to the presence of oil development activities remains largely conjectural. However, in the absence of quantitative data, resource agencies err on the side of conservatism in the management of the herd.

The CAH has been the subject of a considerable amount of scientific investigation in the past ten years, including many projects funded by the oil and gas industry (Table 3). These investigations have added substantially to an understanding of the CAH and its responses to human disturbance and insect harassment. Certain generalities can be made on the basis of this research.

There are two kinds of insect harassment; one resulting from oestrid flies and one resulting from mosquitos. Caribou are oblivious to development activities and facilities when being harassed by oestrid flies. Therefore, it is the mosquito season--the first three weeks of July--which is the time of concern for caribou/development interactions.

Caribou freely cross a road, a pipeline (assuming a 5 ft minimum height), and a pipeline and road with limited traffic levels. There is only one situation which has the potential to impact the free passage of caribou. The three requisite elements of this potential impact situation are the simultaneous occurrence of 1) a pipeline, 2) adjacent to a road with traffic levels in excess of 360 vehicle passes/day, and 3) caribou during the mosquito season (July). Mitigation measures include any action that results in precluding the simultaneous occurrence of the three requisite elements for the potential impact situation. For example, separation of the road and pipeline, traffic controls, gravel ramps, facility siting and construction windows are possible mitigation measures.

The agency concerns for caribou, including the concern for free passage to important habitats, are acknowledged. There are several features of the Endicott Project which effectively respond to these concerns. Of significance are the scheduling differences between the gravel construction, with its associated heavy levels of traffic, and the pipeline construction which occurs after the gravel work and during the winter from an ice road. Therefore, there is no time in which heavy levels of traffic occur simultaneously with a pipeline; when the pipeline is present, traffic will be at significantly reduced operational levels. Also of significance is the location of the proposed pipeline/road corridor and the primary gravel source. The corridor is located on the higher ground between the east and west river channels. These channels are the major caribou movement zones. Therefore, the corridor is parallel to the major caribou movements, minimizing caribou-corridor interactions. In fact, the caribou movement zone associated with the east channel and two areas of repeated caribou use are east and/or south of the pipeline/road corridor and will be unaffected during both the construction and operation phases.

Regarding the west channel movement zone, the primary gravel source, Exxon Pit #1 (Figure 14), is east of all but one movement zone. This has significant mitigative value for the special temporary situation regarding the high levels of traffic required by major gravel construction activities. For the Endicott Project, this occurs during the mosquito

season--July--of 1985. Construction-related traffic in 1986 will not be at the peak levels since construction of the major gravel facilities should be substantially completed during 1985.

Additionally, there are several other features of the project which have mitigative value regarding potential caribou impacts (Table 4). It is concluded, based on the results presented in this assessment, that the Endicott Project as proposed effectively mitigates for the resource agency concerns in a manner consistent with accepted mitigation strategies, and provides for free passage of caribou in the project area. It is therefore the finding of this evaluation that, in the absence of new information regarding caribou movements and behavior or a major change in the proposed Endicott Project affecting caribou, no additional actions are necessary for caribou mitigation.

INTRODUCTION

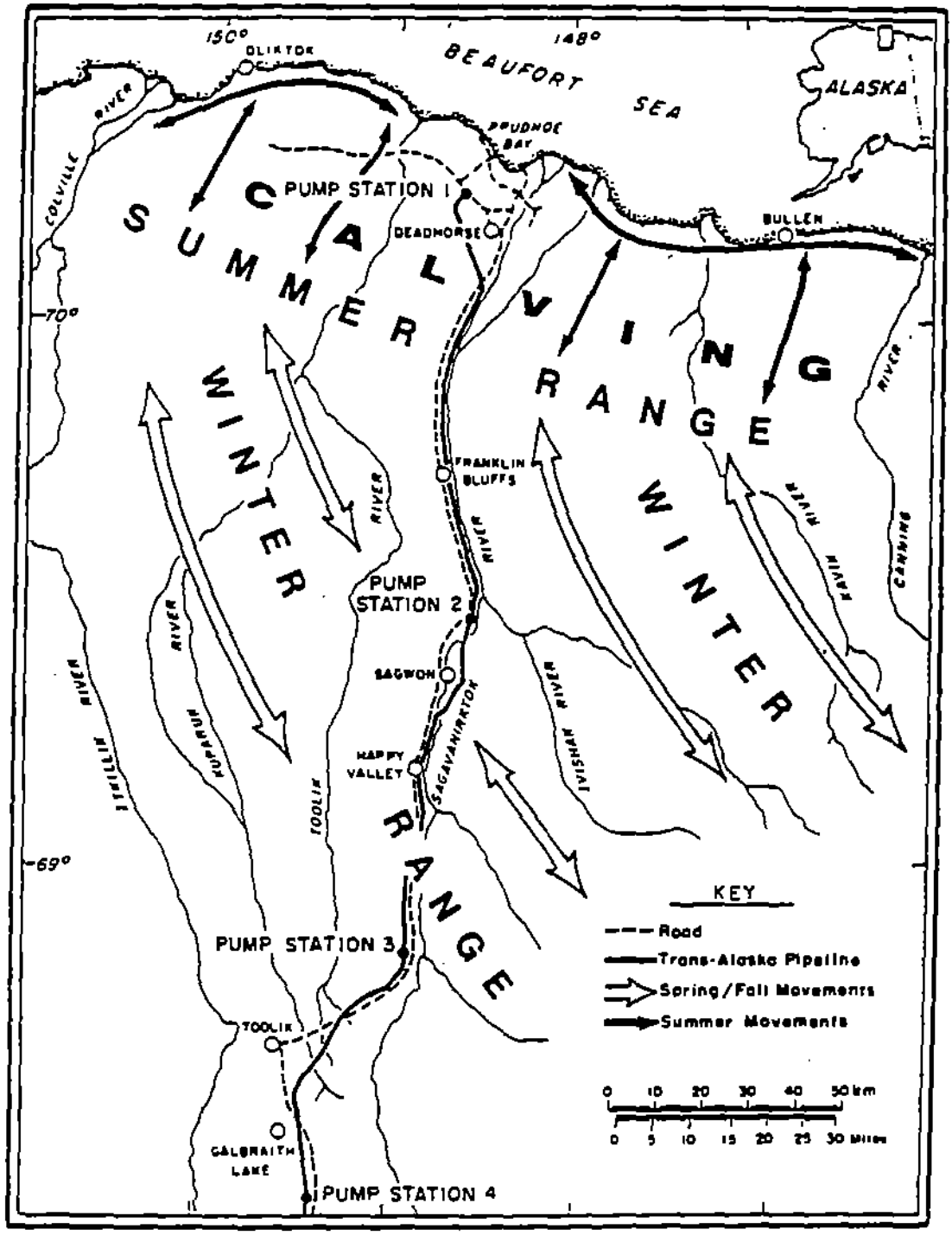
Sohio Alaska Petroleum Company (Sohio) is in the process of obtaining the permits and authorizations appropriate for the construction and development of the facilities necessary to produce the hydrocarbon reservoir located in the vicinity of the Sagavanirktok River Delta on Alaska's North Slope known as the Endicott Project. An integral part of this permitting process is the preparation of an Environmental Impact Statement (EIS) to analyze, among other things, the potential impact of the proposed development on the environmental resources of the area.

One of the terrestrial resources of concern is the population of barren-ground caribou, generally referred to as the Central Arctic Herd (CAH), which summers on the Arctic Coastal Plain between the Canning and Colville rivers (Figure 1). The proposed Endicott Development is located within the summer range of this herd. The EIS (COE 1984) describes the CAH's use of the coastal plain and discusses the potential impacts to the herd from the onshore facilities of the Endicott project, in particular, the proposed road/pipeline corridor through the delta (Figure 2). This report is Sohio's evaluation of the project as it pertains to potential impacts on caribou and is supportive of and consistent with the information contained in the EIS.

The purpose of this report is to compile--in a single document--details regarding the major components involved in making a responsible and informed evaluation of the Endicott Project regarding impacts to caribou. These components are: 1) specific project details, 2) caribou use of the project area, 3) resource agency concerns, and 4) results of recent caribou research. This information will then be used in presenting and discussing Sohio's project evaluation regarding caribou including a description of the features of the proposed development which mitigate impacts to caribou.

Caribou is a highlighted issue within the State and it is thought that having this information compiled in one document will be useful to decision-makers. Of particular interest to Sohio is that project reviewers are made aware of the mitigative value of certain features of the proposed project. This may not be readily apparent without closely scrutinizing the EIS. Additionally, the Alaska Department of Fish and Game (ADF&G)--which has management authority for caribou--has requested this information from Sohio in support of the Right-of-Way application for the road/pipeline corridor.

