Oil Terminal and Marine Service Base Sites in the Kodiak Island Borough

Final Report

December 1, 1977

Prepared for

Alaska Department of Community and Regional Affairs
Division of Community Planning

Woodward-Clyde Consultants
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18245

STATE OF ALASKA

JAY S. HAMMOND, GOVERNOR

DEPT. OF COMMUNITY & REGIONAL AFFAIRS

DIVISION OF COMMUNITY PLANNING / POUCH B — JUNEAU 99811

November 22, 1977

This evaluation of oil terminal and service base sites in Kodiak Island Borough represents a major step in the preparation for offshore oil development which may occur in the Western Gulf of Alaska. The Department of Interior's OCS Lease Schedule now proposes a federal sale off Kodiak Island to take place in October 1980.

The study itself embodies many "firsts" for Alaska. It is the first time the State has joined with a Borough and a Native Regional Corporation to design, monitor and review a project of this type. In addition, it is the first time that petroleum company opinions concerning OCS site preferences and industrial needs were solicited and obtained in advance of a siting decision. And finally, it is the first time that the method of decision-analysis has been used to organize and integrate the viewpoints of many interest groups for the purposes of site evaluation.

What is presented here is a useful working document providing a basic description of sites considered, an evaluation of their development potential--advantages and disadvantages, and a ranking of the sites. The study suggests a way of thinking about site choices. We are advocating an approach to siting decision that is firm as to purpose but flexibly open to alternative solutions. To accomodate the unknowns inherent in offshore oil exploration, several sites should be considered for future development, pending the outcome of exploratory activity.

Knowing local preferences and oil company viewpoints early on will help to position each group positively for future negotiations. In reality, several locations may support offshore operations equally well. Final site selection will involve tradeoffs and compromises by all groups be they oil companies, the Borough, the cities, the State or private landowners.

While no absolute decisions need to be made at this time, the Kodiak Island Borough through its land use planning powers, can reserve sites which reflect a balance of viewpoints, are capable of meeting oil company needs, suitable in terms of existing laws and policies, and avaliable for development.

We hope that this report will be of use to the Kodiak Island Borough and that its results will be incorporated into the Borough's comprehensive planning program.

Sincerely,

Kevin Waring

Kevin Waring
Director

WR.

Alaska Department of Community and Regional Affairs
Division of Community Planning

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CHAPTER 1

PROJECT DESCRIPTION

1.1 INTRODUCTION

This report presents the results of a study to evaluate and rank possible sites for marine service bases and oil terminals in the Kodiak Island Borough, under the sponsorship of the Alaska Department of Community and Regional Affairs, Division of Community Planning. The main purpose of this report is to assist the State of Alaska, the Kodiak Island Borough, and other interested parties in the planning process for Outer Continental Shelf (OCS)-related onshore industrial development. The study has had four specific objectives. These were to:

1. assess the potential demand in the Kodiak Island Borough for onshore OCS-related industrial facilities;
2. identify potential onshore locations in Kodiak Island Borough for OCS industrial uses;
3. evaluate the geotechnical and environmental suitability of these alternate locations for marine service bases and oil terminals; and
4. rank the candidate locations for each facility type with regard to pertinent engineering, geotechnical, and environmental considerations.

1.2 THE PROBLEM: OIL IN THE WESTERN GULF OF ALASKA

The U.S. Department of the Interior has scheduled in October, 1980 an OCS oil and gas lease sale in the Western Gulf of Alaska. Figure 1-1 shows the lease area in relation to the Kodiak Island Borough. Probably within six months after the sale, the successful bidders will begin exploration. It can be expected that one to several, and possibly as many as eight, exploratory rigs eventually would be operating offshore. Exploration will last from four to eight years, and the first discovery could be during the first year of exploration. The first oil production

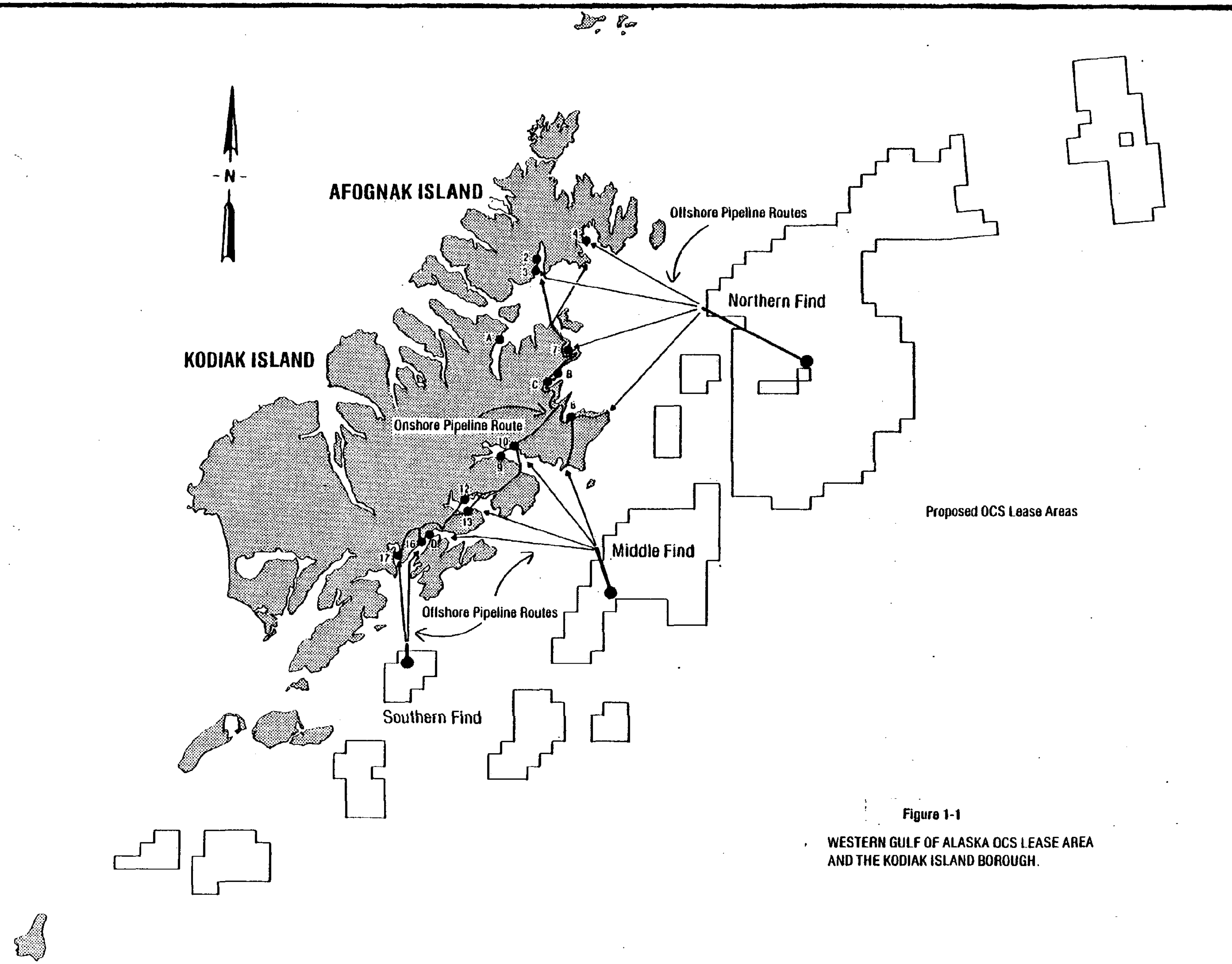


Figure 1-1

WESTERN GULF OF ALASKA OCS LEASE AREA
AND THE KODIAK ISLAND BOROUGH.

platform could be installed, if oil was found in commercial quantities, three to five years later. Oil production could last 20 to 30 years.

No one knows how much oil will be found in the Western Gulf of Alaska; but, most authorities agree that no commercial quantities of natural gas will be found. The guesses as to how much oil will be found range from 250 million barrels to two billion barrels. If the lower figure turned out to be accurate, no development of the Western Gulf of Alaska would take place because 250 million barrels is not enough oil to cover development costs. If the oil found is in greater quantities, possibly as few as one or as many as seven production platforms could be installed, depending on the amount of oil found and the location(s) of the discovery(ies). Judging from the distribution of the acreage which may be leased (see Figure 1), if oil is found it appears that a northern discovery is a likely situation. A middle discovery also appears possible, but to the south the lower acreage in the lease area makes the chance of a discovery less likely.

There are two basic methods of transporting oil from a production platform to an oil tanker: a pipeline to a shore-based oil storage terminal which includes docks and transfer facilities for tankers, and a single point mooring (SPM) which does not require pipelines to shore or a shore-based terminal facility. The preference of an operator of a lease area for either of these two methods will be developed on the basis of technological feasibility and economics. A very important economic factor is the cost of the sea portion of the pipeline, which may be as low as three million or as high as 11 million dollars per mile. Obviously, as offshore pipeline construction costs rise toward the higher figure, at least some operators will give more careful consideration to the use of an SPM system to transfer their oil to tankers.

To support OCS exploration and production activities in the Western Gulf of Alaska, two types of on-shore facilities may be constructed on Kodiak -- a marine service base and an oil terminal. Marine service bases provide materials and logistical support to ships which service exploratory rigs and production platforms. It is unlikely that temporary service bases would be constructed on Kodiak; early in exploration, operators would tend to use existing facilities, such as those at Yakutat and Seward. A permanent service base would be considered for construction on Kodiak only if the forseeable level of activity in the Western Gulf justified such an expenditure. Consistently disappointing exploratory drilling results would tend to discourage this type of investment. An oil terminal would be needed only if oil were found in commercial quantities and if it is determined to pipe the oil to shore for storage and tranfer to tankers, rather than direct transfer offshore to a tanker. Considering the severe offshore conditions, water depths, and other factors, at this time it seems likely that most, but not all, petroleum companies would consider piping oil to an onshore terminal for transfer to tankers as their first choice, at least until pipeline costs appear prohibitive.

The approach to evaluating site suitability was organized into four tasks; the objectives of these tasks were listed in Section 1.1. Alternative facility development scenarios were reviewed with petroleum company and State of Alaska representatives to determine those facilities most likely to be constructed on Kodiak. This resulted in the identification of marine service bases and oil terminals as the facilities to be considered in the evaluation and ranking process. The potential sites where these facilities could be located were then reviewed; this resulted in the candidate sites which were subsequently considered in the study. The potential sites were visited by a reconnaissance team, and using their observations and other available data, the consequences (or impacts) of placing each of the two facility types at each candidate site were evaluated. The technical staff involved in this evaluation, various interest groups in the Kodiak Island Borough, and petroleum company representatives were interviewed to determine their preferences for the various consequences. Using these preferences, the sites then were ranked from the various technical and interest group viewpoints.

1.3 REPORT ORGANIZATION

The remaining chapters of this report are organized as follows:

- chapter 2 describes the facility characteristics considered in the evaluation of consequences;
- chapter 3 presents the methodology used in the evaluation and ranking of the sites; and
- chapter 4 presents the results of the ranking.

Following chapter 4 are appendices which present a more technical description of the ranking methodology, which is a formal decision analysis technique, candidate site descriptions, and descriptions of the measures used to evaluate site impacts.

In addition to this report a summary report is also available which provides a brief overview of the study and its conclusions.

CHAPTER 2

SITES AND FACILITIES CONSIDERED IN THE RANKING

2.1 FACILITY CHARACTERISTICS

In the early planning stages of this study four types of onshore support facilities were considered for evaluation in the site ranking: marine service bases, oil storage and terminal facilities, an offshore-facility fabrication yard, and a liquification facility for natural gas (LNG). Because the available estimates of natural gas potential in the Western Gulf of Alaska are very low, an LNG facility was not considered feasible for siting on Kodiak. Presently, offshore exploration rigs active in Alaskan waters are fabricated elsewhere and towed to work sites. Petroleum company representatives have judged that the economics of establishing a new fabrication yard for exploratory rigs or production platforms dictates against such an investment in Kodiak. Therefore, a fabrication yard as a potential facility type for consideration in the site ranking also was discarded.

In order to evaluate the impacts of siting service bases and oil terminals on Kodiak, general facility characteristics were assumed based upon a review of information provided by the State of Alaska, and discussions with petroleum companies and Earl and Wright, Consulting Engineers. These characteristics are listed below:

Service Base

Acreage Requirement - 30 to 40 acres;

Land Use - open and enclosed storage, including water and fuel tanks; dock facilities for three to five vessels;

Bay Requirements - 800 foot diameter turning basin and 36 foot depth.

Oil Terminal

Acreage Requirement - 100 to 300 acres;

Land Use - up to ten 500,000 barrel storage tanks;
5000 foot airstrip;
pumping facilities, holding tanks for ballast, and support buildings;
docks for tankers;

Bay Requirements - 4000 foot diameter turning basin and 72 foot depth.

All oil terminal sites were also used in the analysis as potential service base sites. The differences in characteristics between temporary and permanent service bases are difficult to quantify. We assumed that temporary bases only would be located near an existing town because of the desire to minimize investment in such a facility. It is important to note that locations outside of Kodiak, such as Seward, will be considered by petroleum companies for use in support of offshore activities, at least as temporary service bases.

2.2 SITE SELECTION FOR RANKING

There are a number of potential sites within the Kodiak/Afognak archipelago which could be considered in the evaluation and ranking process. Seven potential sites selected by the Alaska Department of Community and Regional Affairs (DCRA) were reviewed, and other potential sites were selected for comparison, in order to identify the sites which would be evaluated and ranked. The aim of this study was not to rank all potential sites, but to rank sample or typical sites which are located in bays that have a high probability for development consideration.

The seven sites identified by DCRA were in Kazakof, Monashka, Kalsin, Ugak, Barling, and Three Saints Bays, and in the vicinity of the town of Old Harbor. In meetings with petroleum company and Koniag, Inc. representatives, several other areas of interest were identified: Izhut, Tonki, and Kiliuda Bays. Tonki Bay was eliminated from further consideration because of its similarity to other bays on Afognak Island. In an effort to establish that no oil terminal sites were arbitrarily dismissed from the geographic area bounded by Izhut Bay and Three Saints Bay, the following screening criteria was applied to all bays:

1. oil tanker requirements are a water depth of 72' below mean low water and a turning basin diameter of 4000 feet;
2. land acreage requirements for an oil terminal are 100 to 300 acres, and locations with relatively flat level land are preferred.

No additional bays were added as a result of this procedure. However, a number of sites were added within some bays. Eighteen sites within the bays met these criteria for an oil terminal development. These, plus four additional sites, constituted the potential service base sites (see Figure 2-1).

The time available to complete this study did not make it feasible to evaluate 22 sites. Therefore, the following 7 sites were eliminated for the reasons indicated:

Site 1 - Kazakof Bay. Site 1 was further away from the find locations than other Kazakof Bay sites and was similar to Site 2 in general characteristics;

Site 5 - Izhut Bay. Topographic features and the proximity to the Alaska State Fish Hatchery in Kioti Bay made Site 5 less desirable than Site 4;

Site 6 - Monashka Bay. The location of this site at the entrance of the bay, and therefore being exposed to storms, made this site less desirable than Site 7;

Site 11 - Ugak Bay. Exposure and proximity to an anadromous fish stream made this site less desireable than other sites in the bay;

Site 14 - Kiliuda Bay. Exposure was the criterion for elimination of this site relative to other Kiliuda Bay sites;

Site 15 - Old Harbor. Land availability and requirements for extensive dredging eliminated this site from further consideration for an oil terminal.

Site 18 - Three Saints Bay. Proximity to a National Historic site and less desirable engineering factors made this site less favorable when compared to Site 17.

The number of potential service base sites in Kodiak is very high, as with oil terminal sites. However, for the purpose of this project it was assumed that a service base could be located with an oil terminal, thus all terminal sites have the potential for being service bases. In addition, temporary service bases could be located near areas with existing infrastructure. Therefore, four additonal sites were added to the oil terminal sites. These were at Port Lions, Kodiak, Womens Bay, and Old Harbor.

2.3 POSSIBLE PIPELINE ROUTES

A major consideration in the siting of an onshore oil terminal will be the cost, both environmental and engineering, of associated pipelines. In an effort to include this factor in the analysis, possible pipeline corridors from several different find locations were identified (see Figure 1-1). These are presented in detail in Figures 2-2, 2-3, 2-4, and 2-5. To establish the location of potential oil finds, blocks in three of the largest groupings were arbitrarily selected as possible find locations. The three blocks selected were numbers 203, 379, and 215.

In developing the pipeline route, the following assumptions and considerations were made:

1. the pipeline right-of-way on land is 100 feet wide;
2. the best route for a pipeline is overland, as cost and scheduling problems are reduced;
3. unusual topographic features or access problems should be avoided in selecting the route;
4. developed areas and roads should be used, if possible;

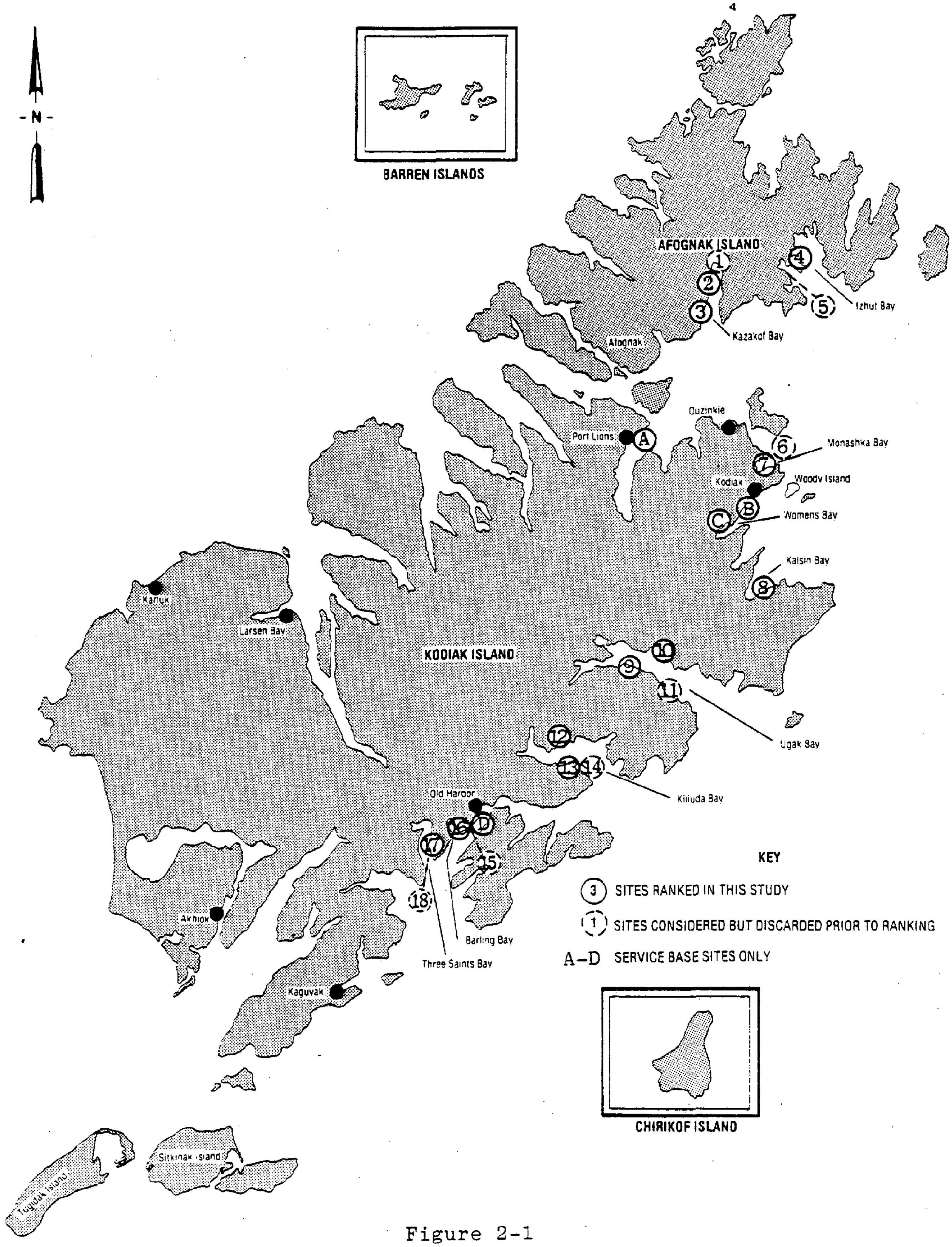


Figure 2-1
SITE LOCATIONS

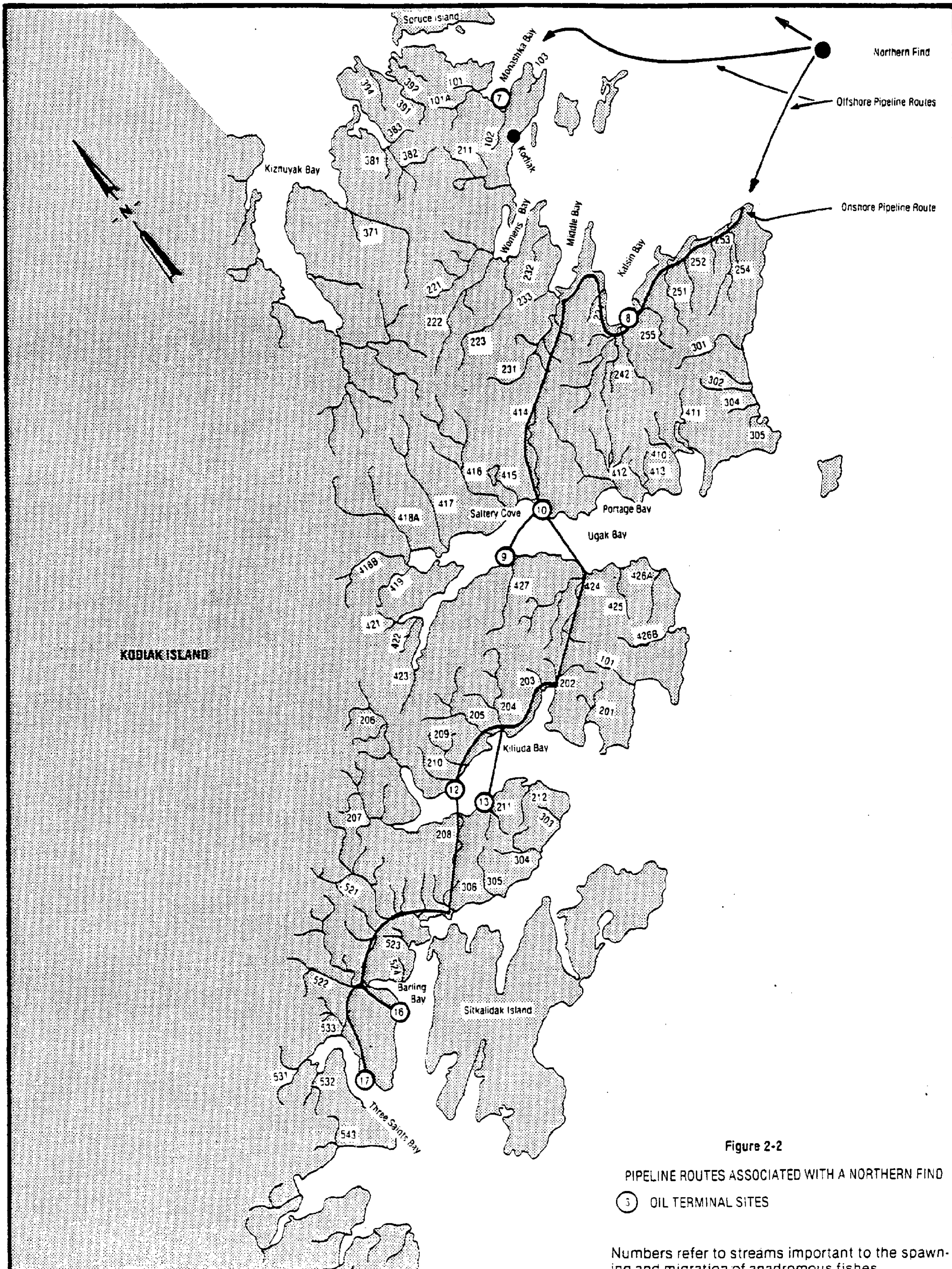


Figure 2-2

PIPELINE ROUTES ASSOCIATED WITH A NORTHERN FIND

(3) OIL TERMINAL SITES

Numbers refer to streams important to the spawning and migration of anadromous fishes.

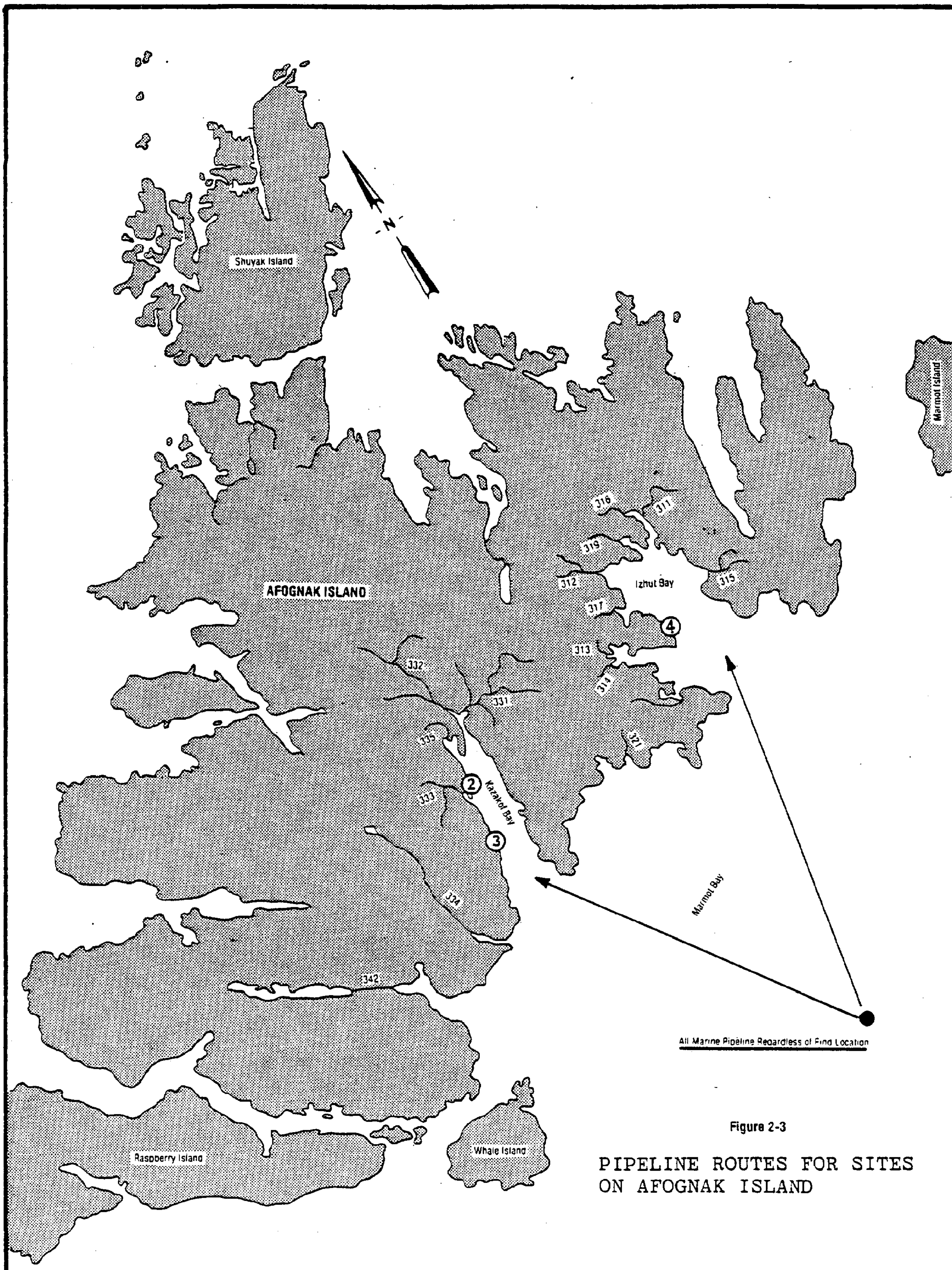


Figure 2-3

PIPELINE ROUTES FOR SITES ON AFOGNAK ISLAND

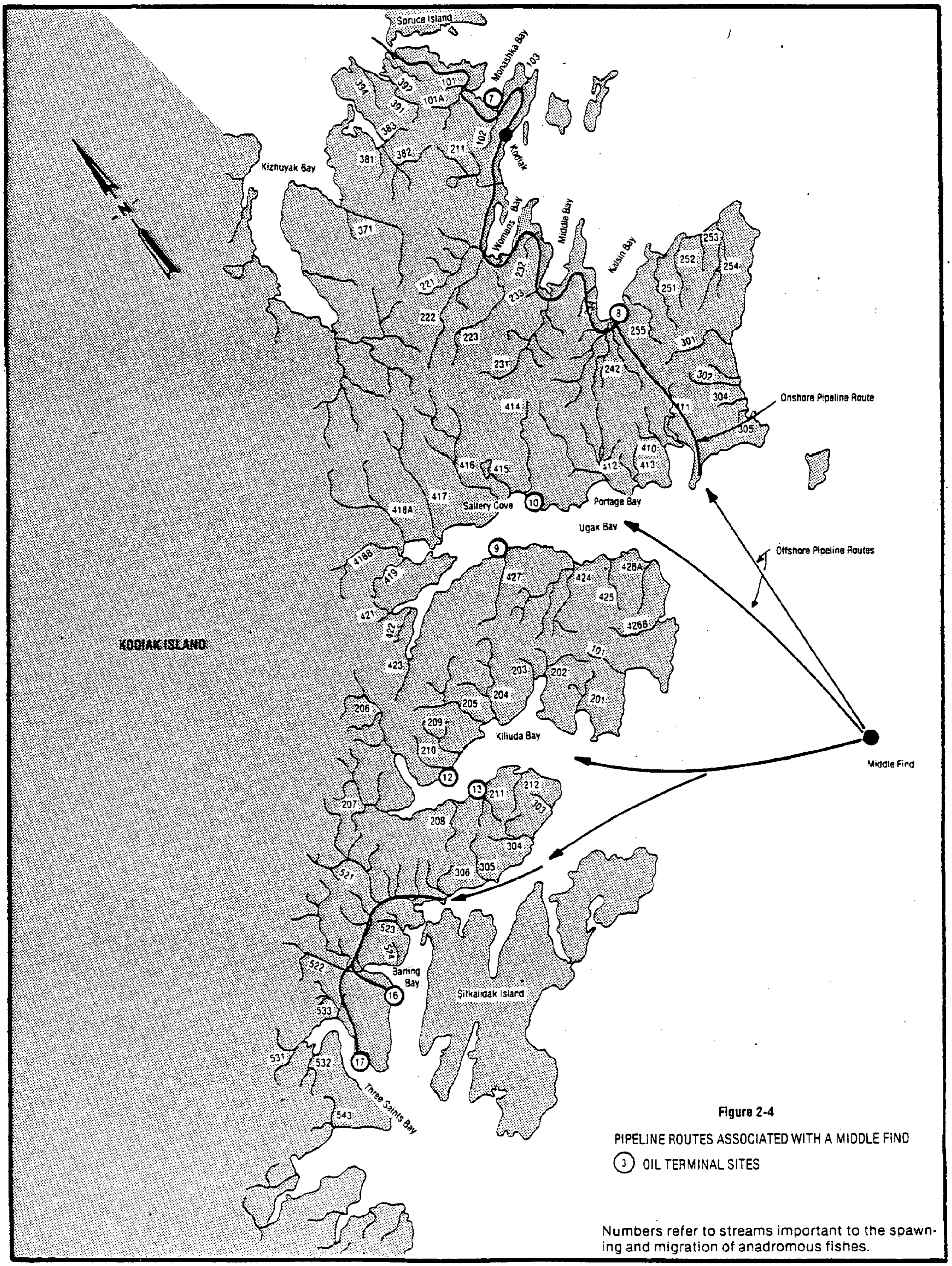


Figure 2-4

PIPELINE ROUTES ASSOCIATED WITH A MIDDLE FIND

(3) OIL TERMINAL SITES

Numbers refer to streams important to the spawning and migration of anadromous fishes.

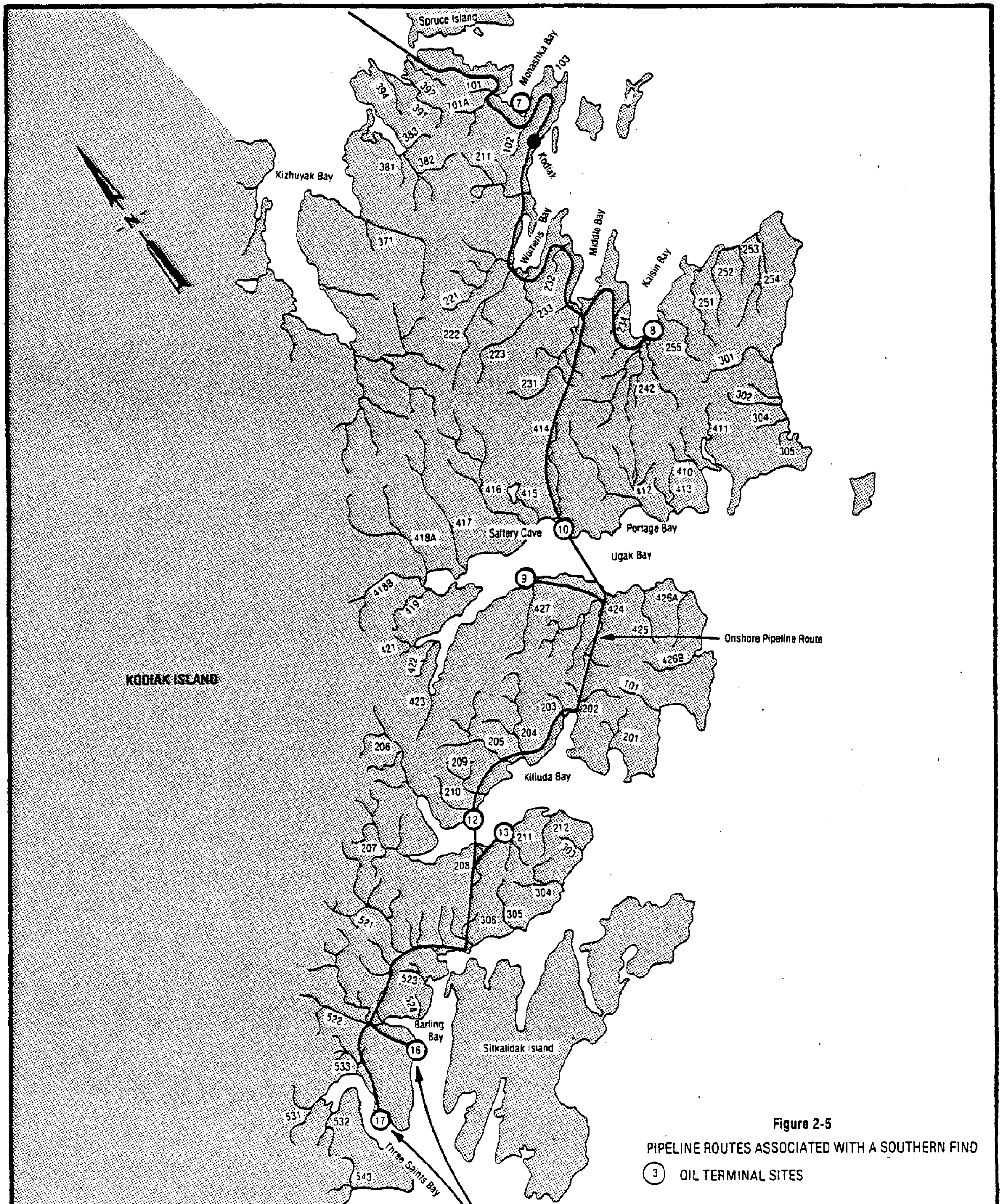


Figure 2-5

PIPELINE ROUTES ASSOCIATED WITH A SOUTHERN FIND

(3) OIL TERMINAL SITES

Numbers refer to streams important to the spawning and migration of anadromous fishes.

5. bay crossings are preferred where the on-land cost to circumvent the bay exceeds the bay crossing cost; and

6. offshore pipelines are straight line routes because technical data available to make other alignment assumptions are not presently available.

The primary considerations in the routing of the pipeline were engineering factors, as these ultimately reflect cost to the petroleum company. The consideration of environmental factors in the selection of pipeline corridors was not within the scope of this project. However, the corridors available for pipelines on Kodiak Island are limited because of the topography of the island. Therefore, the pipeline route used in this study probably represents a logical route. It is important to note that the ranking presented in Chapter 4 is sensitive to this route, as environmental effects of the pipeline and pipeline costs are major factors affecting the impacts of any terminal site.

CHAPTER 3

METHODOLOGY USED IN EVALUATING THE ALTERNATIVE SITES

3.1 INTRODUCTION

The evaluation and ranking of alternative Kodiak sites for OCS support facilities is difficult because of the need to address a number of complex issues.

The Need to Consider Tradeoffs Between Impacts in Different Areas

There may not be a site which is the best site with respect to each and every impact or concern. When a situation such as this occurs, it is necessary to make tradeoffs between impacts in different areas in order to rank the alternative sites; in other words, we must specify how much impact we can accept in one area in order not to have an impact in another area.

The Presence of Several Affected Groups and Decision Makers

With respect to the Kodiak sites, there are a number of different interest groups including petroleum companies, the Koniag Native Corporation and village corporations, various fishing and processing interests, and the municipality of Kodiak which could be affected by the selection of any particular site for development. These groups may have different preferences for various impacts. It is important to be able to take into account these different points of view in evaluating the sites.

Identification of Impacts Which Can be Used to Compare Sites

There are many areas of potential impact (economic, environmental, social) due to a facility. Some impacts are difficult to characterize because of their subjective nature; e.g., impacts on the lifestyle of natives. There is often uncertainty in the estimates of impacts for particular sites. This is true with ecological impact analysis as ecosystem response to an impact producing action is difficult to quantify. In addition, some impacts are long term (>5 years) while others are short term (1-2 years) in their effect on the system.

These issues are very difficult to deal with simultaneously in an intuitive manner. Such an approach would be of little use in providing a basis for future planning decisions or in assisting affected parties. In evaluating the alternative sites, we therefore made use of a formal approach, called decision analysis, in order to address the complexities of the problem. Decision analysis can be divided, for the purpose of this discussion, into four major steps:

1. formally structuring the problem;
2. estimating the impacts of the alternatives;
3. determining the preferences for different impacts; and
4. synthesizing the information to evaluate and rank the alternative sites.

These steps are pictorally shown in more detail in Figure 3-1. While decision analysis is done in a systematic manner using formally derived procedures, it is essentially a common-sense way to approaching the evaluation problem. The complex problem is broken down into smaller and simpler parts which are solved individually and then tied together to rank the sites.

The steps in this decision analysis approach, as they were implemented for the Kodiak ranking, are discussed in the subsequent paragraphs of this chapter.

3.2 STEP 1: STRUCTURING THE PROBLEM

The proposed facilities and the alternative sites for these facilities were described in Chapter 2. The identification of facilities

STEPS IN DECISION ANALYSIS APPROACH TO RANKING SITES

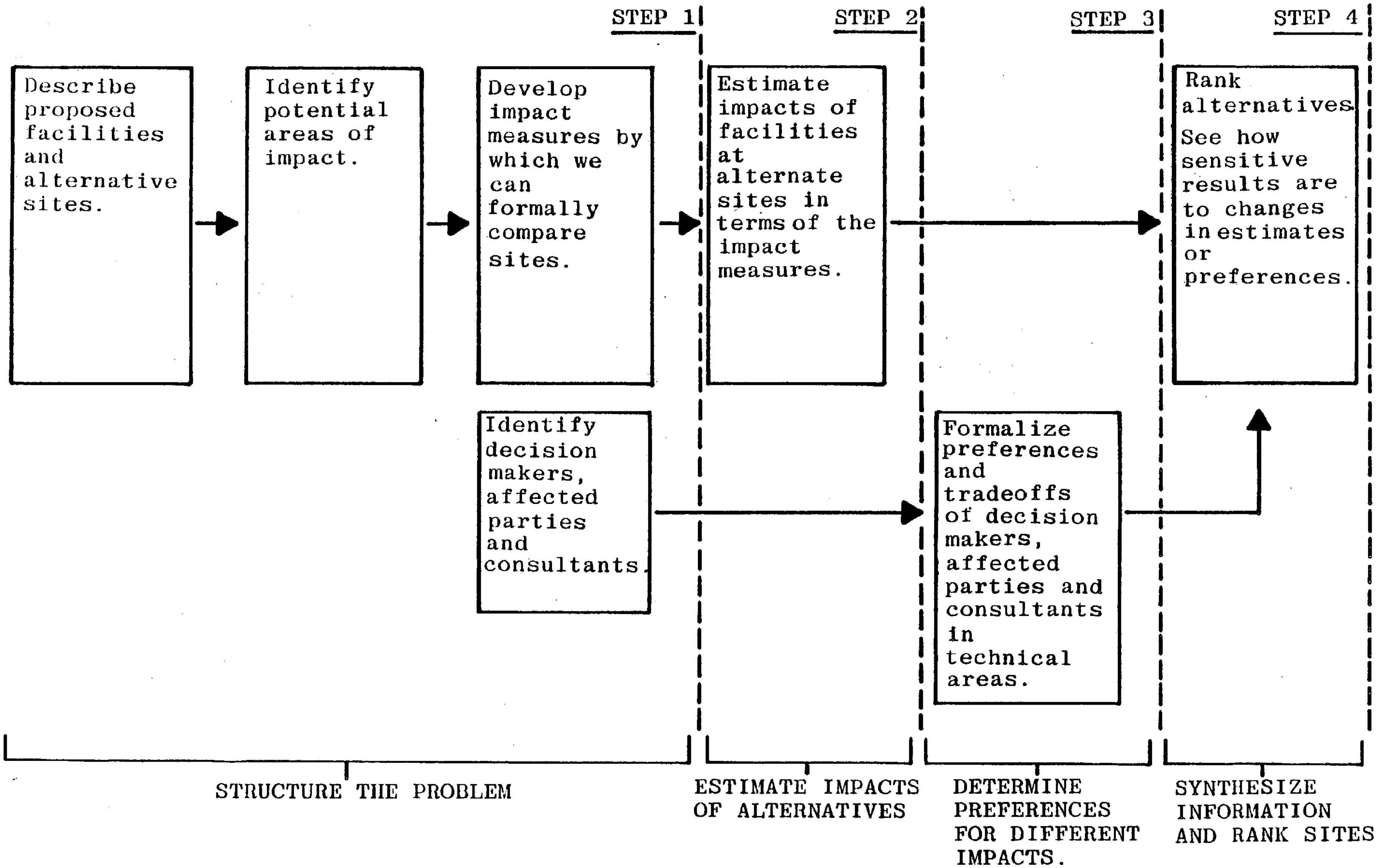


Figure 3-1

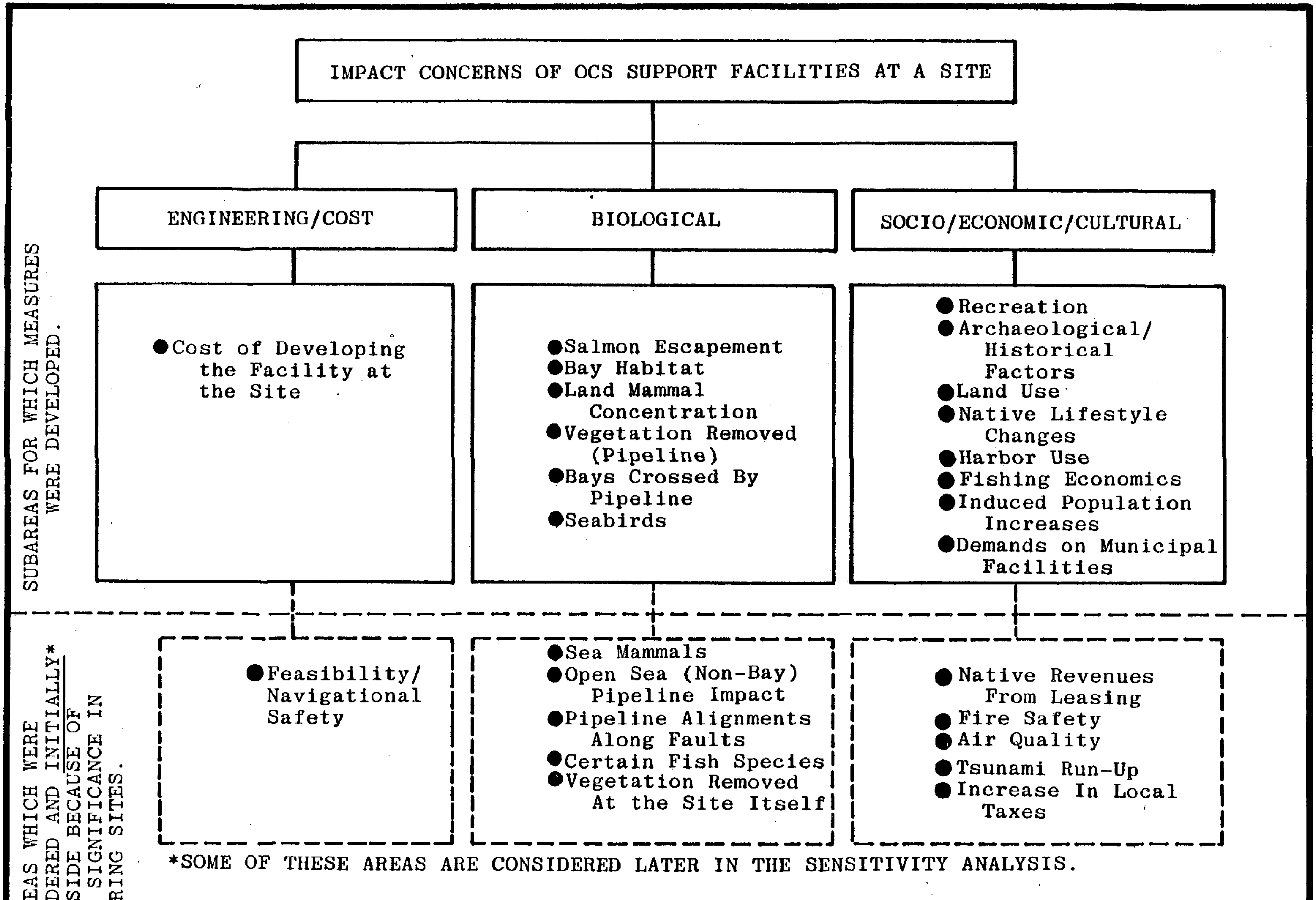
and alternative sites constituted the first phase of Step 1. The next phase of structuring the problem consisted of identifying impact-producing actions and developing a means of measuring these impacts on the systems of Kodiak. Decision analysis requires that these measures be well-defined so that they can be used in a formal manner. A multi-disciplinary team identified and discussed many topics which were thought to be relevant to the problem of comparing alternative sites for OCS support facilities. First, broad concerns were listed in areas where the sites were expected to show different impacts. These broad areas of concern were then subdivided into more specific subareas. The process continued until we were able to define measures which indicated how well a site addressed a particular subarea of concern. Figure 3-2 shows the specific subareas for which measures were developed.

At each stage, factors that contributed little to discriminating among the alternative sites were set aside. The considerations for doing this were as follows:

1. The variation of discernable impact between the sites is negligible. For example , the adverse impacts on groundfish spawning may be important, but we could not demonstrate significant impact differences for groundfish spawning among the sites because of the lack of data. Other consequences that had negligible variations among sites were increases in the local tax base and pipeline alignments with respect to geologic faults.

2. The likelihood of occurrence of a significant impact is very small. For example, all of the sites were considered sufficiently elevated above mean sea level such that the likelihood of impact due to a tsunami run-up was considered to be very small.

3. The relative significance of an impacting feature of the site as it relates to other site features was determined. For example, air



IMPACT CONCERNS

Figure 3-2

quality alteration at each site was not used in the ranking process as other impact features of the site (e.g., topography, biological and socioeconomic impacts) were considered more significant and provided better discriminatory measures.

For each of the subareas which were retained (Figure 3-2), measures were developed to indicate how well any site addressed that particular concern. Several kinds of measures were used. One kind, called an objective scale, is one which is commonly understood. For example, a dollar measure indicates how well a site is minimizing certain costs. Another kind of measure is a subjective scale. Such a scale is defined by associating a specific description of events or conditions with each point on the scale. Subjective measures are often appropriate when dealing with issues that do not lend themselves to common units of measure. Sometimes, a measure was used which indirectly reflects the level of impact. For example, socioeconomic impacts due to induced population increases may include housing shortages, an increase in the cost of living, and overburdened facilities. A scale consisting of the number of people added to the population, while not directly measuring the impacts, still reflects these impacts because it measures a key variable underlying these socioeconomic effects. The details of the specific impact areas and how the measures were selected are discussed in Appendix C.

The last part of Step 1, structuring the problem, was to identify the people who would input their preferences for use in the ranking. Woodward-Clyde Consultants provided an interdisciplinary project team from which several persons contributed their expertise in a specific discipline such as biology or socioeconomics. Indications of preferences from different interest groups were also obtained by means of interviews. These groups included petroleum companies, the Koniag Native Corporation, the municipal government of Kodiak, and the United Fishermens Marketing Association. The information from these sources was utilized to formulate various preference viewpoints in the subsequent analysis. The interviews with representatives from these different groups indicated that the measures which were developed seemed appropriate for comparing and ranking the sites.

3.3 STEP 2: ESTIMATING THE IMPACTS OF THE ALTERNATIVES

The next step of the approach was to specify the consequences (impacts) of each of the alternatives in terms of the measures which were described in the previous section. In our problem, the consequences of siting a facility at a particular location depend, among other things, on which type of facility is located at the site (oil terminal or service base) and, for an oil terminal, on the nature and route of the oil pipeline. For oil terminal candidate sites, impacts were estimated for three different oil find areas (northern, middle, and southern finds) coupled with two different pipelines (land-sea and all-sea). These estimates allowed us to rank the sites for different oil find scenarios.

The impact estimates for the sites were obtained by using:

1. existing literature, data, and interviews with individuals in different fields;
2. professional judgment of the project team members; and
3. models for predicting certain types of consequences.

For each site, assuming a particular facility and scenario, a single number best-estimate was obtained for each of the 16 measures. Thus, each site was characterized by a set of 16 numbers. The uncertainty involved in these estimates is addressed later in Chapter 4. The ranking results were then examined to see what effect changes in the impact estimates have on the rank ordering of the sites.

Tables 3-1 through 3-5 present the impact estimates for oil terminals and service bases. An examination of the Kazakof Bay 2 site on the first table (northern find, oil terminal at the site, land-sea pipeline) will illustrate how the measures were used to characterize each alternative site. Each of the numbers assigned to the site was interpreted using the measure definitions. Thus, for 2 Kazakof, we have:

cost = 217.4; the pipeline and excavation costs total $217.4 million.

bay habitat = 2; the bay habitat is characterized by salmon escapement of nearly 60,000 fish, confined shoreline 50 percent covered by organisms and nearly 30 miles in extent, shrimp production between 2 and 7 million pounds per year and limited kelp beds. It is this type of bay habitat which will be exposed to the impacts of the oil terminal construction and operation.

facility demand = 0 no effect at Kodiak/Port Lions/Old Harbor service systems, roads; minimal effect on airports (personnel transfer only).

Using the measures, the impacts or index to impact at each site that are relevant to comparing the alternatives have been formalized into a concise representation. At the same time, we have tried to define the meaning of each number as clearly as we could so as to characterize the relative consequences of activity at a particular site.

There are certain general features present in the impact tables that agree with intuition. The sites with the lower costs for oil terminals are close to the find areas because they have the shorter pipelines. Sites with relatively long overland pipelines have more stream and vegetative impact as well as other adverse impacts because of pipeline construction. For the service base and all-sea pipeline tables, several biological measures are at levels indicating no on land pipeline impact since there is no longer an overland pipeline.