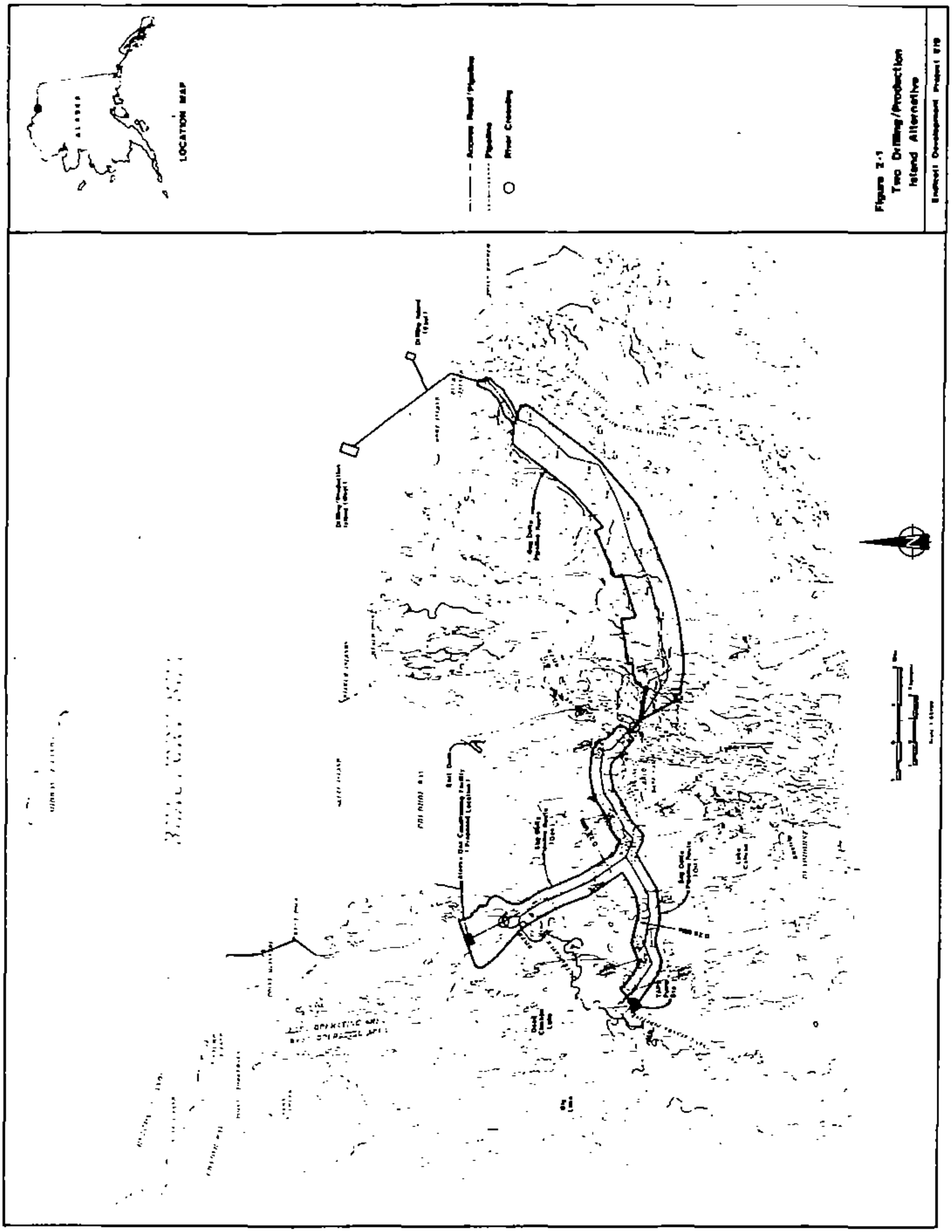
FIGURE 1



Range of the Central Arctic Herd

Taken from Banfield et al. 1981

FIGURE 2



PIPELINE/ROAD CORRIDOR Taken from COE 1984

PROPOSED ENDICOTT PROJECT DETAILS

A detailed description of the proposed Endicott Development is contained in the Environmental Impact Statement (EIS) for the project (COE 1984). Therefore, the project information is only briefly summarized here. The onshore project components are the most important in evaluating the potential impacts to caribou--particularly the effects of the proposed road/pipeline corridor.

Project Location

The Endicott Project Area is located on the North Slope of Alaska about 15 miles east of Prudhoe Bay. Project production facilities will be on artificial gravel islands located about 2.5 miles off the coast of the Sagavanirktok River Delta, shoreward of the barrier islands, in water depths up to 14 feet. A sales pipeline and an access road will necessarily cross the Sagavanirktok River Delta to join existing systems at Prudhoe Bay (Figure 2).

Onshore Project Facilities

Onshore pipelines would transport the crude oil across the Sagavanirktok River Delta to the sales point at Prudhoe Bay. Gravel operations and support systems would be onshore in the delta; and support systems located at Deadhorse are also expected to be utilized to service the drilling and production activities. The road system for the Endicott Development Project would include a main access road between the causeway approach and the existing Prudhoe Bay road system at Drill Site 9. The causeway approach is a gravel structure on the outer 1.5 miles of the delta that gradually joins the elevated causeway with the 5-ft level of the access road. These project components are illustrated in Figure 2 and discussed in more detail below.

Sag Delta Sales Pipeline: The proposed project provides for transporting sales oil from the production island (west) to the sales point at Prudhoe Bay via a 16-inch pipeline across the Sagavanirktok River Delta constructed, for the most part, on the higher ground between the east and west channels of the river (Figure 2). The pipeline will be routed along the causeway from the production island to the onshore causeway approach, along the 1.5 mile onshore approach to the onshore access road, then 9 miles through the delta between the east and west channels to connect with the Prudhoe Bay Unit road network near Drill Site 9. The sales line would continue west paralleling the existing pipeline and crossing the Prudhoe Bay Unit (PBU) Sagavanirktok River pipe bridge, to a point near PBU Flow Station 1. The route continues along an existing right-of-way ending at Trans-Alaska Pipeline System (TAPS) Pump Station 1. The total length of the onshore oil pipeline would be 18.4 miles.

The pipeline would be supported on vertical support members (VSM) spaced at a distance ranging from 50 to 75-ft apart along the pipeline. The cross-bents of the VSMs would be positioned at approximately 5-ft above the tundra, except where the new pipeline parallels existing pipelines. Expansion loops would be constructed approximately every 2500 ft.

For access during installation an ice road would be constructed parallel to the pipeline route for its entire length through the delta.

Road: An access road approximately 9 miles long would be constructed prior to the onshore pipeline, paralleling the pipeline route from the production island causeway to the existing road near PBU Drill Site 9. At Drill Site 9, the pipeline would join the existing right-of-way to its final destination (Figure 2). During the island and causeway construction effort, the main access road would be primarily a material haul road. When construction activities are completed, the road would be repaired and regraded as required for use by operational support traffic. The pipeline would be from 50 to 200-ft to the south and/or east of the road after the pipeline is constructed from an ice road. At Drill Site 9, the access road and pipeline would diverge, as the pipeline heads north toward the existing Sagavanirktok River pipe bridge and the road heads west to join the Prudhoe Bay road system.

Caribou crossings similar to those used on early North Slope projects are planned for portions of the route that are located near and parallel to existing pipelines. Existing gravel ramp crossings would be extended to cross the new pipelines which would be constructed at the same height as the existing pipelines. Pipelines in the new right-of-way would be placed at 5-ft above the tundra, measured at the support.

Project Schedule/Traffic Levels

A detailed discussion of the project schedule is included in the EIS for the project (COE 1984: 2-79) and is depicted in Table 1. Based on this information, the following schedule is applicable to the onshore activities being discussed in this report.

Gravel work (including construction of the access road, islands and causeway) is proposed to begin late fourth quarter 1984 through sealift 1985, and resume during the second quarter 1986 through early third quarter 1986. The heaviest traffic levels are associated with the 1984-1985 gravel season when the access road, causeway and islands will be built. Traffic associated with the 1986 gravel work will be noticeably reduced.

Gravel extracted from Sag Mine Site C (to the west of Drill Site 9) will be used in late 1984 to construct the access road to Exxon Pit #1 (to the east of Drill Site 9). Exxon Pit #1 will be the major gravel source for the remaining access road, causeway and islands.

Pipeline construction (including the ice road) is proposed to begin fourth quarter 1986 and continue into the third quarter 1987.

Traffic levels during the gravel construction phase are estimated to peak at 1200 vehicles/day (COE 1984: 2-80). Construction support traffic levels will be an additional 60 vehicles/day (COE 1984: 2-80). As stated above, peak traffic levels will occur in conjunction with the major gravel hauling operation in late 1984 through the summer 1985. Traffic levels will be much reduced from these peak levels during 1986.

After construction, operational support traffic levels are projected to be 96 vehicles/day (COE 1984: 2-80). These levels are summarized in Table 2.

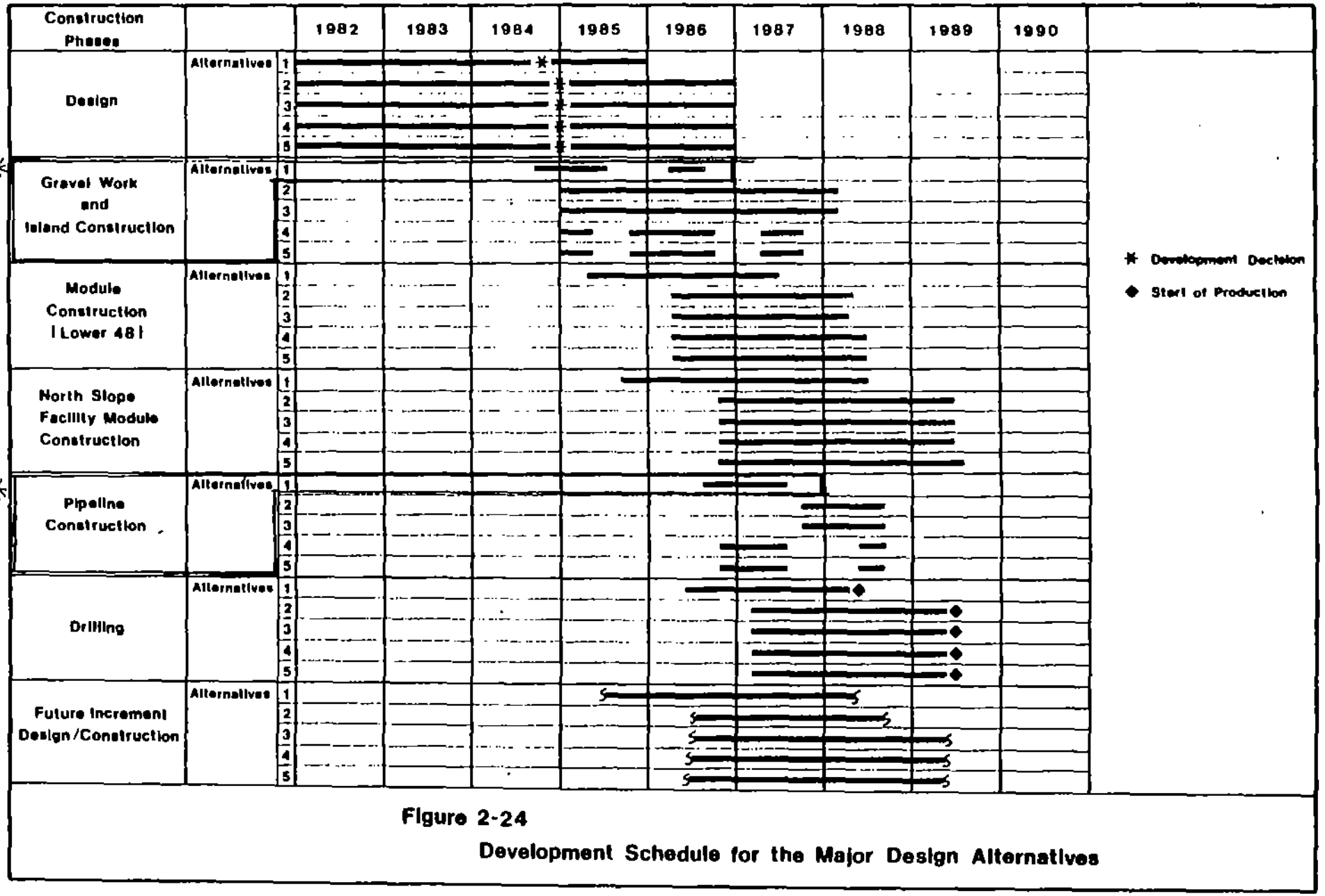


Figure 2-24

Development Schedule for the Major Design Alternatives

TABLE 1

Taken from COE 1984

TABLE 2

PROJECTED TRAFFIC LEVELS

PEAK GRAVEL CONSTRUCTION	1200 passes	50 passes/hour
CONSTRUCTION SUPPORT	60 passes	2.5 passes/hour
Totals	1260 passes	52.5 passes/hour
OPERATIONAL SUPPORT	96 passes	4 passes/hour

Taken from COE 1984: 2-80 - 2-81

CARIBOU USE OF THE PROPOSED PROJECT AREA

Background Information

According to the most recent Alaska Department of Fish and Game (ADF&G) estimates, the Central Arctic Herd currently numbers about 12,700 animals--four times the population estimate for 1972. The herd is increasing at a rate of from 12 to 18% per year, with an average annual increase of 13% (Bergerud et al. 1984). The CAH ranges from the northern foothills of the Brooks Range to the Beaufort Coast and from the Canning to the Colville rivers (Figure 1).