If on each table there was a site that had the best levels for all of the measures, the analysis could stop here since the best site for each scenario would be obvious. As the tables indicate, however, this is not the case. Some sites that have relatively good levels in terms of

TABLE 3-1 ALL SEA ROUTES

Sites	Cost		Bay Habitat	Salmon	Land Mammals	Vegetation	# Bays Crossed by Pipe	# of Birds	# of Bird Colonies	Recreation	Archaeological	Land Use	Lifestyle	Water (harbor) Use	Fishing Eonomics	Demographic	Facility Demands
	Northern	Middle															
2 Kazakoff	220.4	277.4	2.0	0	1	0	0	5	5	2	1	2	1	1	2	1	0
3 Kazakoff	223.2	280.2	2.0	0	0	0	0	5	5	2	0	2	1	1	2	1	0
4 Izhut	188.4	263.4	2.5	0	1	0	0	20	10	2	1	2	0	1	2	1	0
5 Monashka	184.2	211.2	1.0	0	0	0	0	3	3	3	1	3	1	1	1	4	3
8 Kalsin	185.8	188.8	1.75	0	1	0	0	12	3	2.5	1	2	0	1.5	2	3.5	2
9 Ugak	252.0	132.0	3.0	0	2	0	0	25	7	1	0	1	2	1	2	1	0
0 Ugak	247.0	127.0	3.0	0	1	0	0	25	7	2.5	1	2	1	2	2	2	1
2 Kiliuda	290.4	131.4	2.75	0	0	0	0	132	6	1	0	1	0	1.5	3	1	0
3 Kiliuda	286.4	127.4	2.75	0	0	0	0	132	6	1	1	1	0	1.5	3	1	0
6 Barling	318.6	150.6	1.25	0	0	0	0	0	0	2	2	1	2	1	1	1	0
7 Three Saints Bay	370.3	287.3	1.5	0	0	0	0	1	1	1	1.5	1	2	1	1	1	0

TABLE 3-2 SERVICE BASE

Sites	Cost	Bay Habitat	Salmon	Land Mammals	Vegetation	# Bays Crossed by Pipe	# of Birds	# of Bird Colonies	Recreation	Archaeological	Land Use	Lifestyle	Water (harbor) Use	Fishing Eonomics	Demographic	Facility Demands
2 Kazakoff		2		1			5	5	1.5	1	2	1.5	1	2	1	0
3 Kazakoff		2		0			5	3	1.5	0	2	1.5	1	2	1	0
4 Izhut		2.5		1			20	10	2	1	2	0	1	2	1	0
5 Monashka		1.0		0			3	3	3	1	6	0	1	1	2	3
8 Kalsin		1.75		1			12	3	2.5	1	2	0	1.25	2	2	2
9 Ugak		3		2			25	7	1	0	1	1	1	2	1	0
10 Ugak		3		1			25	7	2.5	1	1	1	1	2	1.23	1
12 Kiliuda		2.25		0			132	6	1	0	1	0	1.5	3	1	0
13 Kiliuda		2.75		0			132	6	1	1	1	0	1.5	3	1	0
16 Barling		1.25		0			0	0	2	2	1	1.5	1.25	1	1	0
17 Three Saints Bay		1.5		0			1	1	1	1	1	1.25	1	1	1	0
A Port Lions		1.5		0			14	5	2	2	2	3	1.5	1	3	3
B St. Paul		1.0		0			1	1	0	0	3	0	2	0	2	3
C Womens Bay		1.25		1			13	4	0	1	2	0	1.25	1	2	2
D Old Harbor		1.0		0			0	0	2	1.5	3	3	1.5	1	3	3

TABLE 3-3 NORTHERN FIND

Land-Sea Pipeline

Sites	Cost	Bay Habitat	Salmon	Land Mammals	Vegetation	# Bays Crossed by Pipe	# of Birds	# of Bird Colonies	Recreation	Archaeological	Land Use	Lifestyle	Water (harbor) Use	Fishing Eonomics	Demographic	Facility Demands
2 Kazakoff	217.4	2.0	0	1	0	0	5	5	2	1	2	1	1	2	1	0
3 Kazakoff	223.2	2.0	0	0	0	0	5	5	2	0	2	1	1	2	1	0
4 Izhut	188.4	2.5	0	1	0	0	20	10	2	1	2	0	1	2	1	0
5 Monashka	184.2	1.0	0	0	0	0	3	3	3	1	3	0	1	1.5	4	3
8 Kalsin	163.8	1.75	20	1	167	0	12.0	3	2.5	1.5	2	0	1.5	2	3.5	2
9 Ugak	200.0	3.0	186	3	427	2	25.0	7	1.5	1.5	1	2.5	1	2	1	0
10 Ugak	186.0	3.0	186	3	427	0	25.0	7	2.5	1.5	2	2.5	2	2	2	1
12 Kiliuda	223.4	2.75	251	3	680	2	132.0	6	1.5	2	1.5	2	1.5	3	1	0
13 Kiliuda	237.4	2.75	217	3	640	3.75	132.0	6	1.5	2	1.5	2	1.5	3	1	0
16 Barling	268.6	1.25	318	3	920	3.75	0	0	2.5	2.5	1.5	2.5	1.5	2	1	0
17 Three Saints Bay	274.3	1.5	318	3	960	3.75	1.0	1.0	1.5	2	1.5	2.5	1.5	2	1	0

TABLE 3-4 MIDDLE FIND
Land-Sea Pipeline

Sites	Cost	Bay Habitat	Salmon	Land Mammals	Vegetation	# Bays Crossed by Pipe	# of Birds	# of Bird Colonies	Recreation	Archaeological	Land Use	Lifestyle	Water (harbor) Use	Fishing Eonomics	Demographic	Facility Demands
2 Kazakoff	204.4	2.0	234	3	647	8	5	5	2.5	2	2.5	1	1.5	2.25	2	2
3 Kazakoff	207.2	2.0	234	3	647	8	5	5	2.5	2	2.5	1	1.5	2.25	2	2
4 Izhut	232.4	2.5	234	3	647	8	20	10	2.5	2	2.5	1	1.5	2.25	2	2
5 Monashka	147.2	1.0	219	3	532	0	3	3	3.0	2	3	1	1.5	2.25	4	3
8 Kalsin	111.8	1.75	1	3	162	0	12	3	2.75	2	2.5	1	1.5	2.25	3.5	2
9 Ugak	132.0	3.0	0	0	0	0	25	7	1	0	1	2	1	2	1	0
10 Ugak	127.0	2.0	0	0	0	0	25	7	2.5	1	2	1	2	2	2	1
12 Kiliuda	131.4	2.75	0	0	0	0	132	6	1	0	1	0	1.5	3	1	0
13 Kiliuda	127.4	2.75	0	0	0	0	132	6	1	1	1	0	1.5	3	1	0
16 Barling	150.6	1.25	63	2	143	0	0	0	2	2.25	1	2	1.25	1.5	1	0
17 Three Saints Bay	156.3	1.5	63.1	2	162	0	1	1	1	1.5	1	1	1.25	1.5	1	0

TABLE 3-5 SOUTHERN FIND
Land-Sea Pipeline

Sites	Cost	Bay Habitat	Salmon	Land Mammals	Vegetation	# Bays Crossed by Pipe	# of Birds	# of Bird Colonies	Recreation	Archaeological	Land Use	Lifestyle	Water (harbor) Use	Fishing Eonomics	Demographic	Facility Demands
2 Kazakoff	217.4	2.0	405	3	1205	8	5	5	2.5	2	2.5	1	1.5	2.5	2	2
3 Kazakoff	220.2	2.0	405	3	1205	8	5	5	2.5	2	2.5	1	1.5	2.5	2	2
4 Izhut	272.4	2.5	405	3	1205	8	20	10	2.5	2	2.5	1	1.5	2.5	2	2
5 Monashka	189.2	1.0	389	3	1084	3.75	3	3	3	2	3	1	1.5	2.5	4	3
8 Kalsin	160.8	1.75	298	3	793	3.70	12	3	2.5	2	2	1	1.0	2.5	3.5	2
9 Ugak	128.0	3.0	135	2	570	1.75	25	7	1	1.75	1	1	1.5	2.5	1	0
10 Ugak	141.0	3.0	133	3	533	3.75	25	7	2.5	1.75	2	1	1.5	2.5	2	1
12 Kiliuda	100.4	2.75	67.1	2	280	1.75	132	6	1	1.75	1	1	1.5	3	1	0
13 Kiliuda	100.4	2.75	67.2	2	329	0	132	6	1	1.75	1	1	1.5	3	1	0
16 Barling	96.6	1.25	0	0	0	0	0	0	2	2	1	2	1	1	1	0
17 Three Saints Bay	70.3	1.5	0	0	0	0	1	1	1	1.5	1	2	1	1	1	0

biological consequences have relatively poor levels for socioeconomic consequences. Sites like 7 Monashka and 8 Kalsin are examples of this on the first table for a northern find. Some sites that have relatively good levels for socioeconomic consequences have relatively poor levels for biological and cost consequences.

Even within a broad area of concern, there are sites that are difficult to informally compare. For example, with respect to biological impacts, some sites do relatively well on bay habitat but relatively poorly on salmon streams. In order to rank the sites, we proceeded to the next step of the approach, which is determining preferences for different impacts.

3.4 STEP 3: DETERMINING THE PREFERENCES FOR IMPACTS

The decision analysis approach provides procedures and models for formalizing preferences. The basic elements of the models are not difficult to understand. A decision maker, consultant, or interest group representative is asked to specify preferences for a number of relatively simple alternatives. A model is than formulated based on this preference input. This model allows us to do several things:

1. it can be used to feed back the same preferences which were input as well as preferences for other simple alternatives to check that the model is reflecting a particular viewpoint;
2. it can be used to compare more complicated alternatives (e.g., Kodiak sites) in a manner consistent with (i.e., logically implied by) the inputs for the simpler alternatives; and
3. it can be used to simulate other viewpoints by using different sets of preference input and to perform a sensitivity analysis in changes to site estimates.

The form of the model is a mathematical equation. The inputs to the model once it is formulated are the impact or consequence estimates for the alternative sites. The output from the model is a rating number for each site, called the expected utility. The sites are rank ordered on the basis of expected utility. Those with a higher expected utility are more preferred.

The actual procedures used to formulate the preference model for the Kodiak ranking are presented in the mathematical appendix to this report. In the following paragraphs we provide an overview of the basic approach that was taken to formalize preference viewpoints.

The major element involved in ranking the alternatives is the specification of the tradeoffs between the impact measures. As was illustrated by the impact estimate tables, the key issues for ranking the sites are typified by questions such as:

> Is it preferable to select a site with relatively low cost and low ecological impact but with relatively high socio-economic impact, rather than a site with relatively low socio-economic impact but relatively high biological impact and cost?

The measures which were developed allow us to be more precise in asking this type of question. We can now ask:

> Is it preferable to select a site which would result in an induced population increase to the town of Kodiak of 1500 people during the construction of the oil terminal and which would impact a bay having a bay habitat value of 1 (e.g., like Monashka), rather than a site which would result in virtually no induced population increase to the town of Kodiak but which would impact a bay having a bay habitat value of 3 (e.g., like Ugak). (In this question all other impacts for both hypothetical sites are assumed to be at their best levels and are identical for both sites.)

The decision analysis approach allows us to define a simple tradeoff situation involving only two measures at a time in a relatively precise manner. By asking the decision maker, consultant, or interest group representative a series of questions, it is possible to elicit how much one is willing to trade off in one area in order to gain in another area. For example, a petroleum company representative can be asked how much money he needs to save in order to "move from" (e.g., change his mind about) a site with less biological impact to one with more biological impact.

In the process of assessing preference viewpoints for use in the ranking of alternatives, we proceeded along the following lines. First, tradeoffs between measures of biological concern (e.g., salmon streams vs. bay habitat) were assessed by Woodward-Clyde Consultants using an in-house professional. We felt that determining which impacts are more important from a biological point of view could best be done by a professional in this field. Similarly, tradeoffs were assessed by Woodward-Clyde Consultants using an in-house socioeconomic professional for the socioeconomic measures. These tradeoffs were elicited in a rigorous manner using decision analysis procedures.

The tradeoffs that occur between the cost, socioeconomic, and biological domains are the more controversial ones. (Also, certain "intra-domain" tradeoffs for particular interest groups may be different than those of the in-house expert. For example, salmon streams have particular significance to Native groups because of subsistence fishing and the role of the salmon species as part of their cultural lifestyle.) In order to obtain different viewpoints for the controversial tradeoffs, we interviewed several interest groups mentioned earlier. These interviews were not intended to rigorously assess tradeoffs but were designed to get some indication of the differences in tradeoffs between impacts that different interest groups had.

The preference assessments were utilized in the ranking of the sites as follows:

1. The impacts of most concern for different interest groups were identified; this enabled us to examine the ranking results from different interest group viewpoints.
2. A range of tradeoffs between cost and noncost impacts were developed which could reflect a variety of petroleum company viewpoints.
3. A range of tradeoffs between the broad concerns of costs, socioeconomics, and biology was developed to explore the sensitivity of the ranking results to different degrees of emphasis on these particular concerns.

3.5 STEP 4: SYNTHESIS OF INFORMATION AND SITE RANKING

The final step of the decision analysis approach is to combine the information of the three previous steps to evaluate and rank the sites. Presented here is a brief review of the approach, followed by a general discussion which will help the reader to interpret the ranking results. Chapter 4 will discuss the ranking results in detail.

In the first step of the approach, we developed a set of sixteen measures which enabled us to structure the problem in a formal manner in the subsequent steps. These measures reflect the concerns that are pertinent to comparing the sites. In the second step, each site alternative was quantitatively described in terms of the measures with sixteen numbers being used to characterize a site for any particular scenario. In the third step, preference viewpoints were formalized using a mathematical model. This model takes as input the sixteen number-site descriptions and produces as output a rating number called the expected utility. The model can be formulated to reflect in a consistent way particular tradeoffs one is willing to make between impacts for different areas when no one site is superior on all possible impacts.

The final step, in one manner of speaking, is simply a computational one. To rank the sites, the sixteen number site descriptions are input to the preference model which then produces a rating result for each site. The sites are then rank-ordered from highest to lowest for different scenarios. The important part of this last step, however, is not merely the mechanical computation. Rather, it is the providing of a planning tool which indicates what set of inputs and assumptions results in particular implications.

In Chapter 4, we present a variety of ranking results depending upon different sets of inputs and viewpoints. For each facility and pipeline scenario, six basic rank orderings of the sites will be presented. There will be:

1. A ranking of the sites considering only biological impacts.

2. A ranking of the sites considering only socioeconomic impacts.

3. A ranking of the sites considering only non-cost impacts in which ecological and socioeconomic concerns are given equal emphasis.

4. A ranking of the sites from least expensive to most expensive.

5. A ranking in terms of equivalent cost considering all impacts and assuming an oil company viewpoint of willingness to trade off relatively large numbers of dollars not to incur environmental impacts.

6. A ranking in terms of equivalent cost considering all impacts and assuming an oil company viewpoint of willingness to trade off relatively small numbers of dollars not to incur environmental impacts.

An equivalent cost ranking shows the relative "effective" cost of pipelines, excavation, and non-cost impacts assuming certain preferences for the oil company. It has the same rank order as the expected utility ranking with the least equivalent cost site being the top rated. In addition, it shows two things:

1. Some indication of the difference between sites in terms of the more common dollar yardstick.

2. An indication of how the rankings would change if the real cost estimates change. For example, if one site is $10 million dollars less expensive than the other in the equivalent ranking, and new estimates reveal that the better ranking site is $15 million more expensive than we originally thought, we know that the once better site will now rank below the once inferior site by $5 million in equivalent cost.

All of these different viewpoints will aid in exploring the key elements regarding a ranking of potential Kodiak sites. The six rankings for each scenario will be discussed in terms of how sensitive they are to changes in assumptions such as socioeconomic versus biological tradeoffs and impact estimates. They will also be discussed from different interest group points of view. Finally, some concerns which were not formalized in terms of measures will be discussed as to their possible effect on the rankings.

CHAPTER 4

RANKING OF SITES - RESULTS, SENSITIVITY ANALYSIS, AND CONCLUSIONS

In Chapter 4, the ranking of the Kodiak sites is presented for five scenarios:

1. service base facility
2. oil terminal facility for a northern find with a land-sea pipeline;
3. oil terminal facility for a middle find with a land-sea pipeline;
4. oil terminal facility for a southern find with a land-sea pipeline; and
5. oil terminal facility with an all-sea pipeline.

4.1 SERVICE BASE FACILITY

It is unlikely that temporary service bases will be constructed on Kodiak; early in exploration, operators will tend to use existing facilities, such as those at Nikiski and Seward. Also, by the time of the Western Gulf of Alaska lease sale, exploration in the Lower Cook Inlet OCS area will have been underway for two years. If new service bases are established in the Lower Cook area, they too could be utilized temporarily to support Western Gulf of Alaska exploration. During the early period of exploration, there may be some attempts to use existing dock or storage facilities on Kodiak; this should not occur on a large scale simply because existing facilities are inadequate to completely support exploration efforts without a large investment for improvements. A permanent service base would be considered for construction on Kodiak only if the forseeable level of activity in the Western Gulf justified such an expenditure. Consistently disappointing exploratory drilling results would tend to discourage this type of investment. The selection of a permanent service base site likely will be influenced by preferences for the location of an oil terminal. If a petroleum company is considering the investment, it will tend to select a site which is as close as possible to the area where exploratory activity is highest and most encouraging, since proximity is a major economic factor for service base location. An oil terminal could be constructed at the same site because proximity to the oil find (and resultant pipeline cost) is equally, if not more important for oil terminals than it is for service bases.

Without knowledge of where encouraging exploratory results will occur, it is not possible to incorporate the distance-to-find factor into the ranking. In the absence of these data, if one assumed that the costs of developing a service base at each site do not differ significantly, then Three Saints and Barling Bays are the most desirable sites from the biological and socioeconomic perspectives. Biological impacts are considered to be similar to the oil terminal, all-sea pipeline scenario. The sites were essentially ranked on a bay habitat basis. Although at a service base there is less danger of oil spills, some concern exists in relation to accidental spills of other toxic substances. Socioeconomic impacts are of the same nature for a service base as those for an oil terminal, except that we have assumed the induced population increase, if it occurs, would be smaller. The sites which avoid demographic and harbor-use impacts are near the top of the ranking, while those with heavier impacts in these areas are near the bottom.

If, however, the use of existing airport and logistical facilities resulted in significant cost differences between sites, then sites closer to the Kodiak municipal area, such as Womens Bay or Kalsin Bay, could become highly ranked.

4.2 OIL TERMINAL FACILITY FOR A NORTHERN FIND WITH A LAND-SEA PIPELINE

This scenario is considered the most likely one to occur because most of the oil and gas lease tracts are in the north, and a land-sea pipeline is less expensive than an all-sea pipeline. Thus the ranking results for this scenario takes on added significance.

The six basic rankings for this scenario are shown in Table 4-1 and are discussed in the following sections. The utility ratings have been scaled so that a 0 corresponds to a site with the "poor levels" and a 1 corresponds to a site with the "good levels" as listed in the summary of the measures in Table C-1. Abbreviations have been used for the site names.

4.2.1 Ranking Using Project Team's Preferences

Ranking using Only Biological Measures

The top sites for this scenario with respect to biological measures are essentially those with very short or non-existent overland pipelines. Once an overland pipeline of significant distance is involved, the associated pipeline impacts (e.g. stream and bay crossings) make sites biologically unattractive. Of the top five biological sites, Monashka has the least productive (relatively speaking) bay habitat and no salmon stream impact from pipeline crossings; therefore this is highest in the ranking. The Kazakof Bay sites have more productive bay habitats. Kalsin Bay, while having a slightly less productive bay habitat then the Kazakof sites, has a relatively small salmon stream impact and ranks slightly below the Kazakof sites. Izhut has the most productive bay habitat of the five top biological sites for this scenario. Reference to Figures 2-2 and 2-3 will illustrate the ranking of the top five biological sites. The shortest pipeline distance to the Afognak Island sites (Kazakof and Izhut Bays) from a northern find is an all-sea route. The shortest route to Monashka Bay could include a short on-land portion, but this route would not cross salmon streams. A route to Kalsin Bay could involve a land fall at or near Cape Chiniak, in which about five salmon streams would be crossed between landfall and the site.

TABLE 4-1

OIL TERMINAL SITE RANKING - NORTHERN FIND - LAND-SEA PIPELINE

(1) Biology Only		(2) Socioeconomic Only		(3) Non-cost only; Equal Emphasis on Biology and Socioeconomics		(4) Cost Only (in millions of current dollars)		(5) All Impacts; Equivalent cost cost vs. non-cost Tradeoff #1		(6) All Impacts; Equivalent cost cost vs. non-cost tradeoff #2	
7-Mon	1.03	3-Kaz	.93	3-Kaz	.95	8-Kal	$163.8	4-Izhut	226.3	8-Kal	187.1
3-Kaz	.98	4-Izhut	.93	2-Kaz	.95	7-Mon	184.2	2-Kaz	244.5	4-Izhut	197.9
2-Kaz	.97	9-Ugak	.92	4-Izhut	.92	10-Ugak	186.0	3-Kaz	247.1	7-Mon	204.0
8-Kal	.95	2-Kaz	.92	7-Mon	.84	4-Izhut	188.4	8-Kal	257.1	2-Kaz	224.2
4-Izhut	.92	17-3 Sts.	.88	8-Kal	.81	9-Ugak	200.0	7-Mon	263.5	3-Kaz	229.2
10-Ugak	.53	16-Barl	.86	9-Ugak	.69	2-Kaz	217.4	9-Ugak	356.4	10-Ugak	227.5
16-Barl	.51	12-Kil	.84	16-Barl	.68	3-Kaz	223.2	10-Ugak	371.9	9-Ugak	239.1
17-3 Sts.	.47	13-Kil	.84	17-3 Sts.	.68	12-Kil	223.4	12-Kil	425.7	12-Kil	274.0
9-Ugak	.45	10-Ugak	.72	10-Ugak	.63	13-Kil	237.4	16-Barl	426.9	13-Kil	289.4
2-Kil	.35	8-Kal	.67	12-Kil	.50	18-Barl	268.6	17-3 Sts.	435.9	16-Barl	308.2
3-Kil	.33	7-Mon	.65	13-Kil	.58	17-3 Sts.	274.3	13-Kil	445.3	17-3 Sts.	314.7

Mon = Monashka Bay
Kaz = Kazakof Bay
Kal = Kalsin Bay
Izhut = Izhut Bay

Ugak = Ugak Bay
Barl = Barling Bay
3 Sts. = Three Saints Bay
Kil = Kiliuda

Table 4-1, continued

X_{15} = induced population impact

X_{15} = 1 < 100 people added to the City of Kodiak

X_{15} = 4 1000-1500 people added to the City of Kodiak

Tradeoff #1

Equal emphasis on Biology and Socioeconomics
Alternative Y: (cost = \$100, X_{15} = 4) equally preferred to Alternative Z; (cost = \$114.4, X_{15} = 1)
All other measures at their best.

Tradeoff #2

Equal emphasis on Biology and Socioeconomics
Alternative Z: (cost = \$100, X_{15} = 4) equally preferred to Alternative Z; (cost = \$103.6, X_{15} = 1)
All other measures at their best.

Ranking Using Only Socioeconomic Measures

The top sites for this scenario with respect to socioeconomic impacts are essentially those which are less likely to have significant induced population increase, harbor use, and city facility impacts. The four top socioeconomic sites do this reasonably well. The lowest three sites, Ugak #10 (Saltery Cove), Kalsin, and Monashka, are increasingly more likely to have heavier demographic and city facility impacts than the sites ranked above them. This is due to the proximity of the sites to a reasonably developed municipal area which probably would be attractive to workers as a place in which to reside. In addition, the proximity of the sites to the municipal area increases the chance for competition between OCS facilities and the municipality regarding roads, airport services, and water resources. The socioeconomic impacts will be discussed later under the heading of Kodiak Municipality Concerns.

Ranking Using Only Cost Considerations

The top sites for this scenario with respect to cost considerations are those with the shorter pipelines and, therefore, lower pipeline costs. Kalsin is the top cost site because of its relatively short land and sea pipeline segments. Monashka and Izhut require more sea pipeline miles and Ugak #10 (Saltery Cove) requires more land pipeline miles than Kalsin. The other sites have increasingly higher pipeline costs.

Overall Ranking Considering All Project Team Measures and Initial Estimates of Impacts

There are three rankings in Table 4-1 each of which combine the separate measures, allowing different emphasis on the cost and non-cost factors. The "non-cost only" ranking ignores cost completely (column 3). The ranking in column (5) of Table 4-1 gives some consideration to cost and the ranking in column (6) gives heavier consideration to cost (e.g. column 5 assumes an investment of 14.4 million dollars to avoid adverse environmental impacts, while column 6 assumes a willingness to spend less, 3.6 million dollars, to avoid these impacts).

The ranking in columns (3), (5), and (6) are not very sensitive to the relative emphasis placed on socioeconomic versus biological measures. Different combinations were tried in which relative weights of two to one and three to one (implying different sets of tradeoffs) were placed on socioeconomics versus biology and vice-versa with no significant changes in the rankings.

The top non-cost sites in column (3) are the Kazakof and Izhut Bay sites because they are ranked highly on both the biological and socioeconomic individual rankings. Monashka and Kalsin, while relatively attractive biologically, are unattractive socioeconomically. However, as cost is allowed more and more consideration in the ranking, the order of the top five non-cost sites changes. With some emphasis on cost (column 5), Izhut leads the Kazakof sites. With heavier emphasis on cost, Kalsin leads Izhut.

We can review Table 4-1 again and explore the conditions under which particular sites would be the most suitable for development. Given the initial impact estimates and preferences, Izhut appears to be one of the better sites considering all impacts. It is about 25 million dollars more expensive than Kalsin (see Column 4), but unless heavier emphasis is placed on cost, as in tradeoff #2 (column 6), it will rank ahead of Kalsin because of more favorable socioeconomic impacts. When cost is given more emphasis (as from a petroleum company viewpoint), Kalsin ranks ahead of Izhut. When cost is less emphasized with respect to non-cost impacts, Izhut still ranks ahead of the Kazakof sites. Only when the non-cost impacts are heavily emphasized, as in the non-cost only ranking, do the Kazakof sites rank ahead of Izhut.

4.2.2 Ranking Using Other Viewpoints

Emphasis on Petroleum Company Concerns

From the petroleum company cost perspective, Kalsin is the most attractive site. The cost tradeoffs in Table 4-1 represent a range of views obtained in interviews with petroleum company representatives. Actual indications of tradeoffs were not quite as low as tradeoff #2 and perhaps higher than tradeoff #1. That is to say, some companies would trade at least $3.6 million not to have a particular socioeconomic impact and perhaps even more than $14.4 million. But company views differ. One element that was unclear from these interviews was whether dollars were being traded in relation to impacts or in relation to a particular company's policies. For example, a certain fixed amount of dollars or perhaps a fixed percentage of total cost (e.g., 10 percent) seemed to be available to avoid non-cost impacts; but, no more than this would be spent as long as the project would not be significantly delayed. The cost tradeoffs in the ranking tables are in relation to impacts; in other words, if one is willing to trade dollars to avoid a particular impact, then the implication is a willingness to trade off more dollars if more impacts are involved.

Izhut and Kazakof sites involve more undersea pipeline length than several other top-ranked sites. If future cost estimates for this pipeline are higher because of rough undersea terrain (e.g., $11 million per mile rather than $3 million per mile), the Izhut and Kazakof sites would quickly fall below Kalsin even in the tradeoff #1 ranking. From certain petroleum company viewpoints, the question would be whether it was worth an extra 25 million dollars to move from the more adverse non-cost impacts at Kalsin Bay to the less adverse non-cost impacts at Izhut Bay. The key factors from this point of view are cost, with some concern for non-cost impacts when two alternatives are relatively close in cost.

Emphasis on Fishing Concerns

From the Fishermens Marketing Association point of view, all the contending sites are viewed as disrupting productive fishing grounds. Still, there is a preference for sites with respect to certain measures.

The hierarchy of bays for the fishing economic concern from worst to "almost worst" are Kiliuda, Izhut, Kalsin and Kazakof, Ugak, Old Harbor, Monashka, Three Saints and St. Paul Harbor. The impact estimates of our in-house professionals did not distinguish with respect to fishing economics between Izhut, Kalsin, and Kazakof sites, so there might be a slight preference for Kalsin over Izhut with respect to this measure. However, there are other concerns of importance to fishermen. The harbor use is important in terms of interference with mooring, loading docks, and navigational obstruction. In this respect, Kalsin is less favorable than Izhut. Fishermen who live in the town of Kodiak also would be affected by socioeconomic impacts to that town. An additional population influx would affect the city water supplies which in turn could affect cannery operations that require large amounts of fresh water. Even with no induced population increases, a facility at Monashka could directly compete with the town of Kodiak for water supplies. In summary, there are no large differences between the contending sites from the fisherman's point of view. All are viewed as essentially disruptive.

Emphasis on Kodiak Municipality Concerns

From the local Kodiak government viewpoint, important factors are recreation, land use, fishing economics, harbor use, induced population impacts on housing, and certain city facility impacts. Among the contending sites, Kalsin and Monashka have relative recreational impact drawbacks. The more important factors, insofar as the rankings are affected, are the demographic and city facility impacts. An interview with a representative of local government revealed that up to 500 new people could be reasonably absorbed if they entered Kodiak in a short time period due to facility construction. More than this could be absorbed but the impact would be more severe. The impact of added population and/or the facility on the water supply is an important concern, especially to the canneries in the town of Kodiak. With respect to these impacts, Monashka and Kalsin have drawbacks relative to the other contending sites. Both could cause more than 500 people to be added to the town of Kodiak's population; but, this is a very controversial point. There are several opinions concerning the impacts of additional population due to OCS development facilities. Some of them are:

1. no significant population increases will occur since the workers will be drawn locally or will live at self-contained camps at the site; (local competition for workers between canneries and the OCS development facilities might still be an impact unless most workers came from outside Kodiak);
2. significant population increases will occur, but can be handled reasonably with advanced planning and provision for necessary capital improvements;
3. significant population increases will occur and will cause significant housing and city facility impacts; and
4. population increases will occur, but these will be on top of even larger population increases due to the growth of Kodiak independent of oil facilities; thus, the effect of facility-induced population increases will be small or negligible.

Which of these opinions is most accurate is difficult to determine. If it is the third one, then Kalsin and Monashka would have strong drawbacks relative to Izhut and the Kazakof sites from a local government viewpoint.

Emphasis on Native Concerns

From the Koniag Native Corporation perspective in the siting of an oil terminal, key factors are native revenues from leasing, impacts on Native lifestyle, areas of cultural importance, and in this connection, impacts on salmon streams. Considering the contending sites for the northern find scenario, as long as the sites will be Native owned, there is not much separating the sites from the Native corporation viewpoint. Izhut has little impact on native lifestyle or stream resources as a result of pipeline construction while Kalsin has relatively few streams crossed by an overland pipeline. The Kazakof sites have relatively few impacts on Native lifestyle.

4.2.3 Summary of Ranking Discussion for an Oil Terminal Facility for a Northern Find With a Land-sea Pipeline

Five contending sites emerge from Table 4-1: Izhut, Kalsin, Monashka, and the two Kazakof Bay sites. Depending on the emphasis given to particular viewpoints, each has the possibility of being ranked highest. While the Kazakof sites rank close to each other, as one would expect, the other contenders are not always close under different assumptions. If the initial socioeconomic impact estimates are assumed and cost is given relatively less but some emphasis, Izhut is clearly preferred to the other contenders. If cost is given heavier emphasis Kalsin is preferred. With respect to different interest groups, Izhut may represent more of a compromise site among petroleum companies, socioeconomically impacted groups, fishing, and ecological interests. The Kazakof sites may be significantly more expensive to oil companies, while Monashka and Kalsin may have significant socioeconomic impacts.

Future impact estimates which would affect the rankings are: (1) changes in the socioeconomic consequences of a site at Kalsin; (2) changes in the pipeline cost estimates of the Kazakof and Izhut sites in the direction of becoming significantly more expensive; (3) changes in the pipeline cost estimates in the direction of making the undersea pipeline less expensive than $3 million, and making the land pipeline more expensive than $1 million.

4.3 OIL TERMINAL FACILITY FOR MIDDLE FIND WITH A LAND-SEA PIPELINE

The six basic rankings for this scenario are shown in Table 4-2. Much of the discussions of interest group viewpoints and technical concerns presented in Section 4.2 are applicable here as well.

4.3.1 Ranking Using Project Team's Preferences

Ranking Using Only Biological Measures

The top sites for this scenario with respect to biological measures, as with a northern find, are those with a short overland pipeline. Among these sites, however, there are two competing factors, bay habitat versus stream crossing impacts. Kalsin ranks highest because it has little salmon stream impact while having a relatively lower bay habitat value. Barling and Three Saints Bays have less bay productivity than Kalsin but have associated impacts to stream systems from the pipeline. The Ugak and Kiliuda sites, while having no overland pipeline, have very sensitive bay habitats. The lower ranking sites reflect the crossing of numerous stream systems and the crossing of the Marmot Bay complex for the Afognak sites.

Ranking Using Only Socioeconomic Measures

The top sites for this scenario with respect to socioeconomic impacts are again those which best avoid the demographic, site facility, and harbor use impacts. Among the top contenders, the Kiliuda sites rank lower because of fish economic impacts. Ugak 9 avoids archaeological impacts while having the most benign harbor use impact.

Ranking Using Only Cost Considerations

As with the previous scenario, the pipeline length and land versus sea segments of the pipeline are the key factors determining the order of the sites with respect to cost. Kalsin has a short pipeline with a reasonable stretch overland causing it to be the top ranked cost site.

Ranking Considering all Project Team Measures and Initial Estimates of Impacts

The top "non-cost only" sites, Three Saints and Barling, are again those which are high in both the ecological and socioeconomic rankings.

Kalsin does not fare as well in this ranking because of its relatively heavy socioeconomic impact. As cost is given some emphasis, Ugak 9 and the Kiliuda sites pull ahead of the more expensive Barling and Three Saints Bay Sites. With heavier emphasis on cost, Kalsin becomes a top contender while Ugak 10 pulls ahead of the more expensive Barling and Three Saints sites.

4.3.2 Ranking Using Other Viewpoints

Emphasis on Petroleum Company Concerns

The petroleum company viewpoint would prefer Kalsin as the low cost site. However, with some emphasis on non-cost factors as in ranking column (6), the Ugak and Kiliuda sites are about as attractive as Kalsin.

Emphasis on Fishing Concerns

Fishermen would prefer a Three Saints Bay site to others. They would especially dislike Kiliuda.

Emphasis on Kodiak Municipality Concerns

The potential socioeconomic impact of a Kalsin site would cause this site to be less preferred to the other sites that place highly in the various rankings presented.

Emphasis on Native Concerns

The Native concerns would still focus on whether the site would be Native owned and leased. Three Saints and Barling, having more stream impact, which may directly impact salmon, might be less preferred to Ugak 9 or the Kiliuda sites.

TABLE 4-2

OIL TERMINAL SITE RANKING - MIDDLE FIND - LAND- SEA PIPELINE

(1) Biology Only	(2) Socioeconomic Only	(3) Non-Cost Only Equal Emphasis on Biology and Socioeconomics	(4) Cost Only (in millions of current dollars)	(5) All Impacts; Equivalent cost; Cost vs Non-Cost Tradeoff #1 *	(6) All Impacts; Equivalent Cost; Cost vs Non-Cost Tradeoff #2 *
8 Kal .97	9 Ugak .94	17 3Sts .93	8 Kal 111.8	9 Ugak 176.9	13 Kil 141.3
16 Barl .93	17 3 Sts .94	16 Barl .93	10 Ugak 127.0	13 Kil 183.1	8 Kal 141.6
17 3Sts .91	16 Barl .92	9 Ugak .91	13 Kil 127.4	12 Kil 184.7	9 Ugak 143.2
12 Kil .88	12 Kil .90	12 Kil .89	12 Kil 131.4	18 Barl 188.7	12 Kil 144.7
13 Kil .88	13 Kil .89	13 Kil .89	9 Ugak 132.0	17 3Sts 193.9	10 Ugak 149.8
9 Ugak .88	10 Ugak .76	10 Ugak .82	7 Mon 147.2	10 Ugak 218.0	16 Barl 160.1
10 Ugak .88	2 Kaz .66	8 Kal .76	15 Barl 150.6	8 Kal 230.9	17 3Sts 165.7
7 Mon .77	3 Kaz .66	7 Mon .58	17 3Sts 156.3	7 Mon 356.6	7 Mon 199.6
2 Kaz .38	4 Izhut .66	2 Kaz .52	2 Kaz 204.4	2 Kaz 446.0	2 Kaz 264.8
3 Kaz .38	8 Kal .56	3 Kaz .52	3 Kaz 207.2	3 Kaz 448.8	3 Kaz 267.6
4 Izhut.24	7 Mon .39	4 Izhut .45	4 Izhut 232.4	4 Izhut 508.3	4 Izhut 301.4

* See explanation on Table 4-1.

4.3.3. Summary of Ranking Discussion for an Oil Terminal Facility for Middle Find with a Land-Sea Pipeline

Table 4-2 appears to rule out Monashka, the Kazakof sites and Izhut. Ugak 10 is behind Kiliuda 13 in all the rankings except cost, for which they are essentially the same. Again, depending upon an interest viewpoint or emphasis, several sites have the possibility of being ranked highest. Barling and Three Saints are highest with respect to non-cost factors but are more expensive than sites like Ugak 9 and the Kiliuda sites which do moderately well on all the rankings. Kalsin still has the drawback of socioeconomic impacts, but is an interesting site in being a possible contender for both the northern and middle find areas, where the vast majority of the tracts are located. From the preference viewpoint of column (6) in Table 4-2, four sites are all very close to each other in the ranking and there is no one site which is very far ahead in this ranking.

Future impact estimates which would affect the ranking most are (1) changes in pipeline costs and (2) changes in the socioeconomic impact estimates for Kalsin. Minor changes in the rankings would result from land use impact estimate changes if the land currently assumed to be claimed by the Natives remains under the jurisdiction of the U.S. Fish and Wildlife Service. In this case, Three Saints, Barling, and Kiliuda 13 would drop slightly in their utility and equivalent cost ratings.

4.4 OIL TERMINAL FACILITY FOR A SOUTHERN FIND WITH A LAND-SEA PIPELINE

The six basic rankings for this scenario are shown in Table 4-3. Much of the discussion presented earlier is applicable here; however, the number of tracts towards the southern end of the lease area is low, possibly making the likelihood of facilities being sited associated with southern exploration or development less likely.

TABLE 4-3

OIL TERMINAL SITE RANKING - SOUTHERN FIND - LAND-SEA PIPELINE

(1) Biology Only	(2) Socioeconomic Only	(3) Non-Cost Only Equal Emphasis on Biology and Socioeconomics	(4) Cost Only (in millions of current dollars)	(5) All Impacts; Equivalent cost; Cost vs Non-Cost Tradeoff #1 *	(6) All Impacts; Equivalent Cost; Cost vs Non-Cost Tradeoff #2 *
16 Barl 1.02	17 3Sts .96	16 Barl .98	17 3Sts 79.3	17 3Sts 87.8	17 3Sts 81.4
17 3Sts 1.01	16 Barl .95	17 3Sts .98	16 Barl 96.6	16 Barl 104.5	16 Barl 98.6
13 Kil .74	9 Ugak .89	13 Kil .80	12 Kil 100.4	13 Kil 200.4	13 Kil 126.2
12 Kil .69	12 Kil .89	12 Kil .79	13 Kil 100.4	12 Kil 207.2	12 Kil 127.9
9 Ugak .54	13 Kil .87	9 Ugak .72	9 Ugak 128.0	9 Ugak 270.2	9 Ugak 163.6
7 Mon .47	10 Ugak .72	10 Ugak .59	10 Ugak 141.0	10 Ugak 343.8	10 Ugak 191.7
8 Kal .47	2 Kaz .63	8 Kal .54	8 Kal 160.8	8 Kal 388.7	8 Kal 217.8
10 Ugak .46	3 Kaz .63	7 Mon .41	7 Mon 189.2	7 Mon 483.5	7 Mon 262.8
2 Kaz .11	4 Izhut .63	2 Kaz .37	2 Kaz 217.4	2 Kaz 531.9	2 Kaz 296.0
3 Kaz .11	8 Kal .62	3 Kaz .37	3 Kaz 220.2	3 Kaz 534.7	3 Kaz 298.8
4 Izhu -,07	7 Mon .35	4 Izhut .28	4 Izhut 272.4	4 Izhut 630.8	4 Izhut 362.0

* See explanation on Table 4-1.

The top sites with respect to a variety of viewpoints for this scenario are the Three Saints and Barling sites, with Three Saints having a clear cost advantage and about the same noncost impact. These bays are less sensitive biologically, while at the same time are closest to the southern tracts. Thus, from the interest group points of view and preference points of view explored here, Three Saints appears to be a clear choice for this scenario. Relatively few tracts, however, make the likelihood of a southern find far less than a middle or northern find.

4.5 OIL TERMINAL FACILITY FOR AN ALL-SEA PIPELINE

The six basic rankings for this scenario are shown on Tables 4-4 (Northern Find) and 4-5 (Middle Find). The southern find rankings are not shown since the implications are identical to the results for the southern find land-sea pipeline scenario.

4.5.1 Ranking Using Project Team's Preferences

Ranking Using Only Biological Measures

The top sites for this scenario with respect to biological measures are essentially determined by the bay habitats of the various sites. With no overland pipeline, the main biological impacts are focused on the bay itself. The ranking of the sites essentially follows the bay habitat ranking with Monashka having the lower bay habitat value, Barling the second lowest bay habitat, etc. down to Ugak with the most productive bay habitat. All-sea pipeline routes offshore were not evaluated because impact analysis was not feasible.

Ranking Using Only Socioeconomic Measures

With overland pipeline impacts removed, the main factors of concern are demographic, harbor use, fishing economics, and city facility impacts.

TABLE 4-4

OIL TERMINAL SITE RANKING - NORTH FIND - ALL-SEA PIPELINE

(1) Biology Only	(2) Socioeconomic Only	(3) Non-Cost Only Equal Emphasis on Biology and Socioeconomics	(4) Cost Only (in millions of current dollars)	(5) All Impacts; Equivalent cost; Cost vs Non-Cost Tradeoff #1 *	(6) All Impacts; Equivalent Cost; Cost vs Non-Cost Tradeoff #2 *
7 Mon 1.03	17 3Sts. .96	16 Barl .98	7 Mon 184.2	4 Ishut 226.3	4 Izhut 197.9
16 Barl 1.02	16 Barl .95	17 3Sts .95	8 Kal 185.8	3 Kaz 247.1	7 Mon 201.9
17 3sts 1.01	9 Ugak .94	3 Kaz .95	4 Izhut 188.4	2 Kaz 147.5	8 Kal 205.6
8 Kal .99	3 Kaz .93	2 Kaz .95	2 Kaz 220.4	7 Mon 255.1	2 Kaz 227.2
3 Kaz .98	4 Izhut .93	4 Izhut .92	3 Kaz 223.2	8 Kal 265.2	3 Kaz 229.2
2 Kaz .97	2 Kaz .92	9 Ugak .90	10 Ugak 247.0	9 Ugak 300.7	9 Ugak 264.2
4 Izhut .92	12 Kil .90	12 Kal .89	9 Ugak 252.0	16 Barl 326.5	10 Ugak 270.1
12 Kil .88	13 Kil .89	13 Kil. .89	13 Kil 286.4	10 Ugak 339.5	13 Kil 300.3
13 Kil .88	10 Ugak .76	7 Mon .86	12 Kil 290.4	13 Kil 342.1	12 Kil 303.7
10 Ugak .87	8 Kal .70	8 Kal .84	16 Barl 318.6	12 Kil 343.7	16 Barl 320.6
9 Ugak .86	7 Mon .69	10 Ugak .82	17 3Sts 370.3	17 3Sts 378.8	17 3 Sts 372.4

* See explanation on Table 4-1.

TABLE 4-5

OIL TERMINAL SITE RANKING - MIDDLE FIND - ALL-SEA PIPELINE

(1) Biology Only		(2) Socioeconomic Only		(3) Non-Cost Only Equal Emphasis on Biology and Socioeconomics		(4) Cost Only (in millions of current dollars)		(5) All Impacts; Equivalent cost; Cost vs Non-Cost Tradeoff #1 *		(6) All Impacts; Equivalent Cost; Cost vs Non-Cost Tradeoff #2 *	
7 Mon	1.03	17 3Sts.	.96	16 Barl	.98	10 Ugak	127.0	16 Barl	158.5	13 Kil	141.3
16 Barl	1.02	16 Barl	.95	17 3Sts	.95	13 Kil	127.4	9 Ugak	180.7	9 Ugak	144.2
17 3sts	1.01	9 Ugak	.94	3 Kaz	.95	12 Kil	131.4	13 Kil	183.1	12 Kil	144.7
8 Kal	.99	3 Kaz	.93	2 Kaz	.95	9 Ugak	132.0	12 Kil	184.7	10 Ugak	150.1
3 Kaz	.98	4 Izhut	.93	4 Izhut	.92	16 Barl	150.6	17 3Sts	195.8	16 Barl	152.6
2 Kaz	.97	2 Kaz	.92	9 Ugak	.90	17 3Sts	187.3	10 Ugak	219.5	17 3Sts	189.4
4 Izhut	.92	12 Kil	.90	12 Kal	.89	8 Kal	188.8	8 Kal	268.2	8 Kal	208.6
12 Kil	.88	13 Kil	.89	13 Kil.	.89	7 Mon	211.2	7 Mon	282.0	7 Mon	228.9
13 Kil	.88	10 Ugak	.76	7 Mon	.86	4 Izhut	263.4	4 Izhut	301.3	4 Izhut	272.9
10 Ugak	.87	8 Kal	.70	8 Kal	.84	2 Kaz	277.4	3 Kaz	304.1	2 Kaz	284.2
9 Ugak	.86	7 Mon	.69	10 Ugak	.82	3 Kaz	280.2	2 Kaz	304.5	3 Kaz	286.2

* See explanation on Table 4-1.

Three Saints and Barling avoid these impacts relatively well while Kalsin and Monashka have relatively heavy demographic and city facility impacts.

Ranking Using Only Cost Considerations

For a northern find, the main difference between the ranking for a land-sea and all-sea pipeline is the effect on the cost estimates for Kalsin. For an all-sea pipeline, Kalsin no longer has such a large cost advantage over Izhut. In both equivalent cost rankings, Izhut remains ahead of Kalsin for an all-sea pipeline. The best non-cost sites still have cost drawbacks.

For a middle find, the main differences between the rankings for a land-sea and all-sea pipeline are the raising of the cost estimate for Kalsin and the lowering of environmental impacts for Barling. In fact, all all-sea pipeline has the same cost estimate as a land-sea pipeline for Barling, with less overall non-cost impact.

Ranking Considering All Project Team Measures and Initial Estimates of Impacts

These results illustrate what the rankings would be if the land pipeline were to become as expensive per mile as the sea pipeline because of right-of-way or land terrain difficulties. In the case of Kalsin, even with a land-sea pipeline, only 14 miles are on land compared to 49 at sea and thus the bulk of the pipeline is at sea anyway.

For an all-sea pipeline and a middle find, Kalsin is no longer a contender while Barling has become a much stronger contender. Barling ranks very high on both the biology and socioeconomic rankings. Unless cost is given relatively heavy emphasis, as in the cost only ranking or the tradeoff #2 ranking, Barling is the top site. Even in the tradeoff #2 rankings, Barling is only 11 million dollars below the top site, a small figure relative to the total cost of pipeline construction.

4.5.2 Ranking Using Other Viewpoints

Examination of Tables 4-4 and 4-5 indicates that the petroleum company viewpoint would select Monashka or Ugak Bays, and from the fishermen's viewpoint, Barling and Monashka are contenders for an all-sea pipeline site. Barling Bay is also in contention from the Kodiak Municipality viewpoint.

4.5.3 Summary of Ranking Discussion for an Oil Terminal Facility with an All-Sea Pipeline

The all-sea pipeline causes several changes from the previous rankings. First, many impacts due to the overland pipeline are eliminated. Second, the cost estimates of certain sites are no longer as low as they were since all all-sea pipeline must be used. Finally, we should note that differences between sites with respect to non-bay sea floor impacts have not been considered in the rankings.

4.6 SENSITIVITY OF THE RESULTS

The rankings presented in this chapter are sensitive to several factors. To summarize, changes in the socioeconomic consequences of a site at Kalsin could affect Northern and Middle find rankings, and changes in the pipeline cost estimates of the Kazakof and Izhut sites in the direction of becoming significantly more or less expensive would affect the Northern ranking. The contending sites are not very sensitive to tradeoffs between biological and socioeconomic factors or to minor changes in impact estimates.

When reviewing the ranking tables (4-1 to 4-5), it is important to realize that sites move up and down in the six rankings of each scenario depending on the preference emphasis. It is the viewpoint or combination of viewpoints which will make the siting decision that provide the greatest variability in the rankings. In other words, the site or sites most suitable for development depend upon which factors are emphasized from a preference point of view.

4.7 CONCLUSIONS

In the compilation of the various viewpoints, of the sites investigated, several stand out as the highly likely candidates: Kalsin Bay, Izhut Bay, Ugak Bay-9, and Kiliuda Bay-13. But what will happen on Kodiak regarding the siting of service bases and oil terminals at these or other sites is unknown. Factors which will influence siting and where interest groups in Kodiak can have influence are noted below:

1. The location of blocks selected in bidding, petroleum companies successful in bidding, and find areas are not yet determined. Petroleum companies which have invested in service bases elsewhere for exploration in the Northeast Gulf of Alaska and Lower Cook Inlet (Seward, possibly Homer, and Yakutat) will tend to use those facilities more extensively than companies without access to existing bases.

2. The amount of money that a petroleum company will actually spend to avoid sites with more serious adverse impacts but lower development costs will vary among companies.

3. State facility siting policies and regulatory authority will influence siting decisions. For instance, sites chosen by petroleum companies which may jeopardize renewable resources will influence agencies to advise against siting at those locations. Review of preliminary site choices with regulatory agencies should be considered to minimize delays and unnecessary expense.

4. Interest groups can begin affecting siting decisions now. For instance, the Borough can set aside acreage for one or several sites and dictate, through zoning and other legal means, that these are the only sites available. A private property owner, such as Koniag or a Village Corporation, could offer selected acreage and attempt negotiations with petroleum companies for their use. However, without early, planned local action, it is reasonable to expect that petroleum companies will

select one or several sites which are desirable to them and initiate negotiations with property owners and appropriate regulatory bodies to acquire and devleop the site. It is also reasonable to expect that the petroleum companies will solicit local views. Being prepared to offer these views in an organized fashion can be a significant way to influence siting.

If action is taken to select sites early, careful consideration should be given to obtaining additional data for this selection. Specifically,

1. population and facility demand impacts of the alternative sites should be delineated; means to avoid or mitigate population problems, if they appear to be serious, for sites such as Kalsin Bay should be identified and their costs quantified;

2. impact hazards in all bays require better definition; especially important are questions relating to biological impacts from oil spills, and whether or not spills can move from one bay to another; better definition of these hazards and their significance may be needed to obtain approvals from regulatory agencies; and

3. the economic feasibility of alternatives -- to both an interest group promoting a site and petroleum companies -- should be evaluated prior to major committments of energy or money; to promote a site which is highly undesirable to offshore operators could prove to be a waste of time and money.

APPENDIX A

Introduction

This appendix is intended to describe the mathematical preference models used in ranking sites for OCS development facilities. There are many techniques one can use to formulate and calibrate preference models in the decision analysis approach. However, this appendix is limited to:

1. giving an overview of the philosophy and assumptions underlying the models;
2. enumerating the detailed tradeoffs which were used in formulating the preference models; and
3. describing the models in detail so they can be used for further sensitivity analysis.

It is beyond the scope of this report to describe the techniques used to formulate and calibrate preference models for general situations. In fact, this latter task is best characterized as an art as well as a science. In summary, we do not present here a "how-to-do-it" description of the approach but rather the basic elements of what was done and the mathematical details of the models that were formulated.

Problem Review

The key problem addressed by a preference model is the comparison of alternatives involving different impacts in many different areas. These impacts are characterized by measures which we shall refer to symbolically to keep the notation concise. Each measure is given a symbolic label X_i. For example, X_1 stands for the pipeline and excavation costs in millions of dollars. We shall let x_i stand for a particular value of the measure X_i. For example, x_1 might be 100 indicating a cost of 100 million dollars. With this notation, an alternative can be concisely referred to in symbolic notation. We denote an alternative by the symbol $\underline{x} \equiv (x_1, x_2, x_3, x_4 \ldots, x_{16})$ as being a set of sixteen numbers. The symbols $\underline{x}'$ and $\underline{x}''$ mean different alternatives with possibly different values for each measure. The question we are trying to answer is whether an alternative $\underline{x}' \equiv (x_1', x_2', x_3', \ldots, x_{16}')$ is preferred, indifferent to, or not preferred to another alternative $\underline{x}'' \equiv (x_1'', x_2'', x_3'', \ldots, x_{16}'')$. We would like to make comparisons of such alternatives in a systematic, consistent and theoretically sound manner. This is extremely difficult to do informally in the mind for every possible comparison of 16 values for our measures. The approach that decision analysis takes is to adopt a set of reaonsable preference assumptions which can be used to simplify the problem. With these assumptions, it becomes necessary for the decision maker or consultant to consider simpler comparisons in a consistent manner. Specifically, the simple comparisons never involve more than two measures changing at a time. The models are then used to determine how more complicated alternatives compare with one another. The model ensures that the more complex comparisons are done in a manner consistent with the simpler comparisons and the preference assumptions.

The model referred to in the preceding paragraph is called a multiattribute or a multimeasure utility function. It is used to assign a value (symbolically devoted by u to each alternative. It does this in a way so that $u(\underline{x}')$ is greater than $u(\underline{x}'')$ if and only if the alternative $\underline{x}'$ is preferred to $\underline{x}''$. The main results of multidimensional utility function theory covers conditions for which a preference model can be expressed in a simple form which can be reasonably applied in particular problems. The simple form consists of a function having a number of parameters. These parameters are related to:

1. the preferences for different levels of a particular measure and
2. the tradeoffs between measures.

The important philosophical aspects of the models used in decision analysis are that the models and procedures used are derived formally on a theoretically sound basis. While not describing the basis here, the notions involved are essentially those of common sense. For example, one assumption typifying the kind of assumptions underlying the models is called transitivity. Transitivity states that if a person prefers A to B and B to C, he should prefer A to C. Another assumption that is made to simplify the mathematical form is called preferential independence. An example of this assumption is that tradeoffs between, say, land mammal impact and salmon stream impact, do not depend on the fixed level of bay habitat impact. In other words, given two alternatives having identical bay habitat impacts, it would not matter what the bay habitat impact was in determining how much salmon stream impact one would tolerate to avoid a land mammal impact. Assumptions such as preferential independence are often reasonable for a wide class of problems and help to simplify the models used considerably.