Recently--in the last decade--the CAH was described as a separate herd on the basis of separate calving grounds (Cameron and Whitten 1979). Prior to that, this herd was thought to be an overlap between the Western Arctic herd (WAH) to the west and the Porcupine herd to the east (Figure 3). There is some evidence that the CAH is a subpopulation of the WAH--it was documented that several thousand WAH animals overwintered with the CAH in 1982-1983 (Carruthers 1983, Bergerud et al. 1984).

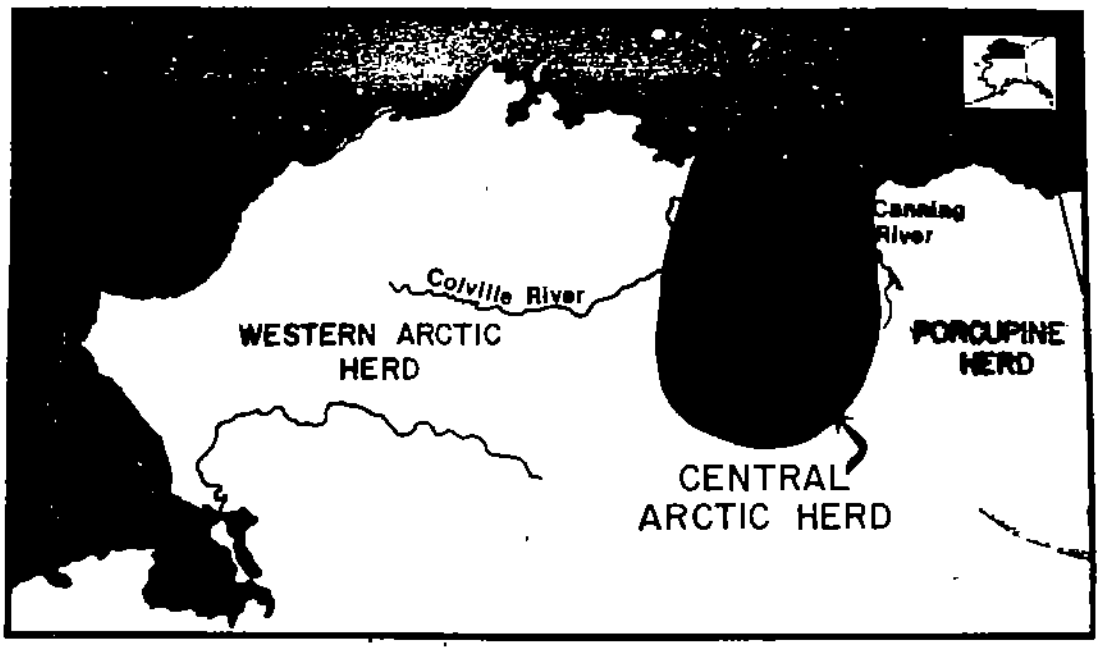
CAH are on the Arctic Coastal Plain from mid to late May until into August. The summer range (Figure 4) is used for calving, foraging and insect relief. The total summer range of the CAH is about 5000 square miles. Of this summer range, about 2200 square miles constitutes calving habitat.

Spring migration occurs along the major river drainages such as the Kuparuk, Sagavanirktok, Canning and Colville rivers (Figure 5). Pregnant cows begin moving toward the Arctic Coastal Plain as early as late April and into early June (Cameron and Whitten 1980). Calving peaks during the first ten days of June (Robus et al. 1983). Although dispersed calving occurs across the coastal plain, two calving concentration areas have been described for the CAH (Figure 4)--one in the Kuparuk area, 5 to 15 miles south of Milne Point, north of the Spine Road, in the vicinity of the Ugnuravik River; and one west of the Canning River Delta, south of Bullen Point (Cameron et al. 1981). Caribou are traditional in their use of general areas for calving, although weather and snow conditions may influence the exact location. The CAH is distinguished from other caribou herds in that its calving area--the Arctic Coastal Plain--is where spring occurs later than on its winter range. Therefore, in years of heavy snow, the CAH calves in the northern foothills of the Brooks Range.

There are two types of insect harassment of caribou--mosquitos and oestrid flies. Caribou behavior in response to these two types of insects is decidedly different and influences caribou reactions to development facilities and human activities.

During the mosquito season, which begins in late June and continues throughout July, swarms of mosquitos harass caribou. In response, caribou actively move to the coast in large groups. Mosquito levels are directly related to the weather; levels are highest on warm, calm days. Caribou seek the coast because the temperature is typically cooler and there are sea breezes which result in lowered insect levels. Caribou travel into the wind and make use of the points along the coast where they can orient into the wind. Coastal beaches, river deltas, and prominent coastal points are

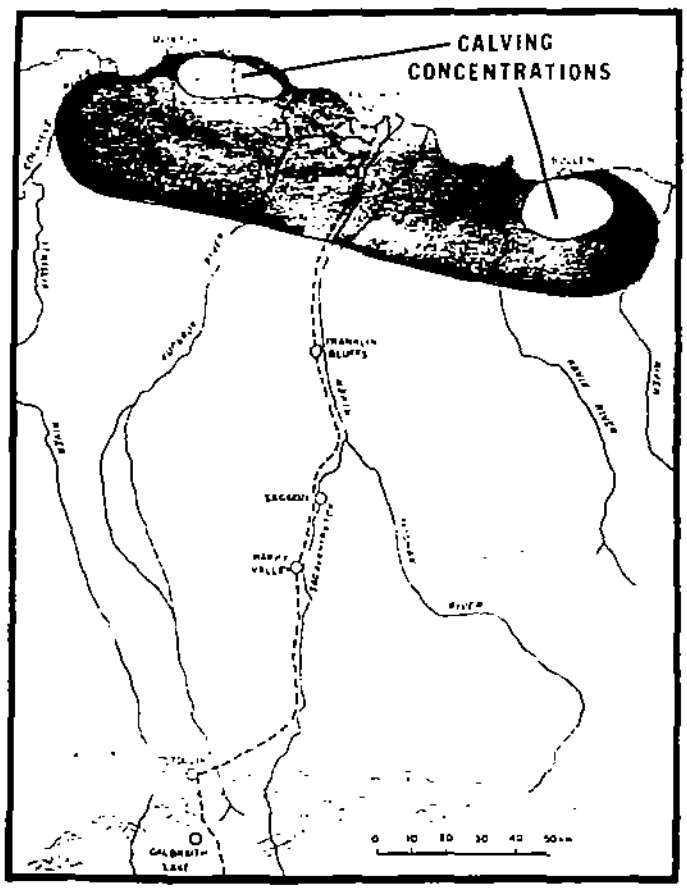
FIGURE 3



Distribution of Caribou in Northern Alaska

Taken from Robus et al. 1983

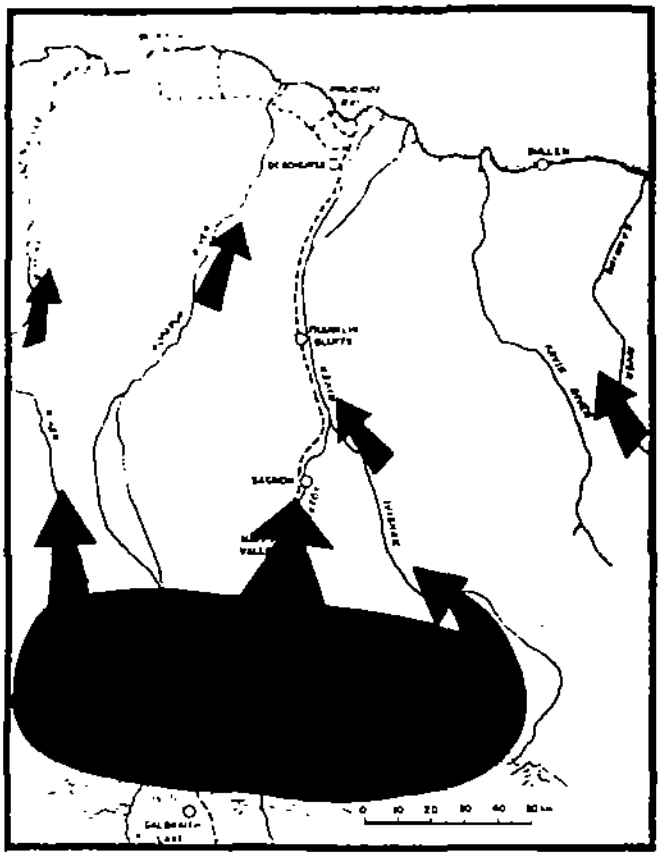
FIGURE 4



Calving and Summer Range
of the Central Arctic Herd

Taken from Robus et al. 1983

FIGURE 5



Spring Migration
and Winter Range
of the Central Arctic Herd

Taken from Robus et al. 1983

frequently used by caribou for insect relief to take advantage of cooler temperatures, wind, and lack of vegetation. Mosquito-induced caribou movements are often directed east-west along the shore and into the wind (Child 1973, White et al. 1975, Cameron and Whitten 1979b, Fancy 1982).

When the weather becomes cool and breezy or foggy, the mosquito levels decrease and caribou disperse inland to preferred foraging areas (Robus 1982, Robus et al. 1983). Any "pattern" of caribou movements is discernible and predictable to the extent that the weather is predictable and follows a pattern--whether it be within a season, between and/or among seasons. Such a generalized pattern has been described for the 4500 animals that regularly use the area west of the Kuparuk River (Figure 6).

In mid July, with the onset of oestrid fly season, caribou behavior noticeably changes (Curatolo et al. 1982, Curatolo 1983). There are two species of oestrid flies which are parasitic on caribou--caribou are the unwilling hosts of the flies' larval stages. During fly harassment, caribou disperse, ignore other stimuli, including human activity, and actively seek gravel structures--natural or man-made--for relief (Fancy 1982, 1983). It is during this time that caribou will seek the shade of buildings and pipelines for insect relief. As fly season progresses into August, caribou disperse to the south in the initiation of their fall migration (Figure 7).

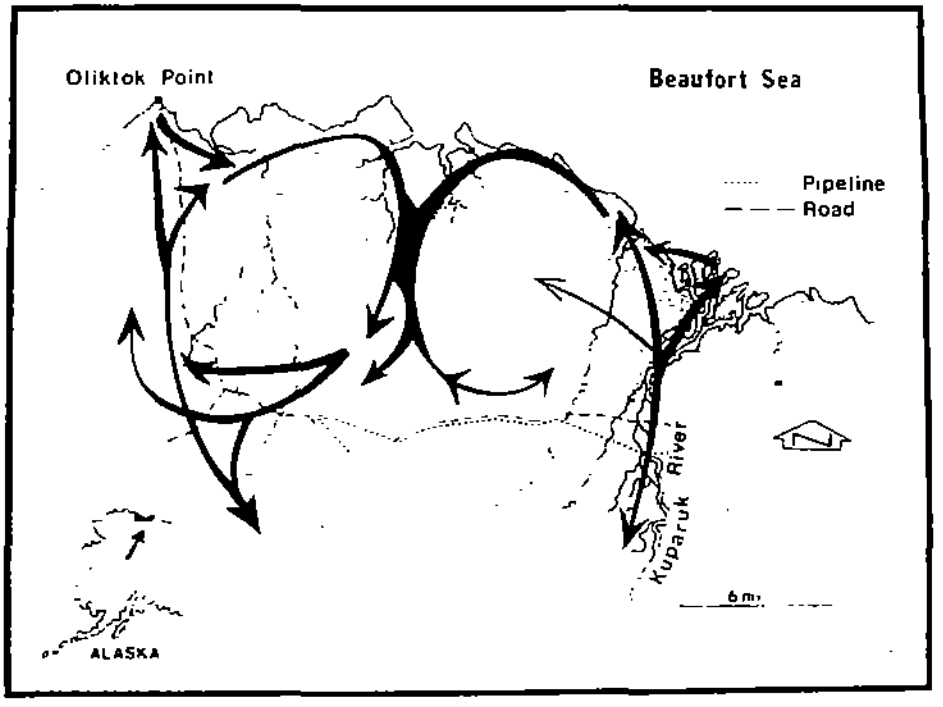
Caribou Use of the Proposed Project Area

The Sagavanirktok River Delta is not one of the identified calving concentration areas. The available information regarding the locations and movements of caribou during the calving period do not suggest annually recurring patterns of distribution in the Sagavanirktok Delta (COE 1984, Fancy and Wright 1982, Woodward-Clyde 1983). "Caribou do not use the Sagavanirktok River Delta to any extent until mosquitos emerge and animals move to the coast for insect relief" (Woodward-Clyde 1983:4-9).

Caribou use of the delta in 1983 was largely as anticipated--that is, directly dependent on mosquito levels. When levels were high, caribou moved north into the delta, travelling downriver into the wind. River terraces and the coastline along Foggy Island Bay were regularly used for mosquito relief (Woodward-Clyde 1983). This is consistent with the findings from previous years (Fancy and Wright 1982, Fancy 1982a). It is probable that Foggy Island Bay is repeatedly used for mosquito relief because maximum exposure to the prevailing winds is provided by the north-south orientation of the shoreline (Woodward-Clyde 1983). The major movement corridors and areas of repeated use are shown in Figure 8 which is taken from the 1983 Lisburne Environmental Studies report (Woodward-Clyde 1983).

As depicted in Figure 8, there are two major caribou movement corridors and two areas of repeated caribou use identified in the Sagavanirktok Delta. The movement corridors are the east (main) channel of the river and the north-south route to the immediate east of Drill Site 16 that extends north to the west channel of the river. The two areas of repeated use for feeding and resting are the area south of Foggy Island Bay and the area along the east channel between the two movement corridors (Woodward-Clyde 1983:4-32).

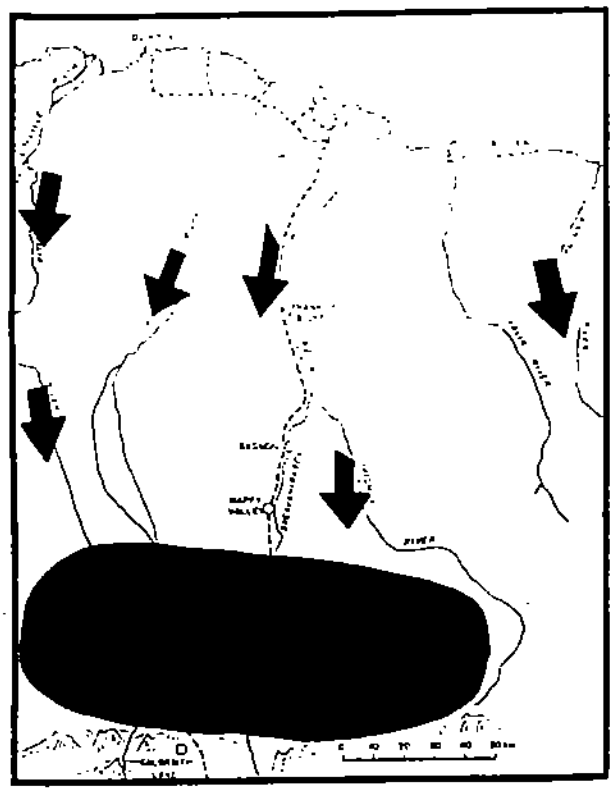
FIGURE 6



Movements of Caribou during Summer, 1982

Taken from Robus et al. 1983

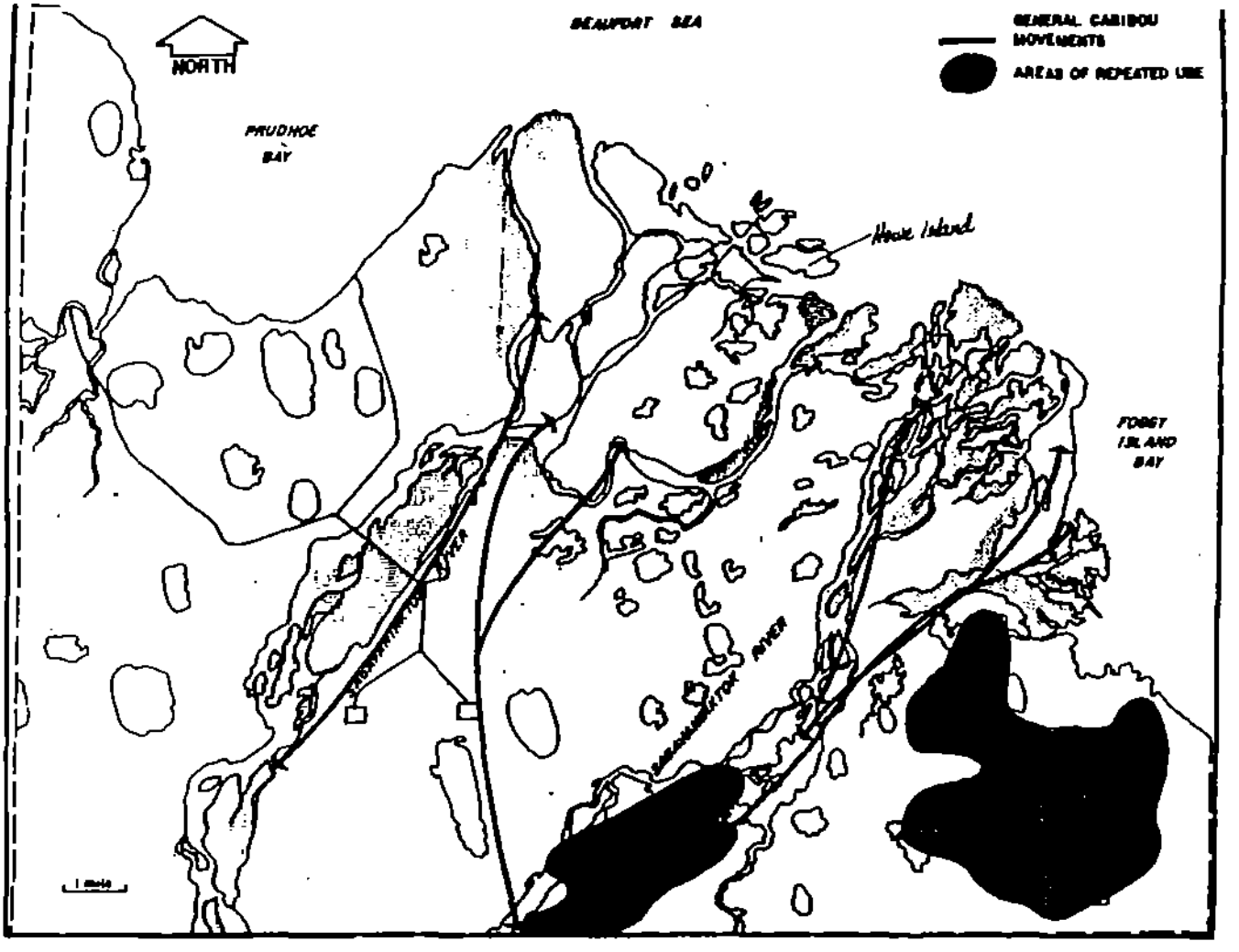
FIGURE 7



Fall Migration and Winter Range
of the Central Arctic Herd

Taken from Robus et al. 1983

FIGURE 8



GENERAL CARIBOU MOVEMENTS SAGAVANIRKTOK RIVER 1983

Taken from Woodward-Clyde 1983

The 1983 Lisburne Studies included aerial surveys along the routes illustrated in Figure 9. The maximum number of caribou observed using the delta at any particular time was about 2000 animals (Woodward-Clyde 1983). This peak usage occurred on only two days in 1983 as shown in Figure 10. This is consistent with previous years' information regarding peak usage (Fancy and Wright 1982, COE 1984). More typically, between 200 to 600 animals can be found in the delta during mosquito harassment (Figure 10, Fancy and Wright 1982). The 1983 Lisburne Studies found that caribou use of the delta was mostly by bull groups.

Caribou use the two river channels as their major movement zones as illustrated in Figure 8. The proposed pipeline/road corridor for the Endicott Project is routed along the higher ground between the east and west channels (Figure 2). Therefore, caribou using the east channel movement zone will not encounter the Endicott pipeline/road corridor. The corridor will similarly not interfere with the two areas of repeated caribou use for feeding and resting which are to the south and/or east of the corridor (Figure 8).