In summary, to address the ranking problem at hand, we formulated a mathematical model making use of reasonable, well-developed preference assumptions and calibrating procedures. We shall now describe the models used in detail and list the important preference input that was used in calibrating the models.

Preference Model Descriptions

Multidimensional utility theory provides two models which were used in this study. The functional forms of these models are:

$$u(\underline{x}) = \sum^{n} k_i u_i (x_i) \text{ with } \Sigma k_i = 1 \text{ (additive) and}$$

$$1 + ku(\underline{x}) = \Pi(1 + kk_i u_i (x_i)) \text{ (multiplicative)}$$

where

$u(\underline{x})$ = multidimensional utility function value for alternative $\underline{x}$

$u_i(x_i)$ = utility function for measure x_i

k_i = scaling constant

n = number of measures involved in the model

The symbols above refer to parameters in the utility function that reflect preference viewpoints. The $u_i(x_i)$ deal with the relative desireability of various levels of each indivdual measure. (Sometimes, preferences are not simply proportional to the level of a measure.) The k_i's deal with the tradeoffs between measures. Certain scaling conventions are often adopted where the utility functions are scaled to be 0 and 1 for certain sets of impact. In our study the functions were scaled to be "0" for the "poor" values and "1" for the "good" values listed in Table 3-2. The k_i's also lie between 0 and 1.

The functions applied in the study were as follows:

1. a multiplicative model was used for the biological measures alone;
2. a multiplicative model was used for the socioeconomic measures alone;
3. the cost, socioeconomic and biological functions were combined in an additive model for the overall evaluation function.

The overall model thus had the functional form:

$$u = k_c u_c + k_b u_b + k_s u_s$$

where u_c = utility function for cost

u_b = utility function for biology

u_s = utility function for socioeconomics

The functional forms utilized here were convenient to implement because they involved asking only a few more than 16 questions to determine the tradeoff parameters. The forms, however, are general enough to adequately reflect a variety of preferences. The multiplicative form in particular allows the model to indicate that good values for some measures may compensate for poor values on other measures in a more sophisticated fashion. With this background, we now describe how the models were calibrated in terms of expressed preferences.

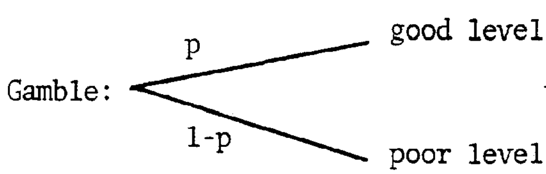
Types of Preference Questions

There are a few basic types of questions which are asked of a decision maker in calibrating the preference models. Each involves a comparison of situations which we label Situation A and Situation B. The questioning proceeds until we arrive at a point where two different situations A and B are equally preferred by the decision maker. This "indifference" implies an equation using the preference model. A set of these equations is solved to compute the model parameters that will reflect the decision makers preferences as expressed by his comparison of Situations A and B.

Question Type 1: Preferences for Different Levels of a Particular Measure.

In this type of question, only one measure is varied and all the other measures are fixed for both A and B. That is, A and B are identical on all measures except one. For this measure, the following question is posed:

A



versus

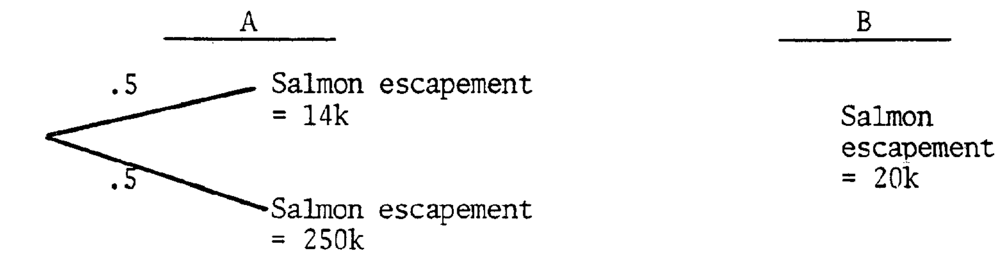
B

Some level in between "Good" and "Poor" for sure.

p = probability of winning

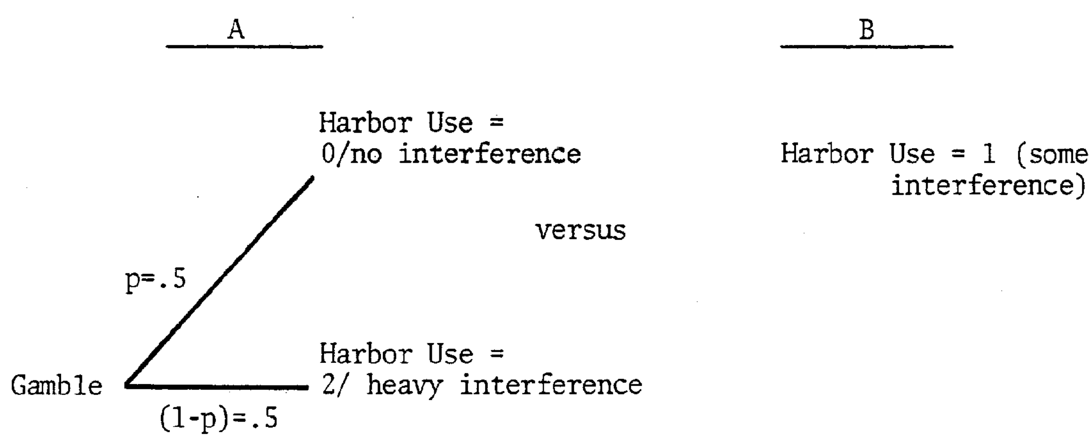
Is A preferred or indifferent or not preferred to B?

When this question is asked, sometimes the probability (p) is fixed and sometimes the level for B is fixed. An example of this question is:



Notice that A represents a risky situation where losing is far worse than B and winning is not much better than B. Most people would prefer B than to gamble with A. Suppose now, that B were changed to 200k. Now, most people would prefer to take the gamble at A rather than settle for B. Suppose that B were changed to 120k. At this point, Woodward-Clyde Consultants' in-house professional was indifferent between A and B. If B were any less than 120k, he would choose B. If B were any more than 120k he would chose A. This answer is used to calibrate the function u_3 for salmon escapement using a model which is flexible enough to reflect preferences that may be non-linear.

Another example of this type of question is:



For this comparison, the Woodward-Clyde Consultants in-house professional preferred B to A not wanting to risk losing the gamble. However, when the odds were changed so p = .75, then the in-house professional was indifferent between A and B. The odds were now good enough so that the likelihood of losing the gamble was low enough to risk the chance.

Question Type 1 is used to give an indication of the relative preferences among levels of a single measure. To speak less rigorously, a harbor use value of 1 from the above example is not necessarily "midway" between a harbor use of 0 and of 2. If we simply had a harbor use measure and assumed 1 was midway between 0 and 2 in preference, we would not be as reflective of the in-house professional's preferences as we are now by asking him a question designed to indicate his relative preferences for harbor use values.

Questions of this type were asked for all sixteen measures and relative preference values (i.e., the u_i $\{x_i\}$) were assigned to reflect the answer of the in-house professionals. The u_i $\{x_i\}$ are listed in Figure A-1. In general, the ranking results are not very sensitive to the $u_i\{x_i\}$ in that if we assumed they were all linear functions, the ranking results would show little change. However, the decision analysis approach does not need to assume linearity and has a procedure for specifying the u_i (x_i) when they are non-linear.

<u>Question Type 2: Tradeoffs Between Measures</u>

In this type of question, two measures are varied and all the other measures are fixed for both A and B. The following question is then posed:

A		B
(x_i = good level, x_j = poor level)	versus	(x_i = poor level, x_j = good level)

Is A preferred or indifferent to or not preferred to B?

Notice that this type of question addresses the issue of tradeoffs directly. In situation A, measure "i" is favorable while measure "j" is not. In situation B things are reversed. If a person prefers A to B, the implication is a willingness to move from the good level to the poor level on measure "j" in order to improve from the poor level to the good level on measure "i"; i.e., the tradeoff is being expressed.

Questions of this type were asked of the Woodward-Clyde Consultants in-house professionals in the areas of biology and socioeconomics and of interest group representatives in a more informal fashion. For example, in the biological area, a question that was asked was:

A		B
(Salmon escapement = 250k, Bay Habitat = 1)	versus	(salmon escapement = 14k Bay Habitat = 3)

In this comparison, the biologist reluctantly preferred B to A. However, when the salmon escapement impact at A was changed to 175k, the biologist was indifferent between the two situations. This answer was used to set up an equation for determining the scaling constant parameters.

The tradeoffs used in formulating the ecological and socioeconomic utility functions are shown in Table A-1. The tradeoffs between a socioeconomic and an ecological impact, and between cost and non-cost impacts were the focus of sensitivity analysis as discussed in the report. The findings were that the rankings were not very sensitive to variations in tradeoffs between socioeconomics and biology, but were sensitive to significant variations in tradeoffs of cost versus non-cost. An advantage of the decision analysis approach is that tradeoffs which must be addressed in a problem are done explicitly and in a well-defined manner. This helps to identify the key factors determining a top-ranking site.

In this study, the important controversial tradeoffs appears to be how much is a petroleum company willing to give up to avoid non-cost impacts. The non-cost tradeoffs involve more technical considerations or the controversy lies not so much in the tradeoff but in the estimate of impacts that will occur for particular sites. (Also, the rankings were not sensitive to variations in the socioeconomic and biological models when they were made to be additive instead of multiplicative.)

Summary of Preference Model Formulation and Sensitivity Analysis

Table A-2 shows that values of the scaling constant parameters used in the mathematical models for evaluating the alternatives in this study. An example of how an alterative is evaluated using Table A-2 and Figure A-1 is shown in Table A-3. We do not indicate here, the mathematical techniques for computing the scaling constants or u_i (x_i) from the preference information that is input. There are several ways of doing this. The important concept is that the calibrated parameters enable the model to consistently reflect the input preferences when it is used to evaluate alternatives.

The decision analysis approach, as well as other analytical techniques, requires careful implementation. The methodology essentially provides a framework of models and procedures for allowing people to address the difficult issue of a problem in a systematic manner. The more important aspects of the approach are the explicit description of tradeoffs, measures, issues, impacts, sensitivity to changes in impact and the capability of being implemented in a practical and sound manner. The mathematical details of the models are more of a computational exercise.

In conclusion, this appendix was designed to describe the preference models in enough detail so the basic preference input would be explained and the evaluation function made available for future use.

This appendix is necessarily limited in its description and did not mention more of the capabilities of an evaluation function once it has been formulated in a decision analysis manner. Some of these capabilities include:

1. the ability to evaluate in a theoretically sound manner probabilistic alternatives where impacts are expressed using probability distributions instead of best single number estimates.

2. the ability to evaluate new sites if they are generated.

3. the ability to generate implications of preference functions including tradeoff curves and equivalent cost representatives.

These and other capabilities are available if desired in future use of the preference model as formulated in this study.

FIGURE A-1 UTILITY FUNCTIONS $u_i(x_i)$

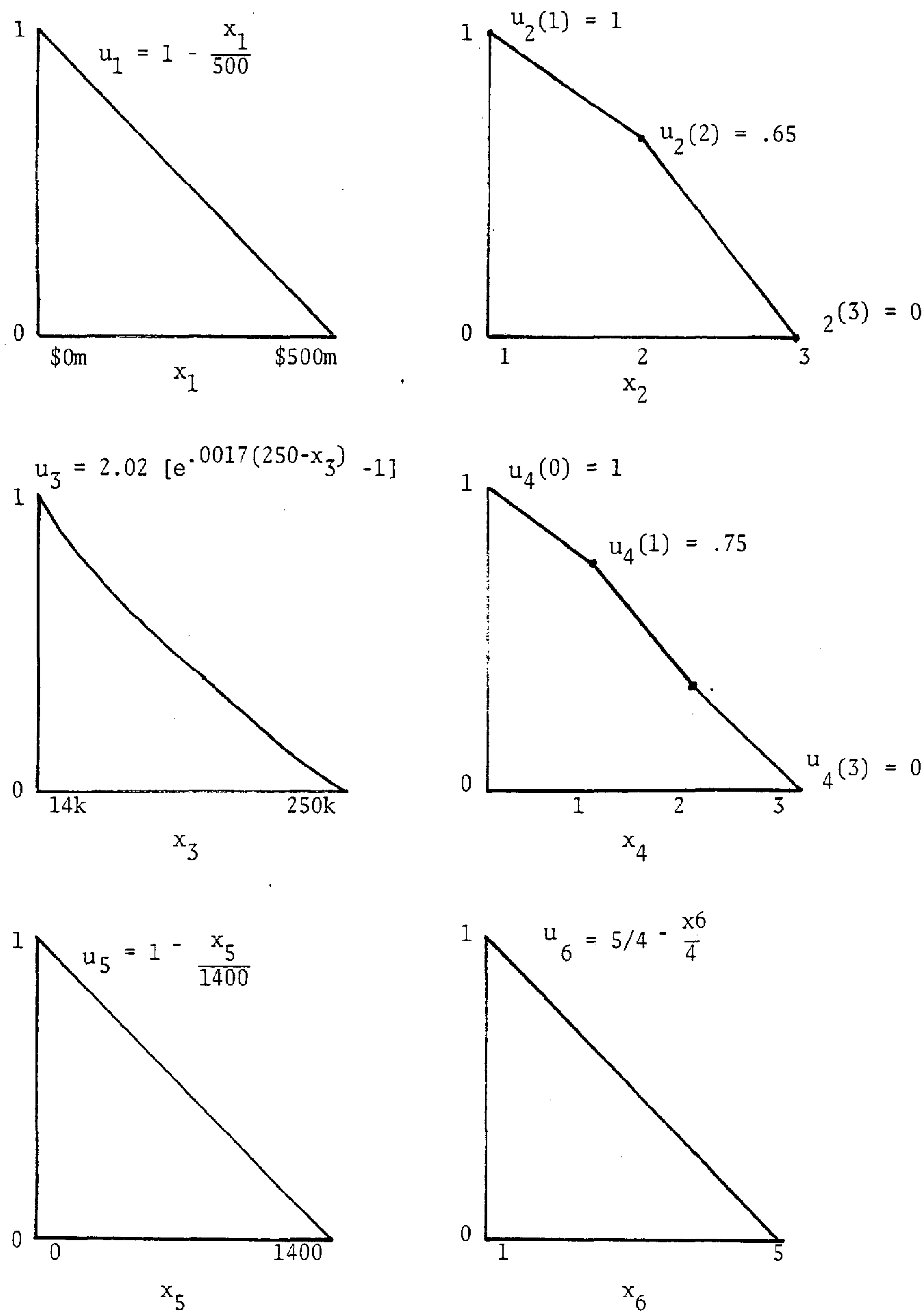


FIGURE A-1 CONTINUED

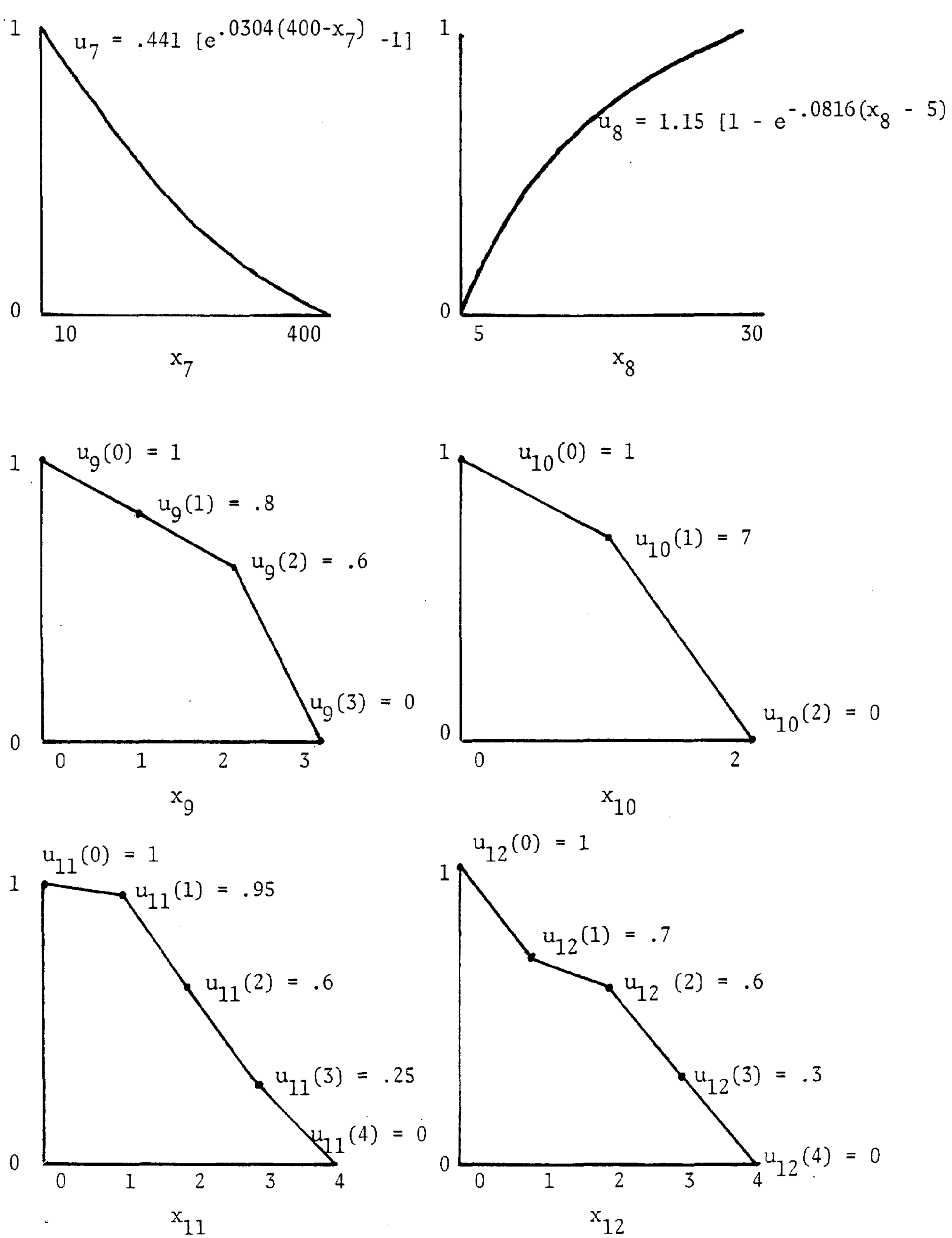
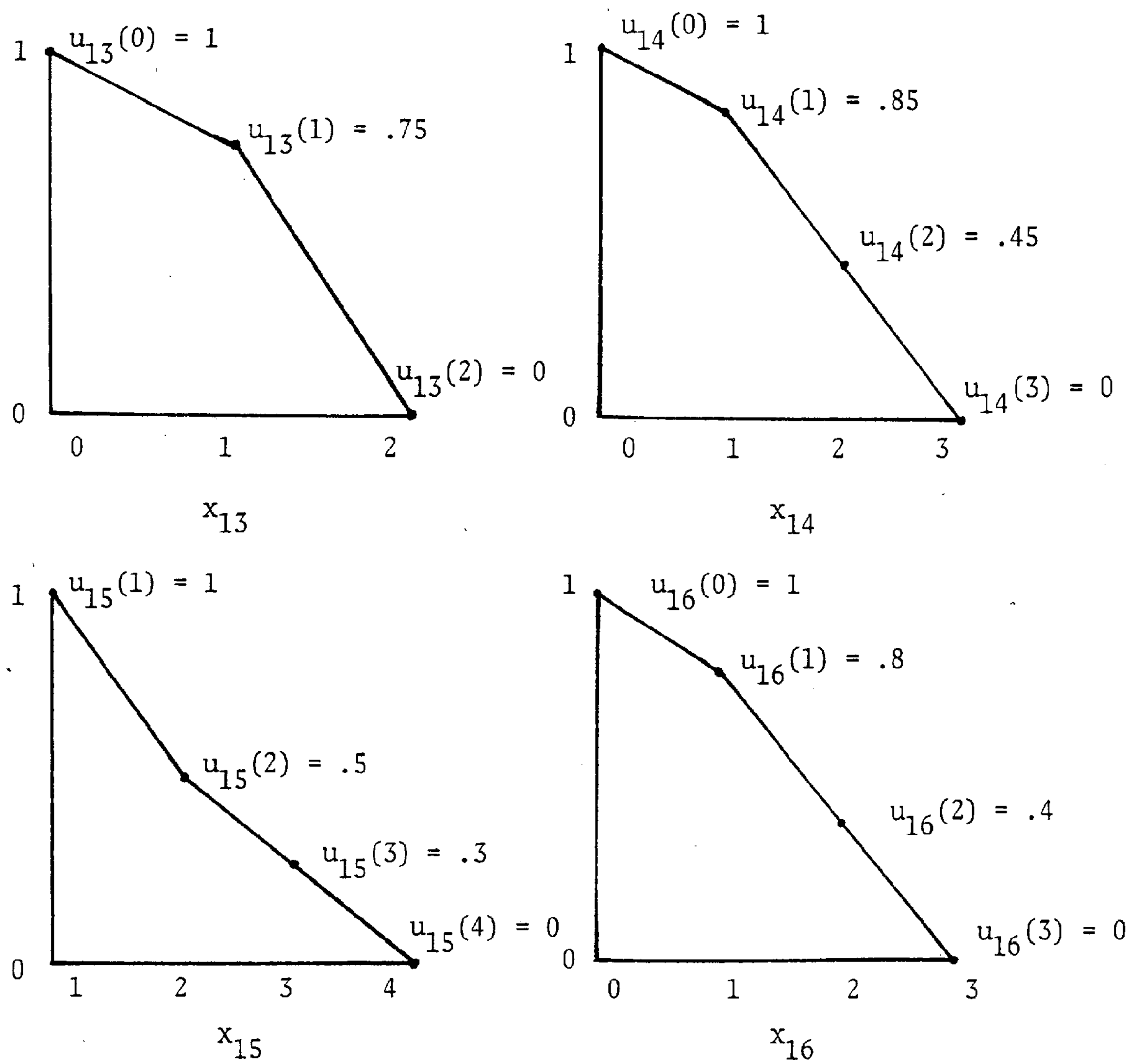
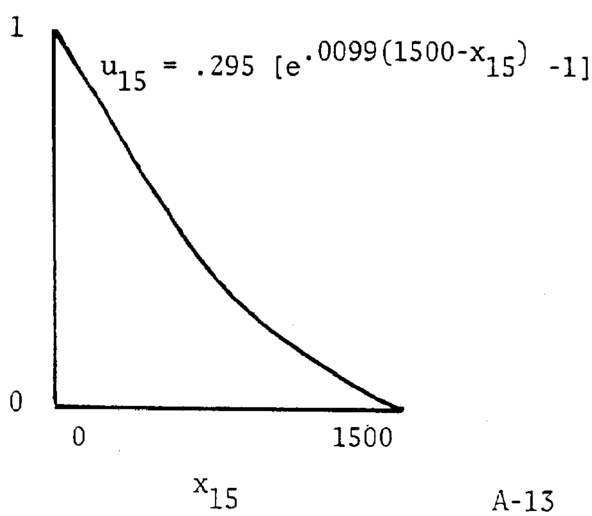


FIGURE A-1 CONCLUDED





* Corresponding continuous measure for x_{15} in terms of people added to Kodiak. This was used during socioeconomic tradeoffs.

TABLE A-1 TRADEOFFS BETWEEN MEASURES

Biological Impact Measures ["∿" means "is equally preferred to"]

$(x_3 = 175k,\ x_2 = 1) \sim (x_3 = 14k,\ x_2 = 3)$

$(x_3 = 30k,\ x_4 = 0) \sim (x_3 = 14k,\ x_4 = 3)$

$(x_3 = 55k,\ x_5 = 0) \sim (x_3 = 14k,\ x_5 = 1400)$

$(x_3 = 70k,\ x_6 = 1) \sim (x_3 = 14k,\ x_6 = 5)$

$(x_3 = 50k,\ x_7 = 10k,\ x_8 = 30) \sim (x_3 = 14k,\ x_7 = 400k,\ x_8 = 5)$

$(x_7 = 150k,\ x_8 = 5) \sim (x_7 = 400k,\ x_8 = 30)$

$(x_7 = 0^{+}k,\ x_8 = 5) \sim (x_7 = 0^{+}k,\ x_8 = 30)$

$(x_3 = 250k,\ x_2 = 1) \sim$ Gamble: .55 → $(x_3 = 14k,\ x_3 = 1)$; .45 → $(x_3 = 250k,\ x_3 = 3)$

* i.e., a site having an impact on 175k salmon escapement and 2 bay habitat of 1 is equally preferred to a site having an impact on 14k salmon escapement and a bay habitat of 3 when all other measures are equal for both sites.

Thus, over the good to poor ranges, the measures in order of importance are: salmon stream impacts, bay habitat, bay crossings, vegetation, birds, and land mammals.

TABLE A-1 CONTINUED

Socioeconomic Impact Measures

(x_{15} is used as the number of people added to Kodiak. See continuous measure in Figure A-1.)

$$(x_{15} = 700,\ x_9 = 3) \sim (x_{15} = 1500,\ x_9 = 0)$$

$$(x_{15} = 700,\ x_{10} = 2) \sim (x_{15} = 1500,\ x_{10} = 0)$$

$$(x_{15} = 450,\ x_{11} = 4) \sim (x_{15} = 1500,\ x_{11} = 0)$$

$$(x_{15} = 700,\ x_{12} = 4) \sim (x_{15} = 1500,\ x_{12} = 0)$$

$$(x_{15} = 400,\ x_{13} = 2) \sim (x_{15} = 1500,\ x_{13} = 0)$$

$$* \ (x_{15} = 0,\ x_{14} = 3) \sim (x_{15} = 1500,\ x_{14} = 0)$$

$$(x_{15} = 300,\ x_{16} = 3) \sim (x_{15} = 1500,\ x_{15} = 0)$$

$$* \ (x_{15} = 1500,\ x_{14} = 0) \sim \begin{cases} .65 & (x_{15} = 0,\ x_{14} = 0) \\ .35 & (x_{15} = 1500,\ x_{14} = 3) \end{cases}$$

$$* \ (x_{15} = 0,\ x_{14} = 3) \sim \begin{cases} .65 & (x_{15} = 0,\ x_{14} = 0) \\ .35 & (x_{15} = 1500,\ x_{14} = 3) \end{cases}$$

* Note: Any two of these three preference inputs imply the other and provided one of several consistency checks to insure that the in-house professional was self-consistent.

Thus, over the good to poor ranges, the measures in order of importance are: population increase, fishing economics, facility demands, harbor use, land use, lifestyle, archaeology, and recreation.