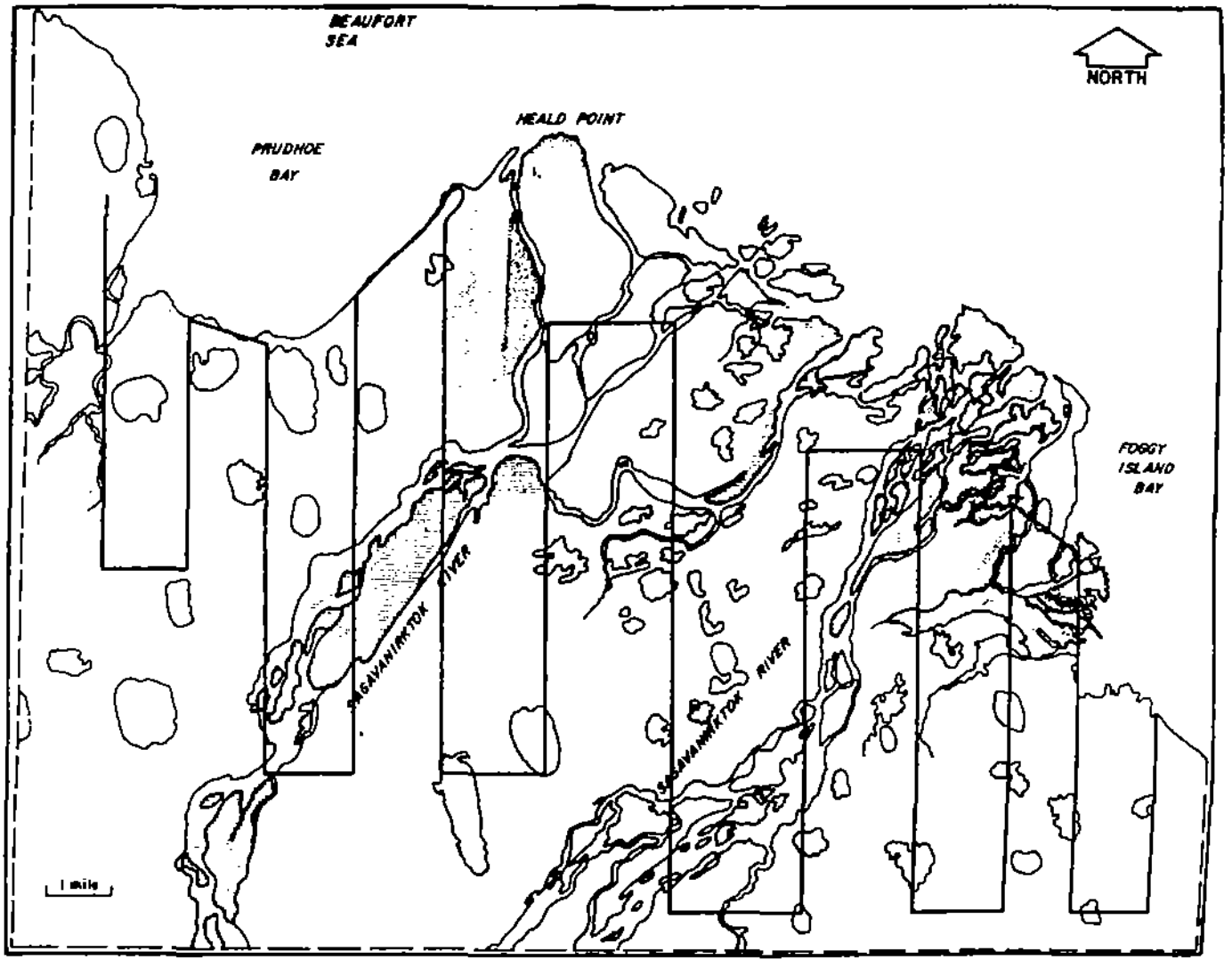
The 1983 Lisburne Studies obtained more specific information on caribou use of the west channel in the vicinity of Drill Site 9 (Figures 13-15). Since this is the area where caribou using the west channel will most likely encounter the Endicott pipeline/road corridor, the Lisburne information is included in this section. Figure 11 depicts the distribution and composition of caribou groups on insect free days along the west channel movement corridor. As would be expected, groups are from one to a few caribou, almost exclusively bulls and no evidence of directed movements of any significance. The caribou in the vicinity of Drill Site 4 probably moved down the west channel through the area of existing Prudhoe Bay oilfield facilities.

Figure 12 depicts caribou group distribution and composition on mosquito harassment days. It is still largely bull groups although there are a couple of large cow-calf groups represented. The few groups exhibiting directed movement are using the major movement corridor associated with the west channel and to the east of Drill Site 16. The lack of much directed movement would seem to indicate that the caribou are not being seriously harassed.

Figure 15 depicts caribou group distribution and composition on mosquito and fly harassment days combined. The noticeable directed movement patterns evident in Figure 13 are reflective of caribou behavior in response to severe mosquito harassment. Some group sizes are noticeably larger and movement, for the most part, is downriver toward the coast. Figure 13 supports that the mosquito-induced use of the delta is along the river channel. The only major non-river channel caribou movements in 1983 occurred when caribou entered the delta from the east, moving into a west wind. These caribou moved along the coast from the Kadleroshilik River (Woodward-Clyde 1983).

The initial gravel source, Sag Mine Site C, is located west of Drill Site 9 and north of Drill Site 3 where the existing road and pipeline are separated. Gravel will be taken from this site in late 1984 to construct a road to Exxon Pit #1, east of Drill Site 9, the major gravel source for the project facilities.