TABLE A-1 CONCLUDED

(Socioeconomics = poor level, Biology = good level) $\sim$

(Socioeconomics = good level, Biology poor level)

Cost versus non cost tradeoff #1

$$* (x_1 = \$100m, x_{15} = 4) \quad \sim \quad (x_1 = \$114.4m, x_{15} = 1)$$

All other measures at their good levels

Tradeoff #2

$$(x_1 = \$100m, x_{15} = 4) \quad \sim \quad (x_1 = \$103.6m, x_{15} = 1)$$

All other measures at their good levels

* i.e., the oil company is willing to spend up to $14.4m more to move from the impact of 1500 people added to Kodiak to the impact of adding less than 100 people to Kodiak.

Tradeoff #1 also implies:
(#2)

(x_1 = $100m, biology = poor levels, socioeconomics = poor levels) $\sim$

(x_1 = $500m, biology = good levels, socioeconomics = good levels)
(125m)

TABLE A-2 SCALING CONSTANTS FOR PREFERENCE MODELS

Waterfowl Impacts $1 + k^w u_w = \prod_{i=7}^{8} (1 + k^w k_i u_i(x_i))$

$k_7 = .97$ $\quad k_8 = .485$ $\quad k^w = -.95$

Biological Impacts $1 + k^b u_b = \prod_{i=2}^{6} (1 + k^b k_i u_i(x_i)) * (1 + k_{78} u_w)$

$k_2 = .442$

$k_3 = .540$

$k_4 = .065$ $\quad k^b = -.75$

$k_5 = .161$

$k_6 = .211$

$k_{78} = .142$

Socioeconomic Impacts $1 + k^s u_s = \prod_{i=9}^{16} (1 + k^s k_i u_i(x_i))$

$k_9 = .173$	$k_{13} = .284$	
$k_{10} = .173$	$k_{14} = .492$	$k^s = -.9353$
$k_{11} = .272$	$k_{15} = .492$	
$k_{12} = .173$	$k_{16} = .334$	

Cost Impacts $u_c = u_1(x_1)$

Overall Model: $u = k_b u_b + k_s u_s + k_c u_c$

Tradeoff #1	Tradeoff #2
$k_b = .25$	$k_b = .1$
$k_s = .25$	$k_s = .1$
$k_c = .5$	$k_c = .8$

Note: The k reflected the relative importance of the measures over their good to poor ranges.

TABLE A-3 SAMPLE EVALUATION OF AN ALTERNATIVE

8-Kalsin for the northern find land-sea pipeline

	from Fig. A-1*	
x_1 = 163.8	u_1 = .672	u_w = .995
x_2 = 1.75	u_2 = .737	u_b = .954
x_3 = 20	u_3 = .969	u_s = .673
x_4 = 1	u_4 = .75	u_c = .672
x_5 = 167	u_5 = .881	u (tradeoff #1) = .743
x_6 = 0	u_6 = 1.25	
x_7 = 12	u_7 = .991	
x_8 = 3	u_8 = -.203	
x_9 = 2.5	u_9 = .300	
x_{10} = 1.5	u_{10} = .350	
x_{11} = 2	u_{11} = .600	
x_{12} = 0	u_{12} = 1.0	
x_{13} = 1.5	u_{13} = .375	
x_{14} = 2	u_{14} = .450	
x_{15} = 3.5	u_{15} = .150	
x_{16} = 2	u_{16} = .400	

Equivalent cost calculation:
e.g. tradeoff #1

In formula for the evaluation function:

$$u = k_b u_b + k_s u_s + k_c u_1 \ (x_1)$$

what must x_1 be for

$$k_b + k_s + k_c u_1(x_1) = u(8\ \text{Kalsin})^{**}$$

$$.5u_1(x_1) = .743 - .5$$

$$u_1(x_1) = .486$$

$$x_1 = 257 \text{ million dollars}$$

* Note that it is permissible to extrapolate the functions outside their ranges for the sites specified in this study.

** This is the formula for a site with only good levels for the non-cost measure and yet equally preferred to Kalsin. In essence, we are costing out the non-cost impacts at Kalsin.

APPENDIX B

CANDIDATE SITE DESCRIPTIONS

The eleven candidate oil terminal/service base sites and four service-base-only sites which are evaluated and ranked in Chapters 3 and 4 are described in this section.

B.1 GENERAL INFORMATION

Biology

The Kodiak/Afognak complex supports one of the richest fisheries in the world. The variety of habitats present results in a diverse and productive assemblage of organisms. This biological productivity, especially in the nearshore area, is important in differentiating sites for oil terminal/service bases. All nearshore areas have some unique characteristic which contributes to the overall productivity of the region, in addition to sharing numerous common features. However, even though the system is vital to the continuing production of fishery resources, little information on the nearshore environments is available. Only recently, with the advent of Outer Continental Shelf Lease Sales, has a funded and concentrated concern for the structure and function of nearshore areas grown. Therefore, differentiation of bays biologically is limited to those characteristics which are commonly known for all bays. For example, five species of salmon are found in the Kodiak area, and escapement levels for major streams to the bays are known for some years. In contrast, groundfish resources are little known, although they ultimately may be important in differentiating bay systems.

The biological portions of the site descriptions are intended to present a general overview of each bay system. For detailed discussions of the Kodiak/Afognak offshore and nearshore environments and their associated flora and fauna the reader is referred to the Environmental Impact Statement, Reference Papers #3 and #6 prepared by the Alaska Outer Continental Shelf Office, Bureau of Land Management (BLM), Anchorage, Alaska. The graphics associated with these reference papers have been modified and are available for review at the BLM offices. In addition, selected papers and unpublished information are available through the Alaska Department of Fish and Game. Most biological data were generated from these sources.

Socioeconomics

Eight general socioeconomic and land use sectors have been utilized to characterize the candidate sites: land use, population center proximity, economic activity (base), infrastructure, transportation facilities, harbor and bay use, recreational resources, and archaeological/ historical resources. A more comprehensive description of the Kodiak Island socioeconomic environment is provided in the Alaska OCS Office Draft Environmental Impact Statement (DEIS) on the Western Gulf-Kodiak Oil and Gas Lease Sale. Some community inventory and other localized socioeconomic data can be found in Volume 2 of the Kodiak Island Borough Outer Continental Shelf Impact Study prepared by Simpson, Usher, and Jones, Inc. Both studies, along with the Chugach National Forest Draft Environmental Impact Statement concerning the Perenosa Timber Sale, the U.S. Army Corps of Engineers Draft Environmental Impact Statement on the Proposed Near Island Small Boat Harbor, consultation with representatives of the Kodiak Island Borough, Municipality of Kodiak, Kodiak Electric Association, Koniag Inc., and Kodiak Fishermans Marketing Association were used as sources of data.

Engineering

The engineering descriptions deal primarily with topography and onsite geotechnical conditions, as these factors were considered to be

B.2 OIL TERMINAL/SERVICE BASE SITES

Kazakof Bay

Refer to Figure B-1.

Biology

Kazakof Bay is located in the Coastal Western Hemlock - Sitka Spruce Forest community of southwest Afognak Island. The terrain around the bay is densely forested, with Sitka spruce and western hemlock as the dominant tree species. Understory shrubs may include Sitka alder, devils club, salmonberry, willow, and red elderberry. Grasses, lichens, mosses, and liverworts occur in the moist understory.

Kazakof Bay supports a nesting population of bald eagles and is utilized by waterfowl and marine birds during the summer. Several small colonies of marine birds occur on rocky cliffs along the shore of the bay. The eastern side of the bay is heavily utilized by Sitka black-tailed deer, and by brown bear in the spring. Elk utilize the upper bay in winter and brown bear concentrate along streams when salmon are spawning. Site #2 is located in a mammal concentration area; elk are known to use this site as an overwintering area.

Confined shoreline of the bay is approximately 30 miles and inter-tidal coverage by organisms is greater than 50 percent. Four streams which enter the bay have a salmon escapement of approximately 60,000 fish in a good year. Commerical catch of king crab and tanner crab averages 75,000 and 100,000 pounds, respectively. Hundreds of marine mammals utilize the bay system.

Socioeconomics - Site 2

The site is located within the boundaries of Chugach National Forest on the western shore of Kazakof Bay, approximately 26 air miles

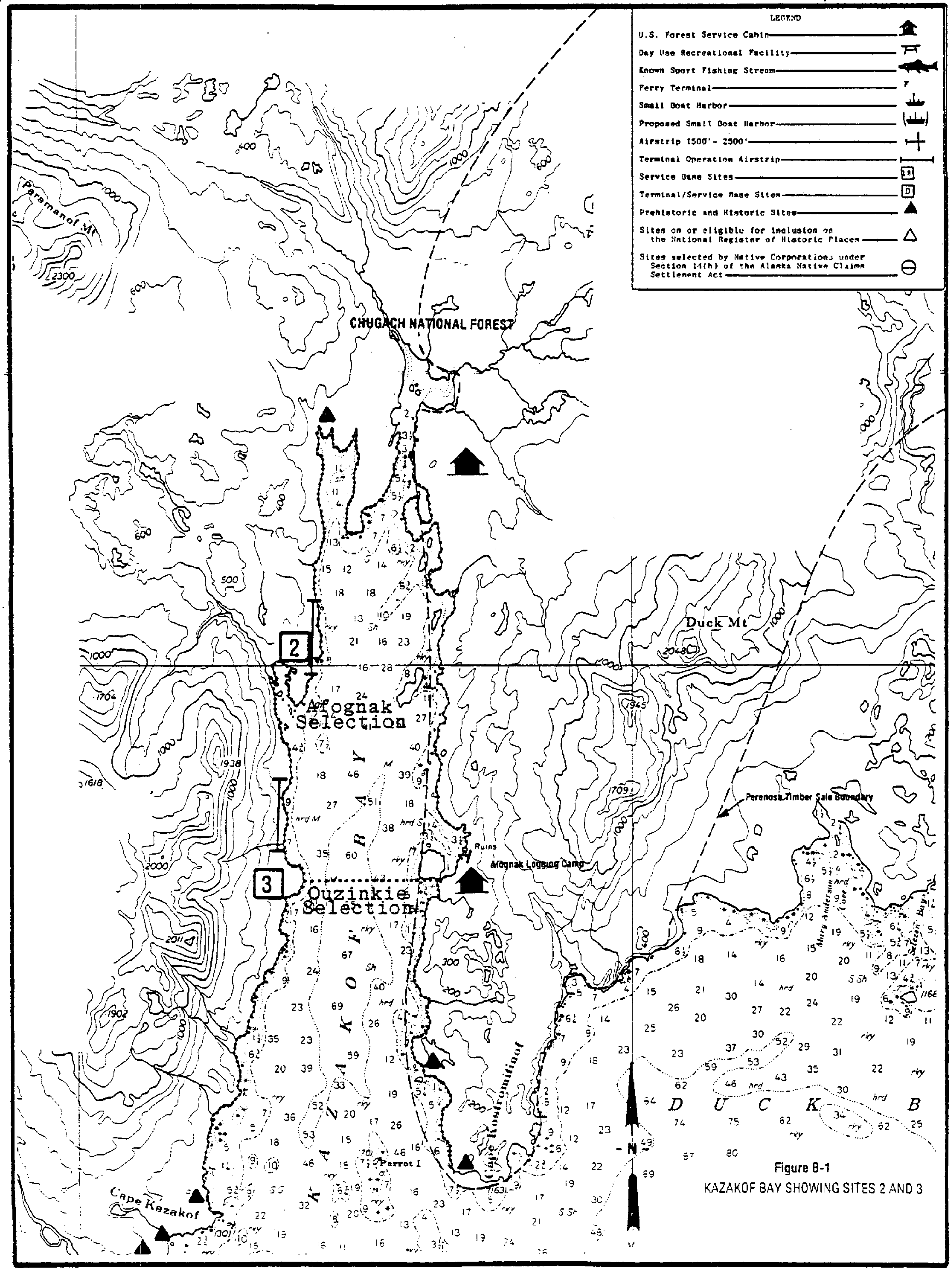


Figure B-1
KAZAKOF BAY SHOWING SITES 2 AND 3

NNW of the city of Kodiak. Ouzinkie lies 17 miles SSE of the site, Afognak approximately 12 miles SW. The nearest center of population is the Afognak Logging Company/U.S. Forest Service camp, with a fluctuating population of under 100 persons, 3 miles southeast of the site. Land use is managed by the Forest Service, principally for timber resources, habitat protection, and recreational use. The site area has been selected the Alaska Native Claims Settlement Act of 1971 (ANCSA) as a Priority #1 selection by the Afognak Village Corporation. The western boundary of the Perenosa Timber Sale begins on the eastern shore of Kazakof Bay.

Primarily economic activities in the vicinity consist of logging in the timber sale area, and commercial fishing in Kazakof Bay for pink and silver salmon, shrimp, and tanner crab.

There is no existing infrastructure at the site. The logging camp has limited power and water supply, housing, and waste disposal facilities. Transportation access to the site is limited to seaplanes and marine vessels. A few small work and recreation boats operate out of the logging camp, and fishing boats from Afognak, Ouzinkie, and Kodiak use the bay during the fishing seasons. The Kodiak Airport is located 29 miles SSE of the site. Maintained dirt roads connect the logging camp with Discovery Bay 15 air miles to the north.

Site recreation use consists of occasional deer, elk, and bear hunting activities, with sport fishing for salmon and crab in Kazakof Bay. Two Forest Service cabins are located on Kazakof Bay, one at the Afognak Logging Camp and one near the head of the bay approximately three miles northeast of the site. Two potential archaeological/historical sites have been identified near the head of Kazakof Bay, approximately three miles north and two miles northeast of Site 2.

Engineering - Site 2

Topographically, this site is relatively flat. The area in which a tank farm might be located is at least one hundred feet above mean water level. The ground surface is rocky although it is covered with a vegetative mat. It is anticipated that due to the rough rocky nature of the ground surface access by foot or wheeled vehicles would be difficult.

The area is underlain by metamorphic and volcanic rocks which are blocky with numerous factures and ragged corners. This rock would probably be suitable for aggregate, although blasting might be necessary to excavate the material.

Access from the water to the shore could be hazardous because of the numerous rock reefs close to shore. The construction of an airstrip would require rock and soil fills and construction of these fills would be moderately costly because of the rock work that would be necessary.

Socioeconomics - Site 3

Site 3 is located two and one half miles south of Site 2 on the western shore of Kazakof Bay, approximately 25 air miles NNW of the city of Kodiak. It also lies with the boundaries of Chugach National Forest, on Priority 1 land selected by the Afognak and Ouzinkie Village Corporations. Ouzinkie lies approximately 15 miles SSE of the site, Afognak 11 miles to the southwest.

Guided hunts for elk and bear in the site area provide some income for Kodiak guides. As with Site 2, there is no existing infrastructure at the site. Transportation access to the site is limited to boats and seaplanes. The Kodiak Airport is located 27 miles SSE of the site.

The two potential archaeological/historical sites identified near the head of Kazakof Bay are approximately five miles north and four miles northeast of Site 3.

Engineering - Site 3

Site 3 is similar to Site 2. The terrain slopes moderately upward to the west. The area in which a tank farm probably would be constructed would have an average slope of approximately 10 percent. There is no obvious level ground at an elevation of plus 50 feet or greater near this site.

The area also appears to be underlain by blocky volcanic and metamorphic rock. The soil cover is minimal. Construction at the site would be difficult because of the lack of soil for fills, the difficult access for wheeled vehicles, and the large volumes of rock that would require moving. An airstrip at this site would either have to be constructed on a fill adjacent to the shoreline or extensive excavations along the slopes would be necessary.

Izhut Bay

Refer to Figure B-2.

Biology

Site 4 is situated in the Coastal Western Hemlock - Sitka Spruce Forest of Afognak Island. The site is heavily forested and has a precipitous rocky shoreline. The dominant tree species are Sitka spruce and western hemlock. Important understory shrubs include Sitka Alder, devils club, salmonberry, willow, and red elderberry. Grasses, lichens, mosses, and liverworts are important nonwoody components of the understory.

The coniferous forest and rocky shoreline of the bay provides nesting habitat for raptors and marine birds (approximately 10 seabird colonies exist in the bay). The western portion of the bay provides winter habitat for elk and the peninsula on which the site is located is utilized as winter habitat by Sitka blacktailed deer. Brown bear frequent streams and tributaries to the bay during salmon migrations and are found on the peninsula during spring.

Aquatically, Izhut Bay is characterized by a salmon escapement of 50,000 fish to nine streams. Confined shoreline is approximately 54

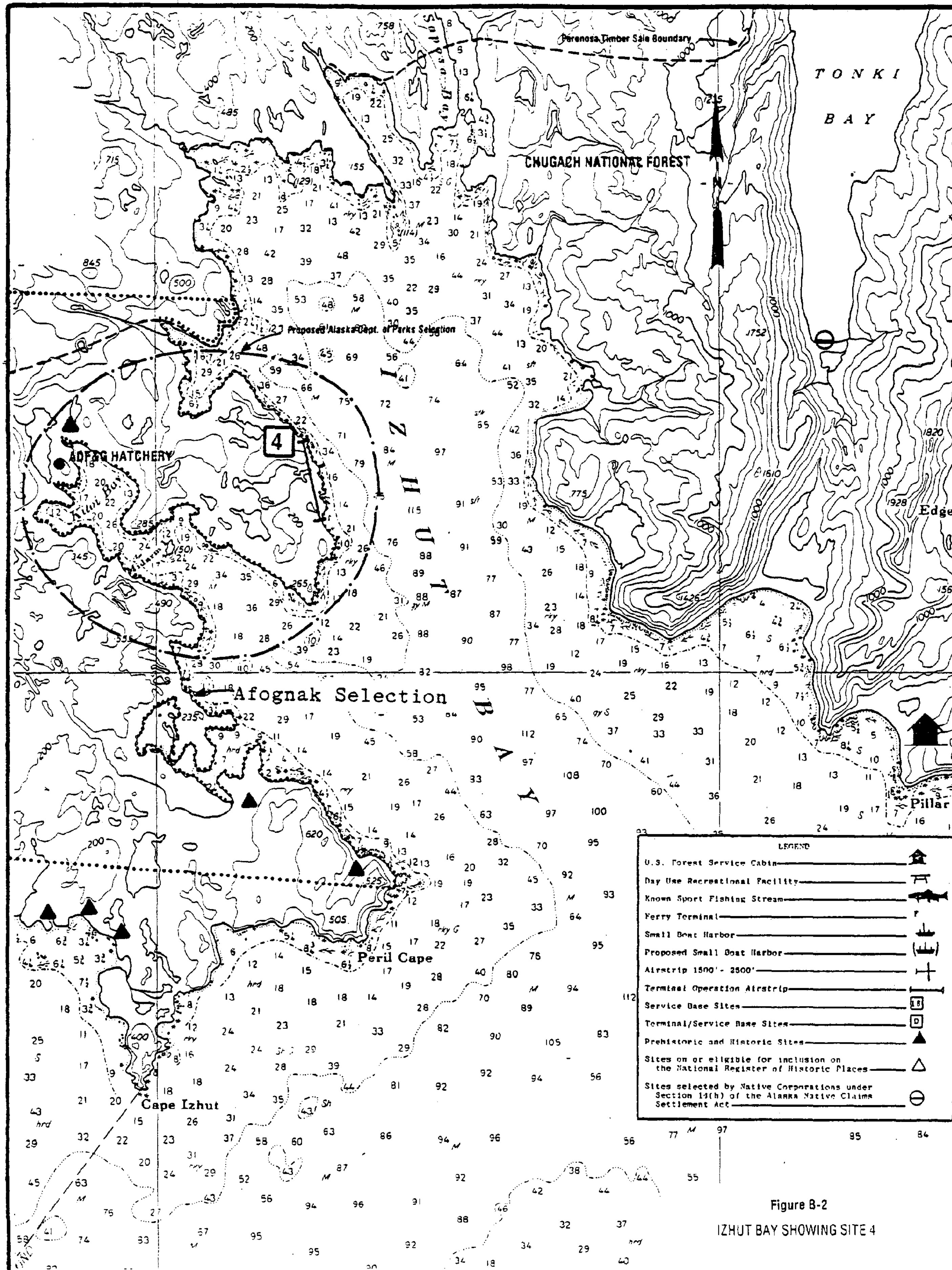


Figure B-2

IZHUT BAY SHOWING SITE 4

miles with over 33 miles of intertidal shoreline completely covered by organisms, while the remaining shoreline is greater than 50 percent covered. Kelp beds, located in the bay in at least two areas, provide vital habitat to such organisms as king crab, certain fish species, and marine mammals. Shrimp production within the bay is relatively high, and contributes significantly to the overall Marmot Bay system catch.

Socioeconomics

The site lies with the boundaries of Chugach National Forest, on Priority 1 land selected by the Afognak Village Corporation, approximately 29 air miles NNE of the city of Kodiak. Ouzinkie lies approximately 22 miles SSW of the site, and Afognak is 22 miles to the southwest. The nearest center of population is the Afognak Logging Company/-U.S. Forest Service Camp, with a fluctuating population of under 100 persons, approximately eleven miles to the southwest. Site land use is managed by the Forest Service, principally for timber resources, watershed and habitat protection, and recreational use. The boundary of the Perenosa Timber sale begins two miles to the northwest of the site. The Alaska Department of Fish and Game operates a small hatchery complex at the head of Kitoi Bay, three miles to the west.

The primary economic activity in the area consists of logging operation within the timber sale area and commercial fishing in Izhut Bay for pink salmon, shrimp, and tanner crab. Guided hunts for elk and bear in the site area provide some income for Kodiak guides. The state employs a small hatchery staff.

There is no existing infrastructure at the site. The hatchery has limited power and water supply, housing, and waste disposal facilities. Transportation access to the site is limited to boat and seaplanes. Some minor small boat traffic emanate from the hatchery and fishing vessels use Izhut Bay during the various fishing seasons. The Kodiak Airport is located 28 miles SSE of the site. No logging roads have been constructed in this portion of the Perenosa Timber Sale area.

Site recreation currently consists of occassional elk and deer hunting. Some sport fishing occurs on streams feeding into Kitoi Bay. The Alaska Department of Parks has nominated this peninsula and Kitoi Bay for state selection as a marine park. Under this system boat anchorage would be provided in areas of scenic quality. A Forest Service cabin is maintained at Pillar Lake six miles ESE of Site 4, offering elk and bear hunting and sports fishing. Two potential archaeological/historical resource sites are located near the terminal site, one approximately a mile to the northwest and the other two miles to the west.

Engineering

This site consists of several small hills interspersed with lakes. The average elevation is about 100 feet above sea level with numerous dropoffs and steep slopes. Access would be difficult. Large volumes of earth moving would be necessary to prepare tank sites, and it probably would be necessary to build a fill along the coastline for an airstrip because of the rough nature of the inland terrain.

Blocky, metamorphic and volcanic bedrock is present very close to the surface throughout this site. There is a soil mantle which is estimated to be very thin.

Monashka Bay - Site 7

Refer to Figure B-3.

Biology

The vegetative association of Site 7 is transitional between Coastal Western Hemlock - Sitka Spruce and High Brush. The overstory at the site is dominated by Sitka spruce and western hemlock and the associated understory components of shrubs, grasses, lichens, and mosses. However, the forest is interrupted by numerous openings occupied by

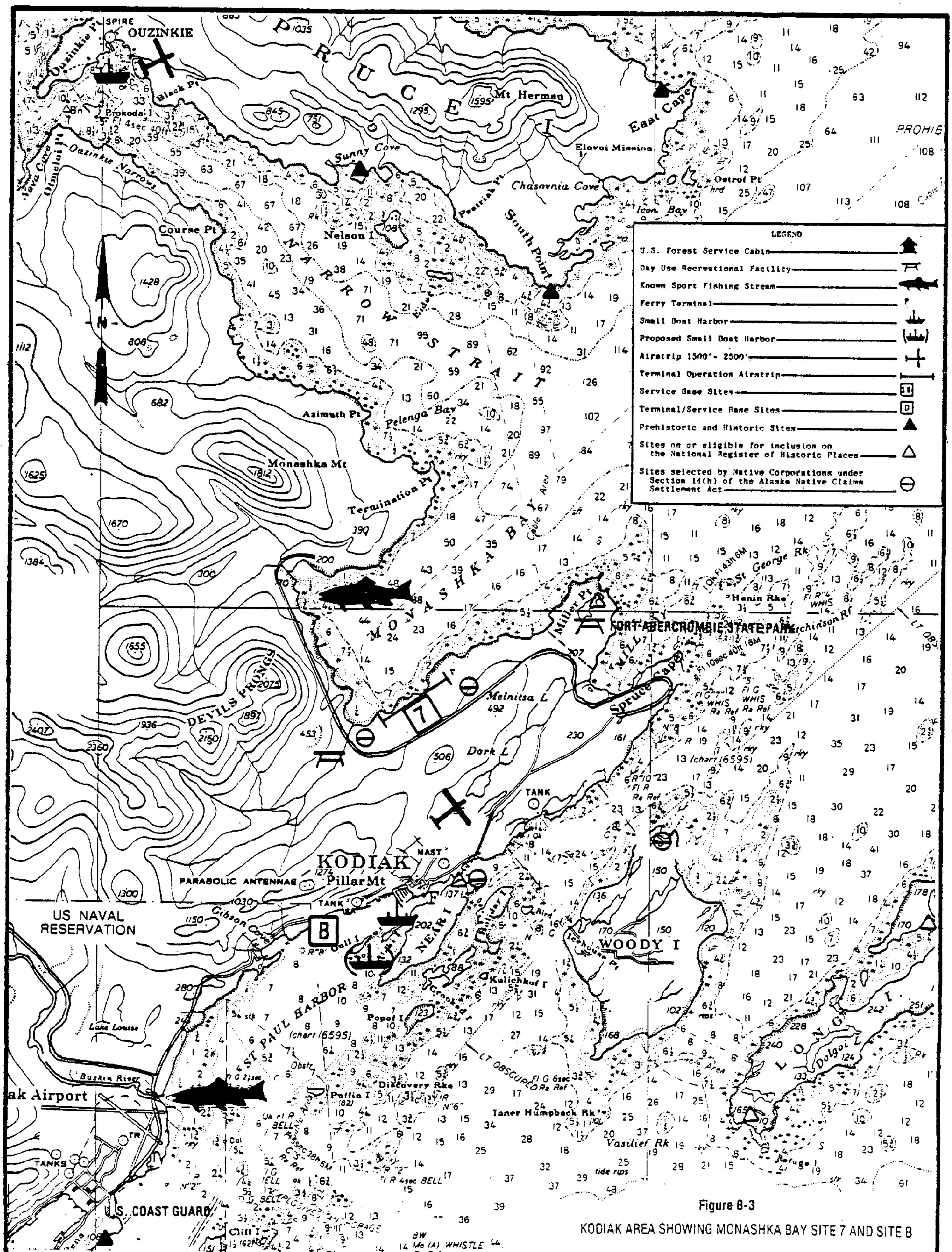


Figure B-3

KODIAK AREA SHOWING MONASHKA BAY SITE 7 AND SITE B

Sitka spruce and green alder, willow, devils club, currant, raspberry and blueberry in the overstory; and grasses, herbs, lichens, and mosses in the understory. The coastline consists of rocky outcrops interrupted by floodplains from a number of small streams. This community provides habitat for brown bear particularly during salmon migration. Three small colonies of marine birds occur on rocky outcrops of the bay, while waters of the bay are utilized extensively by marine birds during the summer and spring for feeding purposes.