FIGURE 9

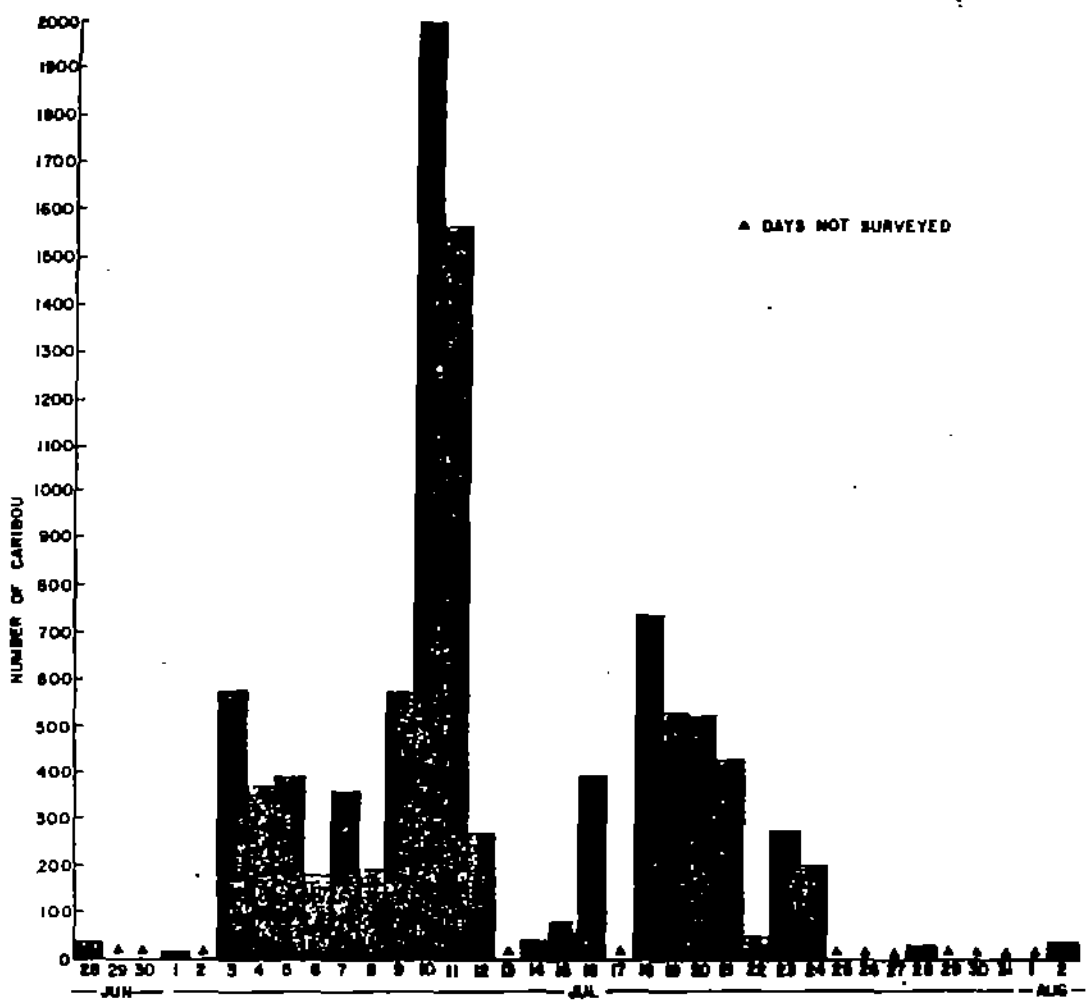


AERIAL SURVEY ROUTES

SAGAVANIRKTOK RIVER 1983

Taken from Woodward-Clyde 1983

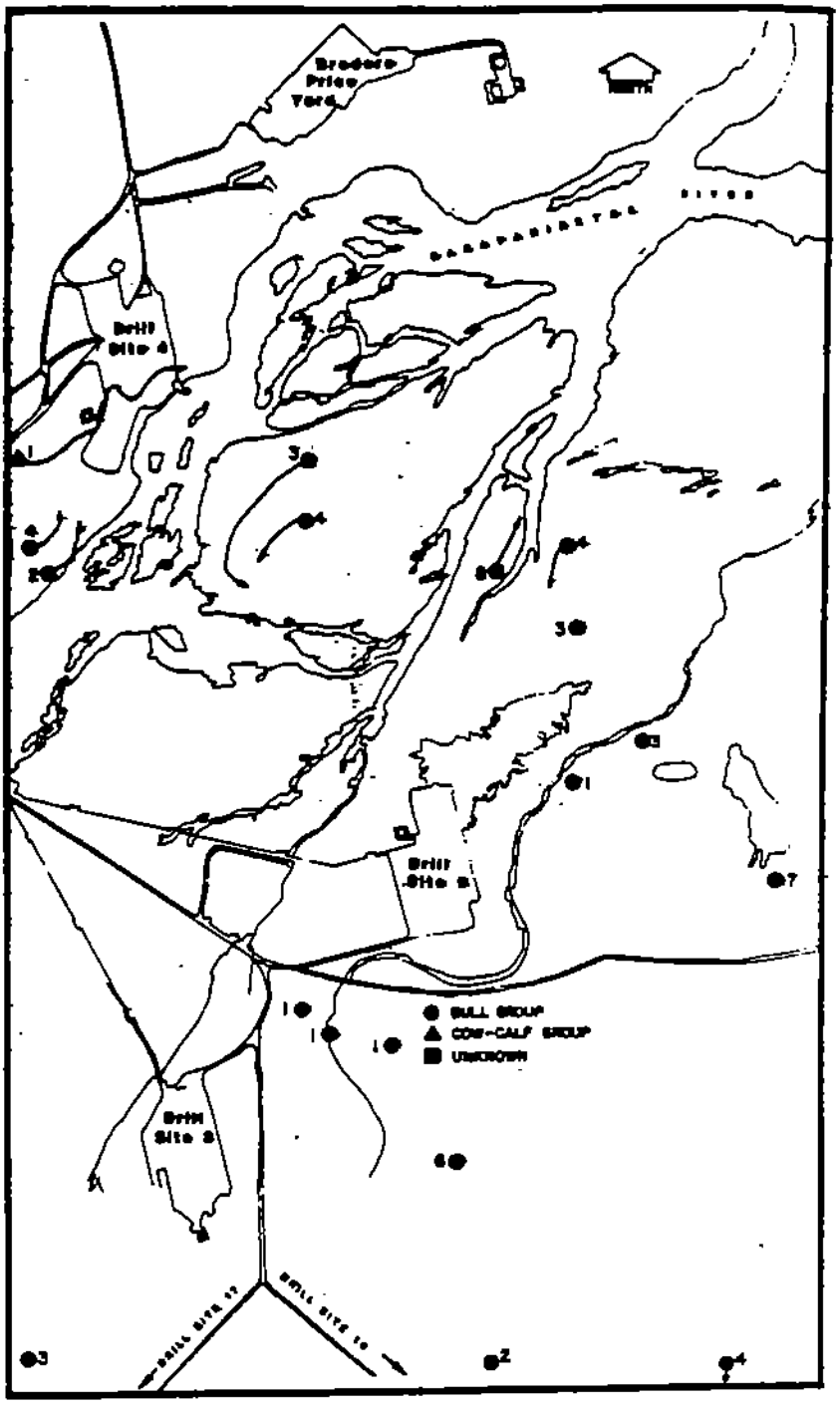
FIGURE 10



RESULTS OF AERIAL SURVEYS SAGAVANIRKTOK RIVER 1983

Taken from Woodward-Clyde 1983

FIGURE 11

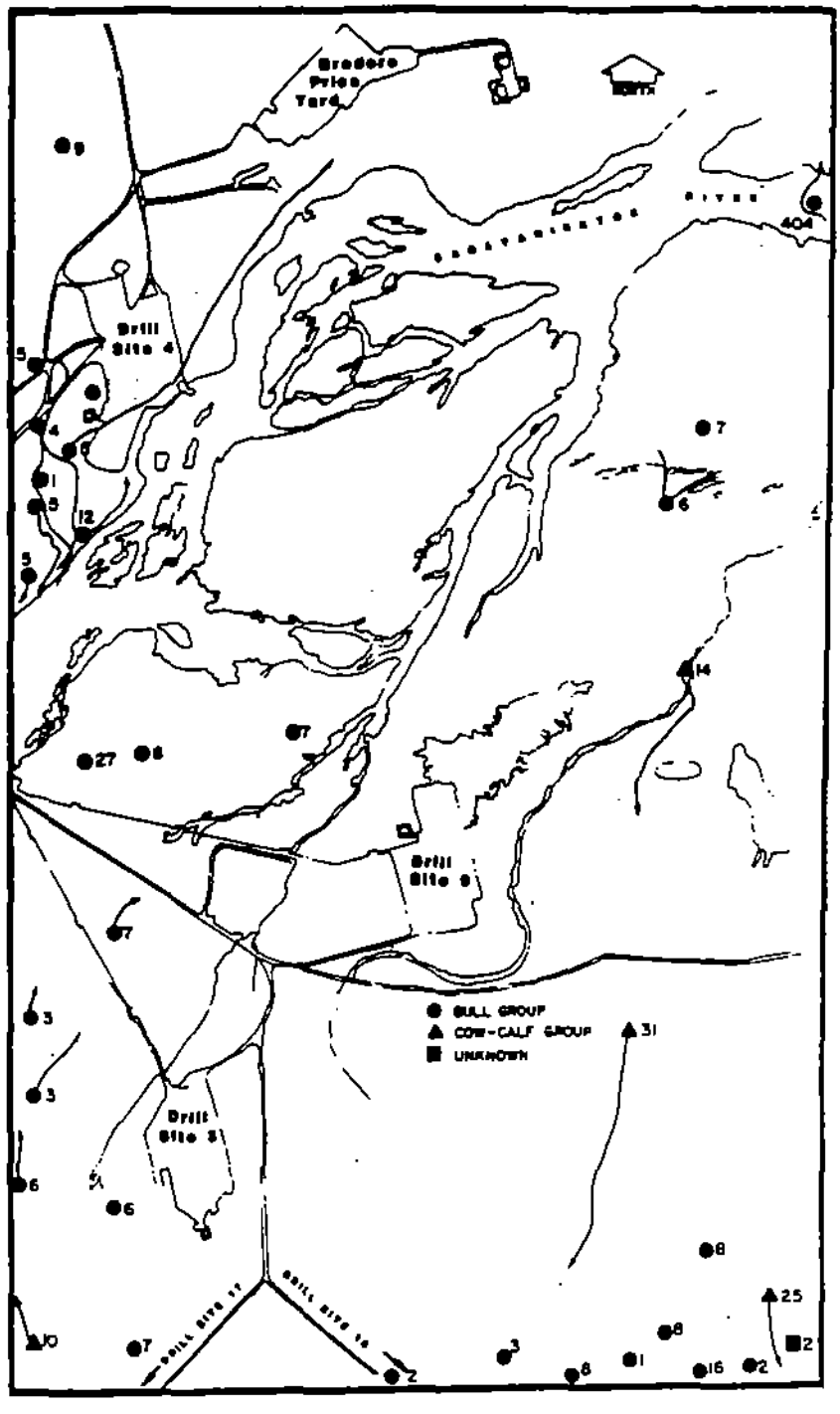


CARIBOU OBSERVATIONS ON INSECT FREE DAYS WEST CHANNEL

SAGAVANIRKTOK RIVER

Taken from Woodward-Clyde 1983

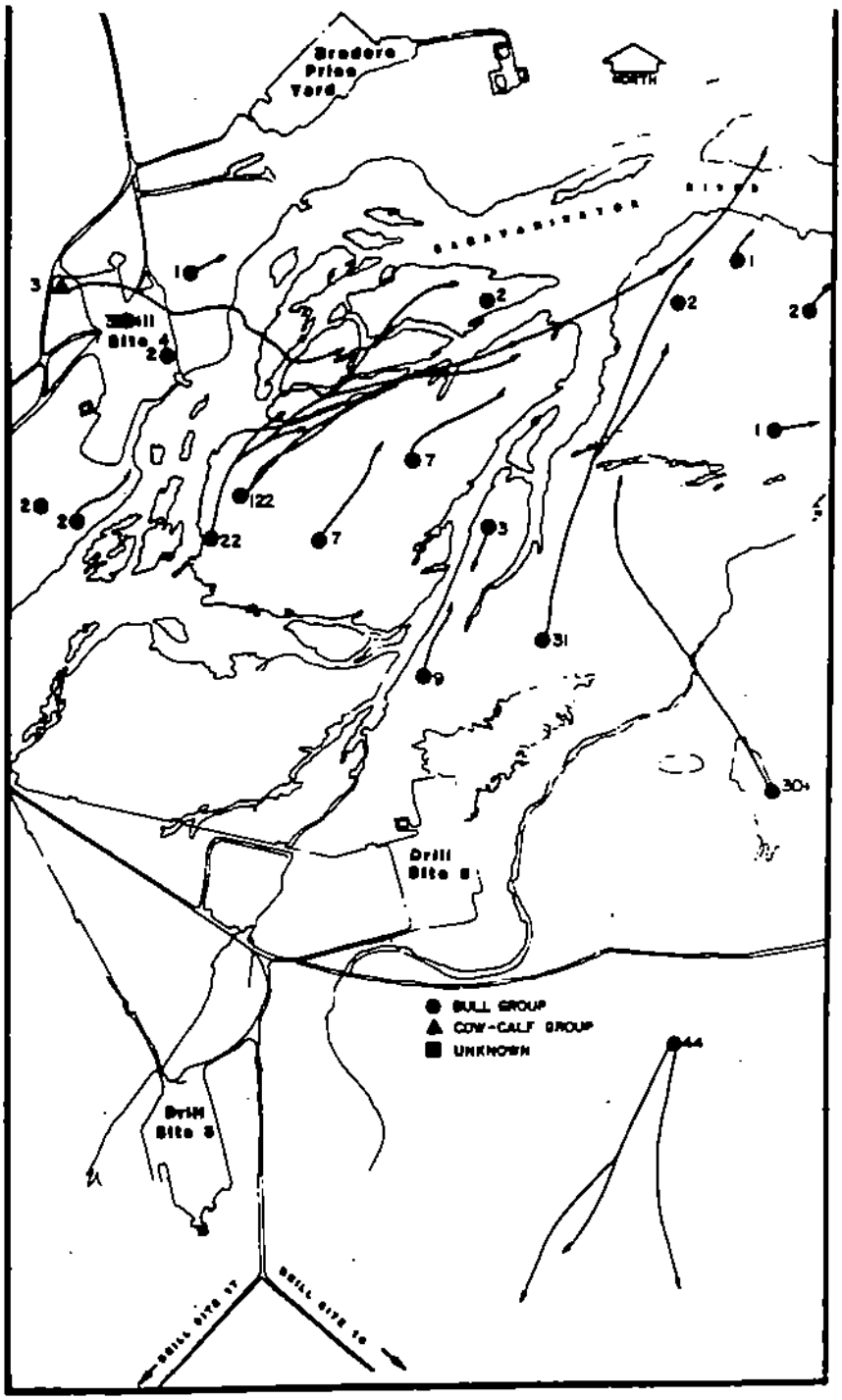
FIGURE 12



CARIBOU OBSERVATIONS ON MOSQUITO DAYS SAGAVANIRKTOK RIVER 1983

Taken from Woodward-Clyde 1983

FIGURE 13



CARIBOU OBSERVATIONS ON MOSQUITO AND OESTRID FLY DAYS SAGAVANIRKTOK RIVER 1983

Taken from Woodward-Clyde 1983

RESOURCE AGENCY CONCERNS

The Central Arctic herd (CAH) encounters industrial activity more than any North American caribou herd. The herd's mosquito-induced movements regularly bring them into contact with oil development during the summer on their way to coastal relief areas. The interaction of caribou and development has become a major resource agency concern and is addressed in stipulations that are imposed on various oil-related activities and facilities. Stipulation of development-related activities is an ongoing, evolving process which started with the proposal to construct the Trans-Alaska Pipeline System (TAPS). The process continues currently in the permitting of oilfield expansions, such as Kuparuk and Prudhoe Bay, and in the permitting of new developments, such as Milne Point and Endicott.