Monashka Bay, relatively small, can be considered one of the least productive bays relative to other Kodiak bays. However, it is still a very productive system, with a salmon escapement to three streams of approximately 15,000 fish. Shoreline areas are essentially 100 percent covered by intertidal organisms, although confined shoreline is only nine miles. Kelp beds are present and the bay is considered vital to king crab rearing.

Socioeconomics

The Monashka Bay site is located on the southern shore of the bay on the Kodiak Borough Sanitary Landfill two miles north of downtown Kodiak. It is zoned Conservation by the municipality. A Veterans of Foreign Wars leased property immediately west of the site is zoned Conservation and is used for recreation, as is the State selected land at the head of the bay. Low density, no-service residential development, zoned Unclassified, occupies the area east of Site 7 and between Fort Abercrombie State Park, two miles to the northwest. The Monashka Creek Reservoir which supplies some water to the city of Kodiak is located three miles northwest of the site.

Monashka Bay is fished commercially for tanner crab with some minor salmon fishing. Home construction is ongoing in the unclassified area east of the site. Fish processing and other important economic sectors of the Kodiak area are located on St. Paul Harbor (Kodiak economic activities are discussed under the Site B description).

Existing infrastructure at the site is limited, although the site is within relatively close proximity of the city of Kodiak. A water line from the Monashka Creek Reservoir passes within a mile of the site. Water use for the city of Kodiak is currently at capacity, but should the Borough be able to expand the reservoir, water might be available for Monashka Bay industrial users. Power and sewer services do not extend the site area but both have capacity for additional users should they be extended to the area. Housing in the Kodiak area is currently critical, with vacancy rates for Kodiak's 1,218 units at under one percent. Kodiak has a hospital, kindergarten through community college education, telephone service, and fire fighting facilities and equipment.

Site 7 lies 2000 feet northeast of Otmelor Point Road, providing connections to St. Paul Harbor, three road miles distant to the Kodiak Airport, 11 miles away. This road provides sole access from the site area to downtown Kodiak. The Kodiak Airport lies six air miles southwest of the site. The city of Kodiak operates a small gravel strip, 2,750 feet by 100 feet, near Lilly Lake, approximately 1.4 miles southeast of the site. Kodiak Western Airlines offers seaplane service out of the St. Paul Harbor area. St. Paul Harbor is also the center for marine freight going in and out of Kodiak Island. Monashka Bay supports some small boat recreation and some commercial fishing traffic.

Monashka Bay is heavily utilized for recreation purposes by the Kodiak metropolitan area. Fort Abercrombie State Park is located near the head of Monashka Bay two miles northeast of Site 7. It is primarily a day use park with facilities for picnicking and hiking. Southwest of the sanitary landfill some picnic tables are located at the marsh at the head of Monashka Bay where the area is used for picnicking, beach activities, saltwater and freshwater fishing. Saltwater sport fishing occurs throughout Monashka Bay.

There are two sites chosen by Koniag Regional Corporation under ANCSA 14(h)(1) within a one mile radius of Site 7, one to the southwest and one to the northeast on the eastern bay shoreline.

Engineering

This site is located approximately three miles from the mouth of the bay. The area on which the tank farm probably would be located is the Borough's sanitary landfill area. The rocky terrain is covered with a vegetative mat and is crossed several times with small, steep sided streams. In the tank farm area the average elevation is at or near one hundred feet. The site can be traversed easily on foot except adjacent to the streams. An airstrip, if necessary, would have to be built on the beach adjacent to the tank farm. This would require some fill and possibly erosion protection.

The rock formations at Monashka Bay are similar to those in Izhut and Kazakof Bays, and the area is underlain by blocky, metamorphic rocks. A moderate amount of earthwork would be required to made this site acceptable for a tank farm. including rock excavation and filling to level the appropriate areas.

At the southwest corner of Monashka Bay, near the city, an old ship hull has washed onto the shore. It appears that this ship was wrecked and washed to the shore during a storm, which indicates that any harbor facilities at this site may require protection against storms and violent weather coming from the northeast. The construction of breakwaters, requiring rock fills, would be very expensive at this site.

Kalsin Bay - Site 8

Refer to Figure B-4.

Biology

Site 8 is situated in the High Brush community surrounding Kalsin Bay. Dominant woody species include Sitka, green and thinleaf alder, although several stands of Sitka spruce and western hemlock also occur

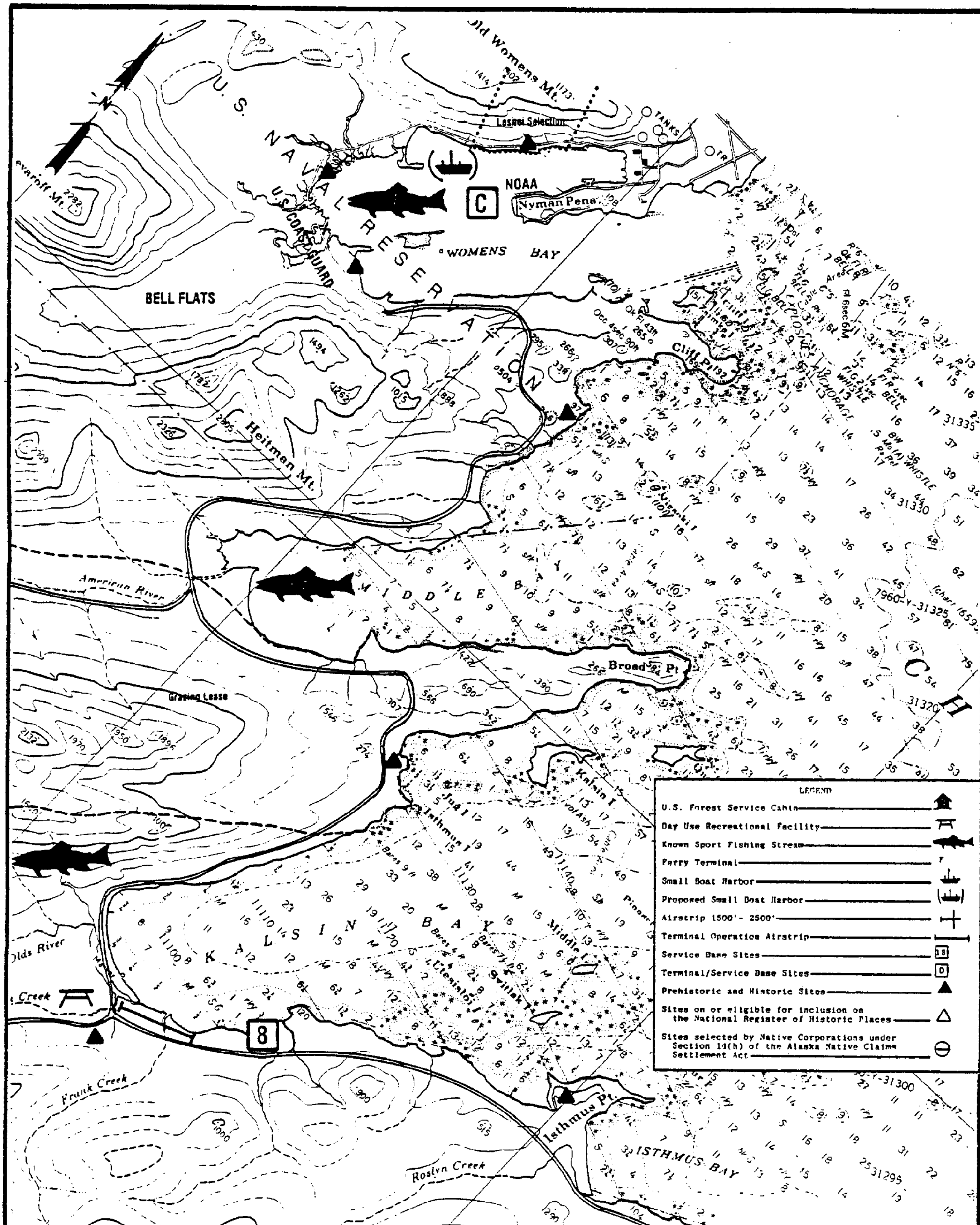


Figure B-4

WOMANS BAY SHOWING SITE C
AND KALSIN BAY SHOWING SITE 8

on the site. Understory species may include currant, blueberry, raspberry, and lingenberry, bluejoint, fescue, lupine, fireweed, ferns, lichens and mosses. The river floodplain near the site supports a number of sedges and cottongrasses and is seasonally utilized by waterfowl and shorebirds.

Kalsin Bay supports high numbers (1000's) of feeding birds during the summer. Three sea bird colonies comprising less than 12,000 birds are also located within the bay. Concentrations of blacktailed deer utilize the uplands and lowlands adjacent to the bay, particularly during winter. The site is located in one of these areas. Approximately 79,000 salmon utilize the bay's four streams for spawning.

The intertidal shoreline of Kalsin Bay is approximately 15 miles in length with approximately 13 miles 50 percent covered by organisms. The remaining shoreline is less than 50 percent covered. No kelp beds are known to exist in the bay. Shrimp harvest in the bay and inner Chiniak Bay averages 1 to 3 million pounds per year. A vital migration route of king crab is known to be located within the bay and the bay is considered very important to the rearing of king crab.

Socioeconomics

Site 8 is located on the eastern shore of Kalsin Bay near its head, on land administered by the Bureau of Land Management and selected by both the state of Alaska and by Lesnoi Corporation as a Priority 1 selection. The site area has been zoned Conservation by the Kodiak Island Borough. There is an enclave of private property in the southwest corner of Kalsin Bay, two miles west of the site, used primarily for residential and commercial purposes. The boundary of a 21,650 acre BLM grazing lease A-07916 lies approximately 3 miles east of Site 8 and intersects Kalsin Bay at Isthmus Island. Bells Flat and the Womens Bay Coast Guard Station are the nearest centers of population, located approximately 10 miles to the northwest. Downtown Kodiak is located 13 miles to the north. The Cape Chiniak Tracking Station facility is located nine miles to the east of Site 8.

Commercial fishing for shrimp, tanner crab, and pink and silver salmon comprises the principle economic activity in Kalsin Bay. Cattle from the nearby lease area are marketed locally and elsewhere in Alaska.

There is no existing infrastructure at the Kalsin Bay site. The Coast Guard Station at Womens Bay has the nearest developed supply of water, and power and sewage disposal. The Chiniak Tracking Station has water, power, and sewage disposal capabilities that are currently not being used to capacity. Site 8 is located on the road connecting Kodiak to Cape Chiniak. Road miles between the Kodiak and Kalsin Bay site is approximately 30 miles. Womens Bay Coast Guard Base is approximately 24 road miles to the north and the Cape Chiniak Tracking facility is 14 road miles to the east. An improved road to Pasagshak Bay and Narrow Cape branches off the Cape Chiniak Road one mile southwest of Site 8. A similar road branches off the Cape Chiniak Road at the head of Menlo Bay and ends on Saltery Cove on Ugak Bay. A state highway maintenance station is located off the Cape Chiniak Road on Kalsin Bay. The Kodiak Airport is located eleven air miles to the northeast. The bay is in relatively close proximity to ship channels into Chiniak Bay and the Coast Guard facilities at Womens Bay. Fishing vessels heading south out of St. Paul Harbor pass the mouth of the bay, and Kalsin Bay contains commercial fishing vessels particularly during salmon and shrimp seasons.

Kalsin Bay and the Olds River and Kalsin Creek at the head of Kalsin Bay are used by Kodiak area residents for recreational sport fishing. The site area itself is used for picnicking and other day use activities. The road to Pasagshak Bay is used for access for hunting and fishing, and camping. Some hunting takes place along the Cape Chiniak Road between Kodiak and Cape Chiniak, including the Kalsin Bay area. One potential archaeological/historical resource site is located at the head of Kalsin Bay approximately one mile southwest of Site 8. The next closest potential resource site is located on the western shore of Kalsin Bay near Isthmus Island. A cluster of seven potential sites are located near the Cape Chiniak Tracking facilities, Cape Chiniak, and Sequel Point 8 to 12 miles east of the Kalsin Bay site.

Engineering

The area at this site in which the tank farm could be built is a rolling hill approximately 100 feet above sea level. The hill probably can be traversed by wheeled vehicles and walking is hampered only by the brush. There are flat low lying areas near the site which could be cleared and leveled for use as an airstrip.

Site 8 lies on the east side of the thrust fault which delineates the contact between the lower tertiary rocks along the southeast coast of Kodiak Island and the cretaceous and jurassic rocks which make up the inner parts of the island and Afognak Island. This fault passes within a few hundred feet of the site. The available preliminary geologic studies to date indicate that there are no young scarps along the fault or other indicators that would lead one to believe that the fault is active.

The tank farm location would be underlain by a mixture of volcanic and sedimentary rocks with a moderate soil cover. In the site area both soil and rock for earthwork construction are available.

Ugak Bay - Sites 9 and 10

Refer to Figure B-5.

Biology

Site 9 is situated in and adjacent to a marsh lowland of Ugak Bay. Alder, poplar, and willow occur along a small stream that traverses the

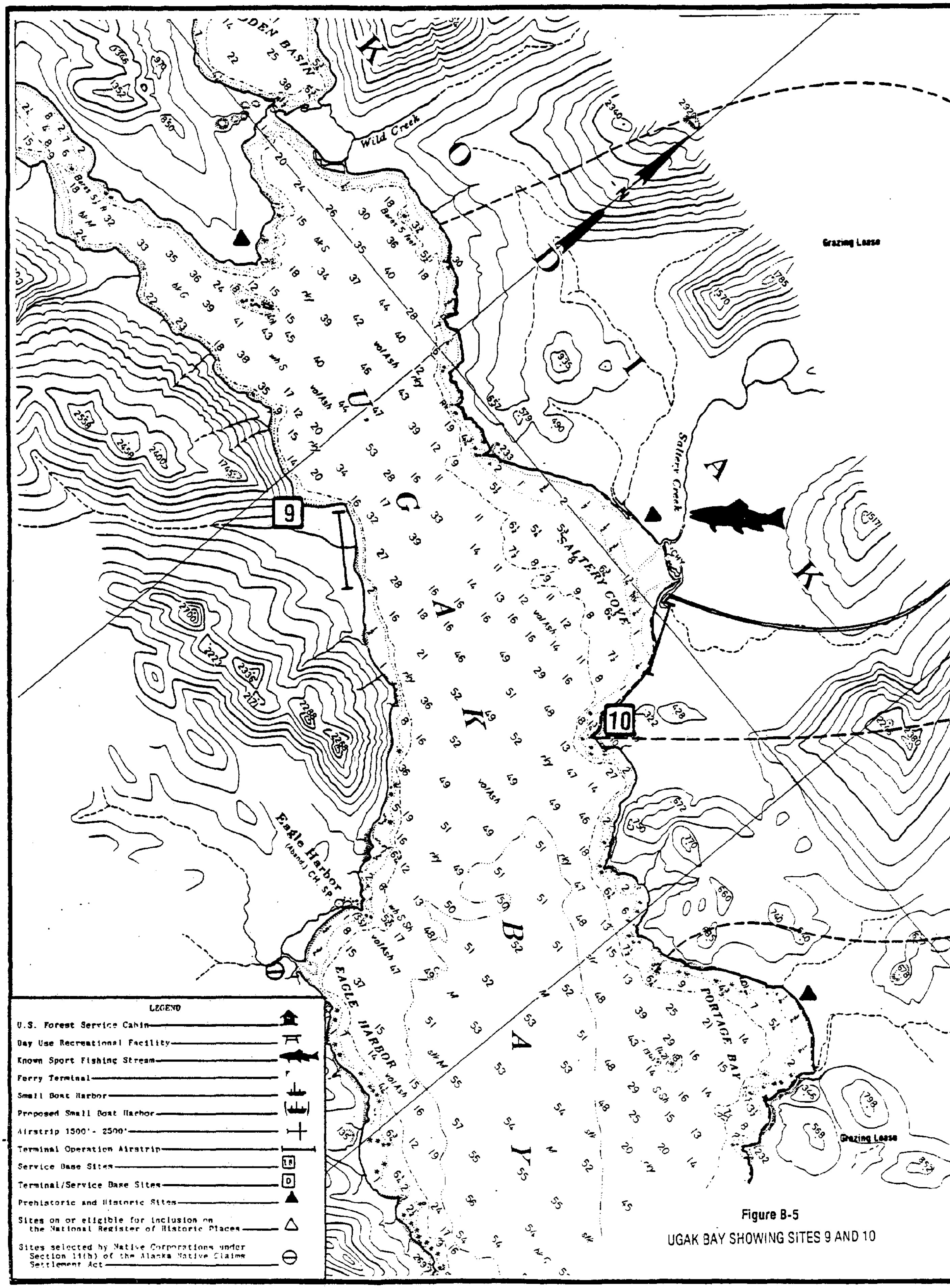


Figure B-5

UGAK BAY SHOWING SITES 9 AND 10

marsh prior to entering Ugak Bay. The marsh is utilized by shorebirds and waterfowl for nesting.

Deer concentrate on the lowlands around the bay during winter and brown bear occur along the streams during fish migrations. Mountain goats occur on mountains directly behind Site 9. These mountains also provide denning habitat for brown bear.

Site 10 is situated in a moist tundra habitat of Saltery Cove of Ugak Bay. The physiography of the site consists of salt and freshwater marsh supported by several small streams. Alders, willows and poplars occur along streams traversing the wetlands. Rushes, grasses, and cottongrasses dominate the wetland vegetation.

Ugak Bay is utilized by raptors, waterfowl, shorebirds, and marine birds. The bay provides winter habitat for eiders, diving ducks, larids, alcids, and cormorants. Seven sea bird colonies are found in the bay. Wetlands provide molting and nesting habitat for shorebirds and waterfowl. The lowlands around Saltery Bay provide important winter range for Sitka blacktailed deer. Brown bear frequent the streams during salmon migrations. Mountain goats occur in the mountains above the bay.

Aquatically, Ugak Bay is one of the more productive systems on the eastern side of Kodiak Island. Annual salmon escapement is 122,000 fish which return to 18 stream systems. The bay has approximately 81 miles of shoreline with over half the intertidal areas covered 50 percent or greater by organisms. Razor clams are present in Saltery Cove, Portage Bay, and between Narrow Cape and Pasagshak Point. Kelp beds are numerous. Historically, Ugak Bay provided abundant shrimp catches. However, overfishing has temporarily reduced stock levels, forcing a closure to fishing. A steller sea lion pupping and hauling grounds is located on Ugak Island at the mouth of the bay.

Socioeconomics - Site 9

Site 9 is located on land administered by the Bureau of Land Management on the southern shore of Ugak Bay, approximately 28 miles southwest of the city of Kodiak and 26 miles northeast of Old Harbor. The site is part of a Priority 1 selection of Bells Flat Corporation, which is currently appealing its ineligibility under the Alaska Native Claims Settlement Act of 1971 (ANCSA). The site has also been tentatively selected by the State of Alaska, dependent on ANCSA settlements. There is no current land use other than open space and wildlife habitat; the closest population center other than the few habitations across the bay at Saltery Cove is the Bells Flat area, 7 miles to the northeast.

Commercial fishing for salmon and tanner crab represents the main economic activity in the area. In the past, Ugak Bay has supported a productive shrimp fishery, but is currently closed to shrimping. Sproadic cattle ranching has occured on BLM grazing leases on the northern side of Ugak Bay.

There is no existing infrastructure at the site. Transportation access is limited to seaplane and boat. Commercial fishing boats use the bay during the various seasons. The nearest road connections, unimproved with no maintenance, are across the bay at Saltery Cove. Air distance to the Kodiak Airport is approximately 23 miles northeast.

Recreational use of the site is close to nonexistent; some hunting for deer and bear may take place. Sport fishing for steelhead trout occurs at Saltery Cove on the northern shore of Ugak Bay. The nearest potential archaeological/historical resource sites are 3.5 miles WNW and 4 miles NNW respectively.

Engineering - Site 9

The topography in the Site 9 area ranges from a flat delta deposit to a very steep sloping hillside. The flat area is only a few feet above sea level and contains several marshes and ponds. In addition, a stream passes through the site area. The area on which the tank farm could be built is southwest of the delta area where the slope rises more gently than other areas. To prepare this area for a tank farm, a significant amount of earthwork will be required to level the tank site pads. Construction equipment movement over the site will be relatively difficult because of the marshy nature of the delta area and the stream passing through the site. Tracked vehicles will probably be required for all the work on the hillsides.

Geologically, this site is located in the volcanic and metamorphic rocks characteristic of the interior of Kodiak Island. Except for the delta area, the rock appears close to the surface with a minimum soil cover on the steeper slopes and a moderate soil cover on the more gentle slopes. Rock and soil for construction appear to be available within or immediately adjacent to the site.

Socioeconomics - Site 10

Located on Saltery Cove on the northern shore of Ugak Bay, Site 10 is 24 miles SSW of the city of Kodiak. It is administered by the BLM as grazing lease (A-031348) and is Priority 1 selection of Bells Flat Corporation. Grazing cattle and a few "residents" were observed in the vicinity of the site. The grazing lease area is one of three on the northern side of Ugak Bay.

In recent years, cattle ranching in the vicinity of Saltery Cove has been somewhat sporadic. Kodiak beef is marketed locally and in other parts of Alaska.

There is no existing infrastructure at Site 10. The few residents in the area are self-sufficient in terms of fuel, water supply, and waste disposal. Transportation access to the site is provided by plane, seaplane, boat and an unmaintained, seasonal road. There is a very rough, small airstrip in the vicinity of the ranch buildings. Road access is currently limited to 4-wheel drive when favorable conditions exist during late spring, summer, and early fall. It is approximately

13 miles to the Middle Bay junction with the Kodiak-Chiniak Road, 25 miles to the Kodiak Airport and 33.5 miles to downtown Kodiak. The road is used for ranch access, and access to sport fishing at Saltery Cove and hunting. Traffic is relatively infrequent. The Kodiak Airport is located 19 miles NNE of Site 10. There is some commercial fishing traffic during the various seasons.

Saltery Cove is popular for steelhead, trout, and salmon fishing. No facilities have been developed, and Kodiak area users drive or fly in and camp. The road to Saltery Cove is used for access to hunt deer, bear, and small game. The area is used primarily during the summer and fall seasons. There is one potential archaeological/historical resource site in the immediate vicinity of Site 10.

Engineering - Site 10

The Saltery Cove area itself appears to be a beach or deltaic deposit, with flat marshes. To the north of Saltery Cove there are some gentle to moderately rolling hills on which the tank sites could be founded. The average elevation of the site on these hills is about 100 feet above sea level.

The bedrock at the site is characteristic of the volcanic and metamorphic rocks on the interior of Kodiak Island. The hills on which the tanks could be sited are weathered and probably have moderate depths of soil overlaying the bedrock. In the delta area, depth of bedrock cannot be estimated from the information available. The area contains silty and sandy soils which would be useable for an airstrip. The major construction cost anticipated at this site would be the excavation and earthwork necessary to prepare the tank sites on the hillside.

Kiliuda Bay - Sites 12 and 13

Refer to Figure B-6.

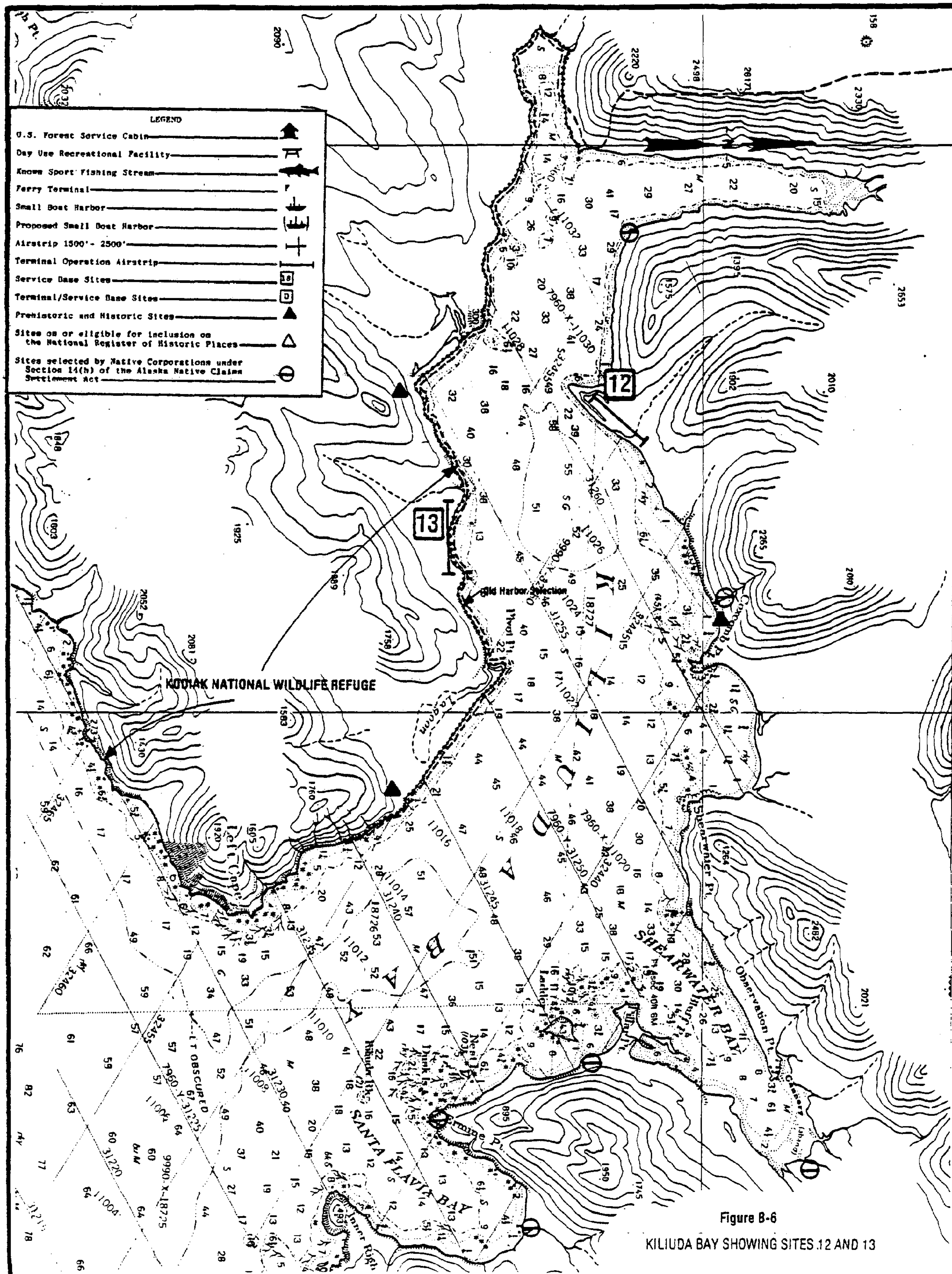


Figure B-6
KILIUDA BAY SHOWING SITES 12 AND 13

Biology

Site 12 is located on and adjacent to a small spit protruding into Kiliuda Bay. A small stream traverses the spit and provides drainage of the wetlands that comprise the site. Wetland vegetation, including grasses, sedges and cottongrasses occupy the spit. Upland vegetation consists of patches of alders surrounded by grasses.