Resource agencies are concerned with providing for free passage of caribou to habitats important to their life cycle. In the case of the CAH, the concern is for free passage to calving, foraging and insect relief areas. There is concern that impediments to free passage would alter major caribou movements. Such alterations of movements have been hypothesized to have the following adverse consequences for caribou: range abandonment, local overgrazing and trampling, loss of access to calving grounds or other range components, herd disunity, discontinuance of interherd movements, increased energetic costs, overall reduction in productivity and population levels (Klein 1979). This is the basis for the resource agencies' concerns, especially those of ADF&G which has management responsibility for the herd. It should be noted, however, that historical declines of caribou resulting from decreased access to habitat are not well-documented, with the rare exception of populations insulated from predators and prevented from dispersing to unoccupied areas--the predator free island ranges like St. Paul and St. Mathew Island (Truett et al. 1982).

The agency concern for free passage has, to date, been accomplished by various means, including construction windows and pipeline design. Minimum pipeline heights of 5 ft have been established as being sufficient for caribou passage. Other mitigation strategies include ramps, consolidation of facilities, and pipeline alignments. Ramps have been required where traffic is heavy or pipelines are less than 5 ft high and where caribou use is frequent. Consolidation of facilities has been required to minimize the sprawl of development. North-south alignments have been recommended to reduce caribou encounters with linear structures.

Even though the agencies are concerned with the direct loss of caribou habitat, the direct loss associated with proposed facilities constitutes a very small fraction of available acreage. Of more immediate concern to the agencies is the possibility of indirect loss through a barrier effect--a behaviorally induced habitat loss--which has the potential to preclude caribou use of much larger areas than what is directly removed by facility placement.

These behavioral effects relate to a basic question--what will be the population response in terms of productivity: "Thus, the importance of sensory disturbances, physical obstruction, and habitat alteration lies in how exposure to these phenomena might be manifested in a population response" (Banfield et al. 1981). Since quantitative data are not

available regarding the specific effects of development, resource agencies have been conservative in the approach to mitigation, although specific cause-effect relationships have not been established.

RESULTS OF RECENT CARIBOU RESEARCH

The Central Arctic Herd caribou have been the subject of a considerable amount of scientific investigation during the past ten years. The Alaska Department of Fish and Game has been active in this effort. The oil and gas industry has similarly devoted substantial funds and efforts toward obtaining information on the behavior and movements of the CAH. A summary of industry-sponsored caribou research is included in Table 3. This listing is probably incomplete, but is included with this document to indicate the numerous research efforts that have been undertaken by the industry. These investigations have added considerably to an understanding of the CAH and its responses to human disturbance and insect harassment. This section is intended to summarize the pertinent findings of these research efforts. The following generalities can be made.

Caribou are oblivious to development when being harassed by oestrid flies. During this time, caribou will use the roads, pads, shade under buildings and pipelines, and other natural or man-made structures and facilities which provide some measure of relief from the flies. Therefore, it is the mosquito season (about the first three weeks in July) which represents the time of concern regarding caribou responses to oilfield activities and facilities.

Caribou will freely cross a road with no traffic. This is not surprising since caribou cross geopmorphologically similar features in the course of their natural migratory movements.

Caribou will cross a road with traffic, although they may hesistate or parallel the road for a short distance (Curatolo and Murphy 1983). Paralleling linear features aligned in their general direction of movement is a normal behavioral reaction of caribou to natural linear features, so some paralleling of linear development features is to be expected (Bergerud et al. 1984). As stated in Curatolo 1983: "Despite frequent adverse reactions to traffic, caribou are usually able to successfully cross roads with traffic". The special temporary situation resulting from the high levels of traffic associated with major gravel construction requirements is addressed separately at the end of this section.

Caribou will freely cross an elevated pipeline alone (Curatolo and Murphy 1983). They may hesitate prior to crossing, possibly a reflection of an adaptive response to potential predator concealing habitat. From Curatolo 1983: "...a five foot minimum pipe height in the absence of traffic allows sufficient 'free passage' ".

It is only the combination of a pipeline and moving vehicles that significantly decreases crossing success. This situation occurs primarily during mosquito season, the first three weeks of July (Curatolo and Murphy 1983, Curatolo 1983). As presented in Curatolo and Murphy (1983) and reiterated in Curatolo (1984): "...as we have shown, it is only a pipeline adjacent to a road with relatively high traffic (e.g., 1 vehicle/4 minutes) that significantly reduces crossing frequency". In a June 29, 1984 meeting in Fairbanks, Al Ott, ADF&G, accepted that it was this traffic level of 15 vehicles/hour that resulted in decreased caribou crossing success. Jerry

Stroebele, U.S. Fish and Wildlife Service, was present at that meeting and subsequently indicated his acceptance of this traffic level limit at a July 27 meeting in Anchorage. For practical purposes involving monitoring and operational realities, this traffic level will be expressed in terms of vehicle passes/day, rather than vehicles/minute, although the latter is useful for comparative purposes. Therefore, the 1 vehicle/4 minutes level of traffic adjacent to a pipeline that results in significantly decreased crossing success translates to 360 vehicle passes/day.

Acknowledging the special case discussed below of high levels of traffic necessarily associated with major gravel construction operations, based on the information presented in this section, there is only one situation which has the potential to impact the free passage of caribou. The requisite elements of this potential impact situation are the simultaneous occurrence of 1) a pipeline, 2) adjacent to a road with traffic levels in excess of 360 vehicle passes/day, and 3) caribou during the mosquito season, approximately the first three weeks of July.

Mitigation measures would include any action that would result in precluding the simultaneous occurrence of the three requisite elements for the potential impact situation. Examples of such measures include, but are not limited to: separation of the road and pipeline, traffic controls, gravel ramps, and facility siting considerations.

The temporary high traffic levels necessarily associated with major gravel construction operations represents a special case for which the traffic level limit is not directly applicable. Although there is no pipeline when the high traffic levels occur, logically, a steady flow of traffic such as that required to construct major gravel project facilities could potentially affect caribou crossing success. This situation occurs only during the mosquito season--July--in 1985, since the facilities will, for the most part, be substantially completed prior to the 1986 gravel season. Further mitigation for this situation would include, but not be limited to, the location of the gravel source and project facilities such that encounters with caribou movement zones are minimized.

TABLE 3

SUMMARY OF INDUSTRY-SPONSORED CARIBOU RESEARCH IN NORTHERN ALASKA

Prudhoe Bay Unit Funding:

Fancy et al. 1981	Caribou movements at Drill Sites 16 and 17
Fancy 1982a	Second year of caribou movements at Drill Sites 16 and 17
Fancy 1982b	Influence of insects on caribou behavior
Fancy 1983	Movements and activities of caribou near drilling sites--publication of 1981-82 work.
Gavin 1977	Caribou migrations and patterns
Gavin 1978	Caribou migrations and patterns
Gavin 1979	Wildlife of the North Slope, A Ten-Year Study
Gavin and Chamberlain 1979	Caribou migrations and population patterns
Curatolo 1983	Synthesis of caribou research and 1982 work on Eileen West End caribou movements and behavior
Curatolo 1984	Caribou responses to pipelines in and near the Eileen West End

Kuparuk Unit Funding:

Curatolo and Murphy 1983	Caribou responses to pipeline/road complex in Kuparuk
Curatolo et al. 1982	Caribou responses to pipeline/road complex in Kuparuk
Robus 1982	Caribou movements and responses near CPF2
Truett et al. 1982	Literature synthesis for Kuparuk

Endicott Unit Funding:

Fancy and Wright 1982	Caribou investigations in the Sagavanirktok River delta area

Lisburne Development Area Cost-Sharing Group:

Woodward-Clyde Consultants 1984	1983 Lisburne Environmental Studies

Individual Company Funding Participation:

Banfield et al. 1981	Caribou Advisory Panel Assessment of Issues
Robus et al. 1983	Caribou in the Kuparuk: overview of biology, research and interactions with development
Carruthers 1983	Interaction of Central Arctic and Western Arctic herds on wintering grounds

TABLE 3 Cont'd.

Company Support of ADF&G research:

Cameron and Whitten 1979b	Caribou distribution and movements in Kuparuk
Cameron et al. 1981	Caribou distribution and movements in Kuparuk
Cameron and Whitten 1980	Caribou distribution and movements in Kuparuk

Alyeska Pipeline Service Company:

Child 1973	Caribou reactions to simulated pipelines and crossings
Renewable Resources 1982	Distribution, movements and behavior in relation to Trans-Alaska Pipeline
Renewable Resources 1983	Distribution, movements and behavior in relation to Trans-Alaska Pipeline

There is current research being conducted in the Kuparuk Oilfield funded by the Kuparuk Unit Owners, and research at the population level being funded by Alyeska, Sohio, Exxon, Chevron, Conoco and ARCO.

EVALUATION OF THE PROPOSED PROJECT REGARDING POTENTIAL IMPACTS TO CARIBOU

The Endicott Project, as proposed, effectively responds to resource agencies' concerns for mitigation of potential impacts to free passage of caribou. Close evaluation of the various aspects of the project in conjunction with knowledge of the requisite impact elements reveal several mitigation measures inherent in the proposed project.

The general information from Woodward-Clyde (1983) illustrated in Figure 8 was transferred onto a map of the proposed Endicott onshore pipeline/road corridor and is included as Figure 14. It is readily evident from Figure 14 that the major movement corridor of the east (main) channel and the two areas of repeated caribou use will be unaffected by the proposed pipeline/road corridor and the high levels of construction related traffic. The movement corridor and repeated use areas are well south and east of the proposed pipeline/road corridor. Therefore, this evaluation will focus on the major movement corridor related to the west channel.

As discussed in the section on project details, the construction traffic levels and elevated pipeline do not occur simultaneously. Pipeline construction is not initiated until after the gravel construction is completed (Table 1). This scheduling feature of the project has the effect of separating the pipeline from the traffic--in this case it is a temporal separation which accomplishes the mitigation goal. The existence of the pipeline occurs during operational levels of traffic. As shown in Table 2, the projected operational traffic level of 96 vehicle passes/day is well within the current agency accepted limit of 360 vehicle passes/day. In other words, during operation, there is a pipeline, but traffic levels are not high enough to result in a potential impact situation. The pipeline will be a minimum of 5-ft high which is sufficient for free caribou passage.

There are several features of the Endicott Project which possess mitigative value regarding potential caribou impacts. For example, the pipeline will be constructed during the winter and it will be constructed from an ice road, rather than a gravel pad; the road/pipeline corridor is parallel to the major caribou movement corridors minimizing the potential encounters between caribou and the road/pipeline. The 11 mitigation features of the proposed project are briefly described below.

Mitigation Features of Proposed Project

These mitigation features, itemized in Table 4, are consistent with the management recommendations and currently accepted mitigation practices of the Alaska Department of Fish and Game.

- 5-Ft Minimum Pipeline Height: This responds to the agency recommendation that pipelines be elevated sufficient height at the Vertical Support Members (VSM) to facilitate free passage of caribou. It has been demonstrated by studies in the Kuparuk Oilfield that a 5 ft height is sufficent for this purpose (Curatolo et al. 1982, Curatolo and Murphy 1983).

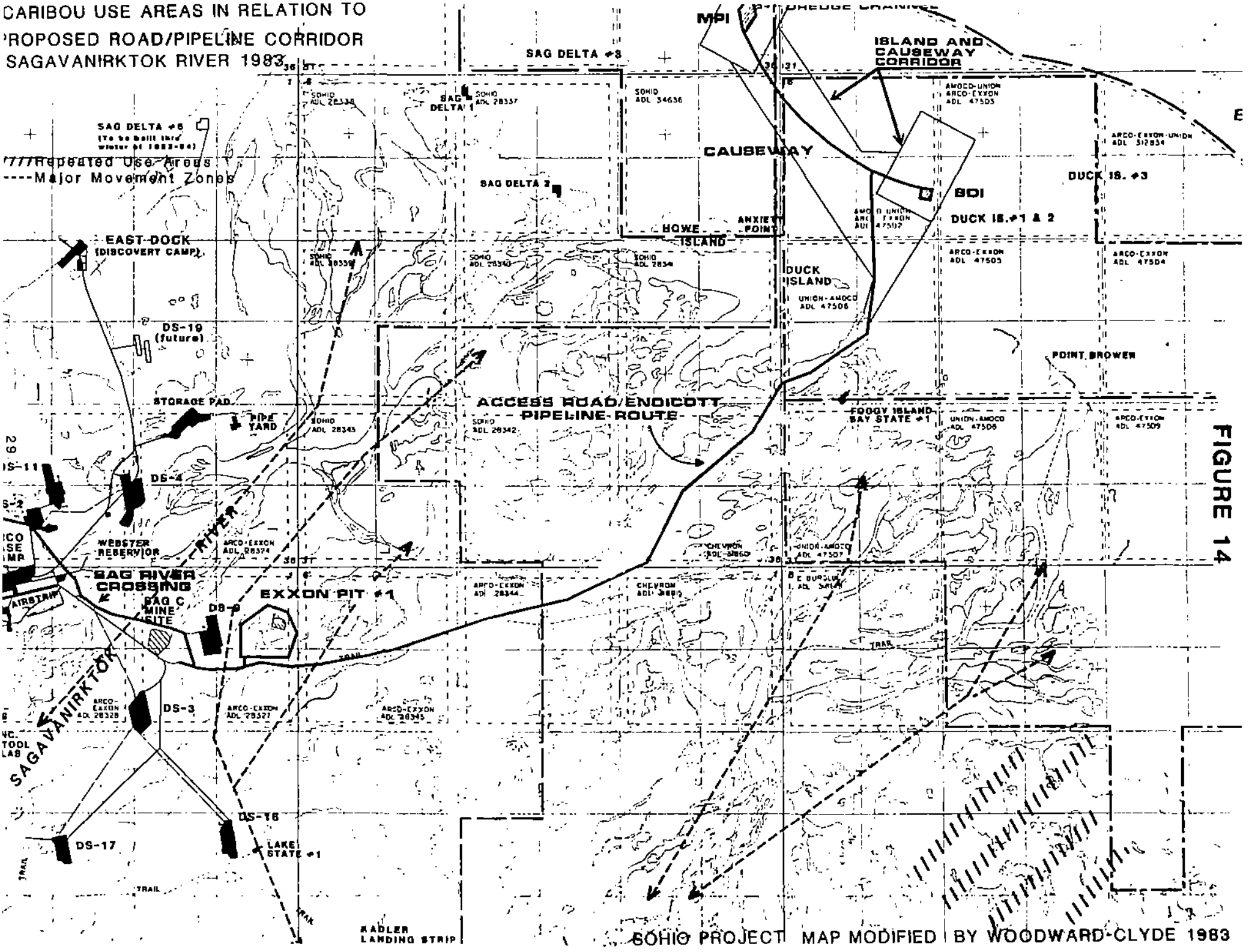


FIGURE 14

SOHIO PROJECT MAP MODIFIED BY WOODWARD-CLYDE 1983

- o Temporal Separation of the Road (Traffic) and Pipeline: As discussed in the Project Description section, the highest levels of traffic are associated with gravel construction (Table 2). The gravel construction operations occur, and are completed, prior to the existence of the pipeline. As discussed in the Results of Research section of this document, it is only the combination of a road with heavy traffic and an associated elevated pipeline which has the capability of reducing caribou crossing success. These "requisite elements for impact" do not occur simultaneously and are effectively mitigated by the project schedule (Table 1).

- o Operational Traffic Levels Well Within Acceptable Levels: As indicated in the Project Description section, the traffic levels during the operational phase are projected to be at about 96 vehicle passes/day. This is well below the levels currently established by researchers, and agreed to by the Alaska Department of Fish and Game and the U.S. Fish and Wildlife Service, of 360 vehicle passes/day, for which there an appreciable decrease in caribou crossing success. Therefore, during project operation, the traffic levels will not be such that caribou crossing is a concern.

- o Winter Construction of Pipeline: Construction of the pipeline during the winter will reduce the level of activity that occurs during the summer when caribou are in the vicinity of the proposed project. Seasonal restrictions on activities have long been an accepted mitigation practice by the resource agencies.

- o Construction of Pipeline from Ice Road: Winter construction of the pipeline allows for it to be built from an ice road, instead of a gravel work pad. This will reduce the amount of gravel to be placed, and thereby mitigates for the direct loss of caribou habitat. Additionally, construction from an ice road will minimize the "complexity" of the linear structure by eliminating the additional gravel work pad, and may be less disturbing to caribou than a pipeline, work pad and access road.

- o Orientation of Road/Pipeline Corridor Parallel to Major Movements: The most frequent caribou encounters with areas of development occur during the mosquito season when caribou movements are generally in a north-south pattern regulated by insect levels. Therefore, it has been suggested by the regulatory agencies and researchers that alignment of corridors parallel to the major direction of movements will minimize the occurrence of caribou/corridor encounters. The proposed Endicott Route is parallel to the major movement zones, thereby having mitigative value. For example, the alignment of the proposed pipeline/road corridor between the east and west channels precludes encounters with the major caribou movement corridor in the east (main) river channel.

- o Spatial Separation of Road and Pipeline in Vicinity of DS 9: Spatial separation of the "requisite impact elements" mitigates for impacts to crossing success and has been recommended by resource agencies and researchers as an alternative mitigation strategy. In the vicinity of DS 9, the pipeline diverges from the existing road system and heads north to cross the existing pipeline bridge (Figure 14). Additionally, the pipeline will be from 50 to 200-ft to the south and/or east of the road for its entire length through the delta. Since there is no information

regarding the spatial separation which mitigates for passage, it is possible that this may have some mitigative benefit.

- o Crossings Extended Over Existing Right-of-Way With Crossings: Where the new pipeline parallels existing lines, it will run at the height of the existing pipeline and will have existing crossings extended to cover the new pipeline. Ramps have been an accepted mitigative practice within the oilfields where pipeline heights are less than the 5 ft minimum, or where traffic levels exceed acceptable limits.

- o Gravel Source East of Major Movement Zone: The primary potential gravel source is Exxon Pit #1 (Figure 14) which is located east of the major movement zone associated with the western channel of the Sagavanirktok River. This means that the construction levels of traffic--which will be to the east of the mine site--will also be to the east of a major movement zone. This offers mitigative value for the special case regarding the high levels of construction traffic required for major gravel facilities.

- o Main Construction Camp Relocated on Main Production Island: The main construction camp has been relocated from the delta to the main production island. This results in less gravel placement, mitigating for the direct loss of caribou habitat. Additionally, it results in reduced levels of activity in the delta which has mitigative value in terms of resource agency concerns.

- o Road/Pipeline Corridor North and West of Two Areas of Repeated Use: The 1983 research in the Sagavanirktok River Delta indicated that there are two zones in the vicinity of the eastern channel of the river that are repeatedly used by caribou. The proposed road/pipeline corridor is north and west of these two major use areas. The Foggy Island Bay area of the delta appears to be particularly frequented for insect relief which may be in part to the orientation of the coastline parallel to the prevailing winds (Woodward-Clyde 1983).

The agency concerns for caribou, including the concern for free passage to important habitats, are acknowledged. There are several features of the Endicott Project which effectively respond to these concerns, most notably the schedule consideration which precludes the simultaneous occurrence of the "requisite impact elements"--that is, when the pipeline is present, operational levels of traffic will be well below those which result in reduced caribou crossing success. Additionally, there are several other features of the project which have mitigative value regarding potential caribou impacts, including the location of the proposed pipeline/road corridor and primary gravel source which will, for the most part, avoid the areas of repeated caribou use and major caribou movement zones (Table 4).

It is concluded, based on the results presented in this assessment, that the Endicott Project as proposed effectively mitigates for the resource agency concerns in a manner consistent with accepted mitigation strategies, and provides for free passage of caribou in the project area. It is therefore the conclusion of this evaluation that, in the absence of new information regarding caribou movements and behavior or a major change in the proposed Endicott Project affecting caribou, no additional actions are necessary for caribou mitigation.

TABLE 4

MITIGATION FEATURES OF THE PROPOSED PROJECT

- 5-Ft Minimum Pipeline Height
- Temporal Separation of the Road (Traffic) and Pipeline
- Operational Traffic Levels Well Within Acceptable Levels
- Winter Construction of Pipeline
- Construction of Pipeline from Ice Road
- Orientation of Road/Pipeline Corridor Parallel to Major Movements
- Spatial Separation of Road and Pipeline in Vicinity of DS 9
- Crossings Extended Over Existing Right-of-Way With Crossings
- Gravel Source East of Major Movement Zone
- Main Construction Camp Relocated on Main Production Island
- Road/Pipeline Corridor North and West of Two Areas of Repeated Use

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