Site 13 is located in the High Brush habitat on the south shore of Kiliuda Bay. The site location is a narrow lowland bordered by steeply ascending mountains on the southwest and Kiliuda Bay on the northeast. Vegetation consists of poplar and willow along the streams and scattered clumps of Sitka and green alder separated by narrow expanses of blue-joint, fescue, and herbacous species.

Kiliuda Bay is used heavily by marine birds (6 sea bird colonies exist in the bay) waterfowl, and shorebirds in spring for feeding and nesting purposes. Nesting raptors, including bald eagles, utilize the bay. Mountain goats occur in the mountains above Kiliuda Bay and during severe winters descend to the beaches at the head of the bay. Brown bears frequent the streams tributary to the bay during salmon migrations.

Like Ugak Bay, Kiliuda Bay is one of the more productive bay systems of the island. Annual shrimp harvest ranges from 7 to 9 million pounds, while the bay's 12 anadromous fish streams have an escapement of 71,350 fish annually. Confined shoreline is approximately 49 miles, with approximately 29 miles of intertidal area covered 50 percent by organisms. Fourteen miles of shoreline, however, have less than the 50 percent average. Kelp beds are located near the mouth of the bay at Duck Island.

Socioeconomics - Site 12

Site 12 is approximately 42 miles southwest of the city of Kodiak. Old Harbor, the nearest center of population, is 12 miles to the south-west. The site itself is under the management of BLM, and is a Priority

1 selection of the Old Harbor Corporation. It has no existing uses other than open space and wildlife habitat. A temporary bear hunting camp is located 2 miles west of the site. The boundary of the Kodiak National Wildlife Refuge runs along the southern shore of Kiliuda Bay, 1.5 miles south of the site and jogs north three miles west of Site 10, although most of the southern shoreline has been selected by Old Harbor Corporation.

Commercial fishing constitutes the primary economic activity in the site area. Kiliuda Bay is very productive and is fished for chum salmon, tanner crab, and particularly shrimp. The Shearwater Bay Cannery, located near the head of Shearwater Bay, processes salmon and is an important employer for the Old Harbor work force.

There is no existing infrastructure at the site. Transportation access is limited to seaplane and boat, the Kodiak Airport is 38 miles to the northeast. Kiliuda Bay has some of the highest levels of fishing traffic outside of the major harbors.

Recreation activities in the vicinity of the site are minimal. The bear hunting camp to the west receives some seasonal use. Two sites have been selected by Koniag under Section 14(h)(1) of ANCSA, 1.4 miles west and four miles east of Site 12. The nearest potential archaeological/historical resource site is located five miles to the east.

Engineering - Site 12

This site consists of a flat deltaic deposit adjacent to the shoreline with a moderately sloping ridge behind this deposit. There is a stream passing on the east edge of the site.

The area is underlain with metamorphic and/or volcanic rock and it is anticipated that the soil cover on nearby slopes is not thick.

Major construction costs at this site would be the excavation necessary to level the tank site pads. The delta would be suitable for an airstrip with minimal leveling. If the delta were used for an airstrip, the stream would have to be crossed to provide enough runway length. In addition, the direction of the runway at this site would not be aligned with the probable prevalent winds. This would mean that the runway could be closed during periods of high winds coming up the bay.

Socioeconomics - Site 13

Approximately 42 miles southwest of the city of Kodiak and 11 miles northeast of Old Harbor, Site 13 is situated on the southern shore of Kiliuda Bay. It lies within the boundary of the Kodiak National Wildlife Refuge on a Priority 1 selection of Old Harbor Corporation. As part of the National Wildlife Refuge system, the site area is managed by the U.S. Fish and Wildlife Service to preserve wildlife habitat. Recreation and subsistance hunting under Alaska Department of Fish and Game regulations constitute other land uses within the refuge. Old Harbor is the nearest population center.

The primary economic activity in the site area is commercial fishing as at Site 12. There may be some wildlife photography and hunting trips in that portion of the refuge, with local guides and air taxis out of Kodiak and Old Harbor.

Site 13 has no existing infrastructure. Transportation access is limited to seaplane and boat. The Kodiak Airport is located 38 miles to the northeast.

As noted above, recreation activities in the vicinity of the site are minimal and a potential archaeological/historical resource site is located within a mile of Site 13.

Engineering - Site 13

The terrain adjacent to the shoreline is flat. It is a deltaic deposit and adjoins steep, rocky ridges. Considerable earthwork would be necessary to provide tank site pads. The delta area is too low and the slopes are very steep. It is possible to prepare a landing strip within the delta area with a minimum amount of grading.

The predominant rock type in the area is probably metamorphic, however, some granitic type rocks have been mapped in the area. The soil cover on the slopes is very shallow. Delta deposits appear to be relatively deep aluvium consisting primarily of silt and sand.

Barling Bay - Site 16

Refer to Figure B-7.

Biology

Site 16 is located on and adjacent to a freshwater wetland that occurs within High Brush habitat near the west entrance to Barling Bay. The wetland vegetation includes grasses, sedges, and cottongrasses. Vegetation on the surrounding uplands consists of patches of Sitka and green alder separated by openings dominated by bluejoint, fescue, and herbaceous species.

Barling Bay is utilized heavily by waterfowl, shorebirds, and marine birds during spring migrations, although no sea bird colonies exist in the bay. The site is located east of a known denning area for brown bear.

Annually, approximately 48,000 salmon return to Barling Bay to spawn in a single stream system near the head of the bay. Shoreline length (6 miles) and coverage by organisms is relatively sparse, with intertidal areas being less than 50 percent covered. However, Barling Bay is considered part of a vital shrimp producing area to the Sitkalidak Strait harvest. No extensive kelp beds exist within the bay.

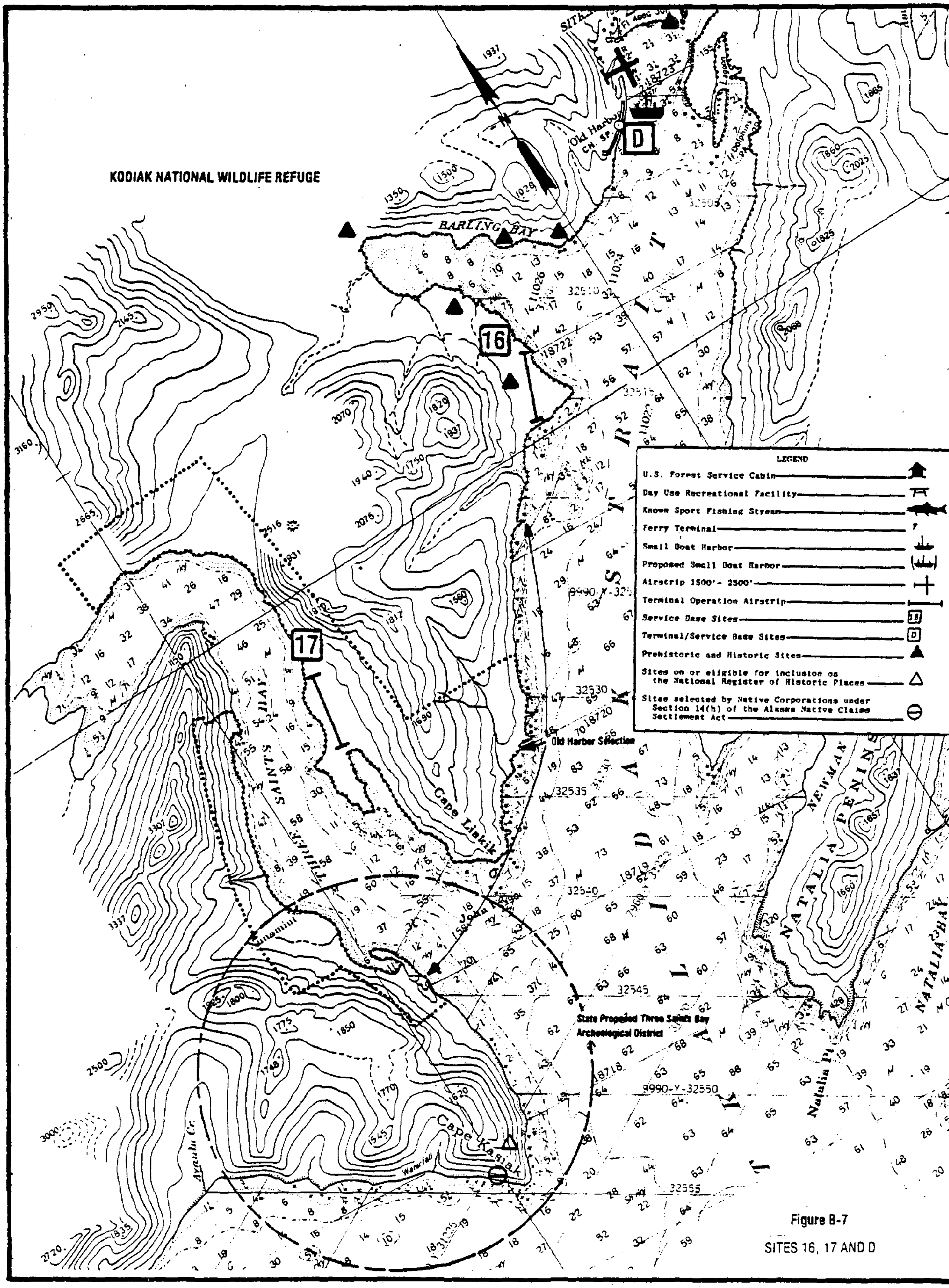


Figure B-7

SITES 16, 17 AND D

Socioeconomics

Site 16 is located at the mouth of Barling Bay on the western shoreline, 56 miles southwest of Kodiak and three miles southwest of Old Harbor, the nearest center of population. The site is within the boundaries of Kodiak National Wildlife Refuge on a Priority 1 selection of Old Harbor. The U.S. Fish and Wildlife Service manages the site area for wildlife habitat protection, and the area probably supports some subsistance hunting by Old Harbor residents.

Barling Bay is currently closed to commercial fishing. Sitkalidak Strait is closed to shrimping from the southern entrance to the Sitkalidak Narrows north of Old Harbor. Old Harbor is the area economic center, based on the fishing industry with a subsistance economy estimated by the Alaska OCS office as less than 50 percent dependence. (For more detail on Old Harbor economic activities refer to the Site D description.) The tourism industry is growing in Old Harbor, attracted by wildlife refuge and archaeological resources in the area.

There is no existing infrastructure at Site 16. (Old Harbor's infrastructure is discussed in the Site D Description.) Site access is limited to boat and seaplane. Barling Bay receives some minor fishing traffic but the Sitkalidak Strait and Old Harbor area is fairly active with fishing and transportation traffic. Old Harbor operates a 2000 foot gravel strip and has a loading dock 32 foot by 64 foot (with a proposed length extension to 131 feet), 15 feet above mean low water. The Kodiak Airport is 52 miles northeast of the site.

Site 16 is probably used by Old Harbor residents and possibly others for recreational purposes. The archaeological/historical resource potential of the Old Harbor - Barling Bay - Three Saints Bay area will probably attract increasing tourism and recreational use. Site 16 has a high potential for archaeological/historic resources. There are two sites within a two mile radius and five sites within a three mile radius of the site.

Engineering

The outermost part of the site is another delta deposit, flat and marshy. The northern part of the site has some gently rolling hills which would be appropriate for tank sites. The delta area could be used for an airstrip.

The bedrock underlying this site is metamorphic and/or volcanic. The rolling hills are probably overlain by a moderately thick soil layer grading into weathered rock, then hard bedrock. In the delta area the soils are primarily silts and sands.

Construction costs at this site will be moderately high because of the earthwork necessary to prepare tank sites.

Three Saints Bay - Site 17

Refer to Figure B-7.

Biology

Site 17 is located on a spit on the east side of Three Saints Bay. The site is located on an upland site covered by High Bush vegetation. Scattered clumps of Sitka and green alder are separated by grassland vegetation including fescue, bluejoint, yarrow, and fireweed. The bay is utilized by shorebirds, waterfowl and marine birds during the spring. Only a single small (1000 birds) sea bird colony is present in the bay. Mountainous habitat west of the site is utilized by brown bears for denning.

Aquatically, Three Saints Bay contributes significantly to the total shrimp harvest of the Sitkalidak Strait system which ranges from 14 to 16 million pounds. However, the bay supports an annual salmon escapement of only 200 fish to three stream systems; confined shoreline is approximately 21 miles. Intertidal coverage by organisms is greater than 50 percent for 17 miles and less than 50 percent for 4 miles. No kelp beds are known to exist within the bay, although the bay is considered vital to king crab rearing.

Socioeconomics

Site 17 is situated 62 miles southwest of the city of Kodiak, and eight miles southwest of Old Harbor, the nearest population center. It lies within the boundaries of the Kodiak National Wildlife Refuge on a Priority 1 selection of Old Harbor Corporation. The U.S. Fish and Wildlife Service manages the refuge for wildlife habitat protection, and allows ancilliary uses such as subsistance and recreational hunting. The Alaska State Archaeological Officer has proposed the creation of a Three Saints Bay Archaeological District on the western shore of the bay.

Three Saints Bay is currently closed to shrimping but supports some commercial fishing for chum salmon, based out of Old Harbor. A growing tourism industry in Old Harbor based on wildlife refuge and archaeological/historical resources uses the Three Saints Bay area to some extent, and this use would probably increase if an archaeological district is created. (For more detail on Old Harbor economic activities, refer to the Site D description.)

There is no existing infrastructure at Site 17. Old Harbor's infrastructure is discussed in the Site D description. Site access is limited to seaplane and boat. Three Saints Bay receives some fishing and local traffic. The nearby Sitkalidak Strait is important for fishing, access to other fishing grounds, and as a marine route into Old Harbor. Old Harbor operates a 2000 foot gravel strip and has a loading dock 32 foot by 64 foot (with a proposed length extension to 131 feet), 15 feet above mean low water. The Kodiak airport is 58 miles northeast of the site.

Site 17 itself has no potential archaeological/historical resource sites in its immediate vicinity but Three Saints Bay itself is very important in terms of prehistoric Native archaeological sites and as the first permanent Russian settlement established in the New World, the headquarters of the Shelikhovgolikof Fur Company. This settlement is on the National Register of Historic Places and is located approximately two miles southwest of Site 17. In addition, there are two sites selected by Koniag, Inc. under Section 14(h)(1) of ANCSA, three miles northwest and four miles southwest of Site 17.

Engineering

The site consists of a unique, relatively flat feature jutting out from the adjacent mountaineous land mass. This flat area is rocky but relatively easy to walk on and would be crossable by wheeled vehicles. The elevation of this flat area is less than 20 feet above sea level. Tanks at this site would have to be on the slope of the hillsides, which are steep and rocky.

The published geology data indicates that this site has metamorphic rock with no unusual geologic structure. Based on a brief field inspection, there is a long lineation across the flat area which could be related to faulting. Water has collected here. The soil mantle appears to be relatively thin throughout the site and consists of primarily sands and silt. Construction would be relatively expensive because of the earthwork necessary to develop tank sites. The runway could be aligned along the lineation discussed above. The earthwork for the airstrip should be minimal.

B.3 SITES FOR SERVICE BASES ONLY

Site A - Port Lions

Refer to Figure B-8.

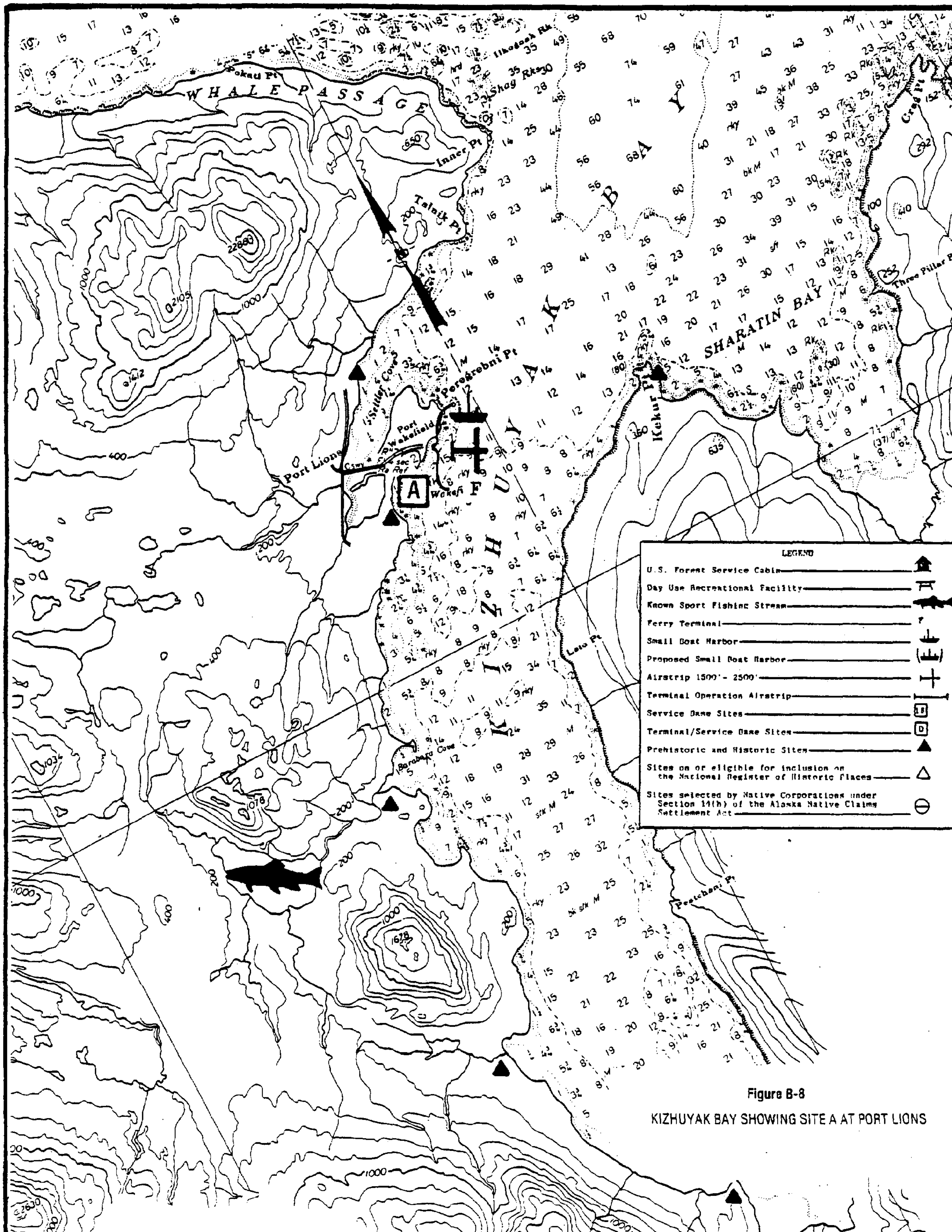


Figure B-8

KIZHUYAK BAY SHOWING SITE A AT PORT LIONS

Biology. Port Lions, located in Kizhuyak Bay, is considered stressed biologically because of the degradation of water quality as a result of the operation of seafood processing facilities. However, the bay itself supports an annual salmon escapement of approximately 16,000 fish and five sea bird colonies. Shrimp and crab utilize the bay for rearing while waterfowl concentrate in the bay from April to June and again from September to November. Confined shoreline of the bay is approximately 45 miles.

Socioeconomics. This site is 23 miles west northwest of the city of Kodiak. Port Lions is a predominantly native community of 227 persons (1970). Residential use (67 single family units) predominates with some commercial and industrial uses. The industrial uses, primarily fishing and fish processing, are located at Port Wakefield, across Settlers Cove from Port Lions. Small boat mooring, a cannery dock and ferry dock, along with the Port Wakefield cannery are located on the east side of the Port Wakefield peninsula, one mile east of Port Lions. Port Lions has a saw mill that is currently inoperable.

Commercial fishing constitutes the primary economic base of Port Lions. Kizhuyak and Marmot Bays are fished for pink and silver salmon, shrimp, and tanner crab. Boats from Port Lions also fish Kazakof and Izhut Bays. The Wakefield Seafood Cannery at Port Wakefield is a major source of employment for the town of Port Lions. Additional employment is generated by a cafe, a hotel, a general store, the Kodiak Electric Association generating plant, and the Alaska Marine Highway System. Port Lions subsistance hunting and fishing base is slightly greater than 50 percent.

The existing infrastructure at Port Lions include a 36,000 gallon water supply, 13,000 gallon capacity sewage facility, solid waste disposal capability, KEA electrical service to Port Lions and Port Wakefield, telephone service, ferry dock, kindergarten through grade 10 education, volunteer fire department, law enforcement, a health aid and a general store, water supply and sewage service have some extra user capacity available. Housing at Port Lions is currently at capacity.

Port Lions operates a 2600 foot gravel airstrip and is served by Kodiak Western flights between Port Lions and Kodiak six days a week. During the summer months, Klondike Airways runs between Port Lions and Anchorage three times a week. The Alaska State Ferry Tustemena serves Port Lions once a week nine months of the year. Supplies are also transported between Port Lions and Kodiak by fishing boats. Port Lions has a gravel surface street system with 4.2 miles of state roads which also serve the Port Wakefield area. A borough maintained boat launching ramp is located on Anton Larsen Bay seven miles from Port Lions. The Port Wakefield dock is 75 feet long with a face 19 feet above mean low water. The Kodiak Airport is located 16.8 miles ESE of Port Lions.

The area surrounding Port Lions is locally used for recreation and subsistance hunting and fishing, with some guided hunting by out-of-town residents for deer and bear. Anton Larsen Bay, seven miles to the east of Port Lions, receives some sport fishing and hunting use by Kodiak residents. There are four potential archaeological/historical resource sites within a 3.5 mile radius of Port Lions, one immediately on site, one two miles to the northeast, one three miles to the east, and one three miles to the southwest.

Site B - St. Paul Harbor

Refer to Figure B-3.

Biology. St. Paul Harbor, located adjacent to the town of Kodiak, has biological characteristics which favor the location of a service base. The area is presently stressed from reduced water quality as a result of seafood processing discharges and boat traffic. However, as with most locations on Kodiak, the area still supports viable rearing habitat for salmon, crab, and shrimp. Sea bird colonies are located at the entrance to the harbor and approximately three miles away the Buskin River system has an annual salmon escapement of 44,000 fish. Marine mammals, though present in the area, are in relatively low abundance and big game habitat would not be impacted sigificantly.

Socioeconomics. St. Paul Harbor is the principle harbor and fishing port of Kodiak Island, and is located with the municipality of Kodiak. Land use in the harbor area is primarily industrial and business, with some commercial and residential use. It is the island's largest and most overcrowded small boat harbor, and is the center for most of the island's fish processors. The National Marine Fisheries facilities are located a mile to the west of the harbor. Kodiak Electric Association and Kodiak Airlines facilities are located in the vicinity of St. Paul Harbor.

The primary economic base of St. Paul Harbor is commercial fishing. Eleven major canneries, major sources of employment and income for Kodiak residents, are located in the vicinity of St. Paul Harbor. Many of Kodiak's commercial businesses are located in the harbor area, as are many of the state and federal governmental offices.

The infrastructure of the Kodiak metropolitan area includes the Kodiak Electric Association, municipal water supply, school district with kindergarten through grade 12 education, junior college, full time fire fighting capacity, a hospital, solid waste disposal, telephone service, sewage disposal, ferry dock, and law enforcement. The water supply is currently being used to capacity, and housing is tight with a vacancy rate of under one percent for 1,218 units. The power demand is only 50 percent of the generating capacity, and demand on the sewage system is also 50 percent of capacity.

The city of Kodiak is the transportation hub of the Kodiak Island Archipelago. St. Paul harbor has high densities of fishing vessel traffic and has two city docks which receive and unload freight coming into Kodiak on a regular schedule. Each dock is 360 feet long by 64 feet wide. The Kodiak Western seaplane dock is located in St. Paul harbor and serves the entire island. The Kodiak Island Airport with a 7500 foot main runway is located 4.8 miles by road to the southeast from the inner harbor. The city of Kodiak operates a 2200 foot gravel strip 1.7 miles northeast of the harbor. The city has 13.6 miles of local roads, and state roads connect the head of Monashka Bay, Anton Larsen Bay, Cape Chiniak, Pasagshak Bay, and Saltery Cove.

St. Paul Harbor itself receives minimal recreational use. There are several city and state parks and facilities within a three mile radius of St. Paul Harbor. Chiniak Bay supports some recreation fishing, as does the Buskin River, six road miles to the southwest of town. The city of Kodiak itself has a bowling alley, camp grounds, ball park, swimming pool, two playgrounds, and two municipal parks, Fort Abercrombie State Park lies just outside the city limits to the northwest, with camping and day use facilities. The city of Kodiak contains two important sites that are on the National Register of Historic Places. The Erkine House, once the headquarters of the Russian American Company, was erected by Alexander Baranoff in 1793 and is located in downtown Kodiak. Fort Abercrombie State Historic Site is located in Fort Abercrombie State Park, five miles north of the city of Kodiak. This site dates back to the construction of defense installations during the early part of World War II.

Site C - Womens Bay

Refer to Figure B-4.

Biology. Womens Bay, as part of the Chiniak Bay system, provides rearing habitat for such species as shrimp, crab, and salmon. Confined shoreline of the bay is approximately 12 miles and four sea bird colonies are located within the system. Salmon escapement is approximately 68,000 fish which return to four stream systems (Buskin River return is 44,000 fish).

Socioeconomics. The Womens Bay site is located at Shannon Point on the western shore of Womens Bay, approximately 3/4 mile southwest of the Kodiak Coast Guard Station and six miles southwest of the city of Kodiak. It is under Coast Guard jurisdiction and is a Priority 1 selection of Lesnoi, Inc. The site is occupied by structural remains of an old dock complex and has no current use. The Kodiak Island Borough has discussed developing a small boat harbor at that site with Koniag, Inc. NOAA operates support facilities for two research vessels across from the site, and the Kodiak Coast Guard Base has residential, light industrial, military and harbor land use. The Bells Flat residential area lies three miles south of the site.

The Coast Guard station constitutes the principal economic activity in the site area. The station employs local and out-of-town residents and provides some revenue for local business establishments. Some commercial fishing for chum and pink salmon occurs in Womens Bay.

There is no existing infrastructure at the immediate site. The Coast Guard station has its own infrastructure, separate from the municipality of Kodiak, that includes power generation, water supply, sewage and solid waste disposal, base hospital, education, fire fighting equipment, and law enforcement. In the past, some Coast Guard housing has been made available to Kodiak residents, but this policy has been terminated.

Womens Bay has a maintained shipping channel marked with navigation aids from its entrance on Chiniak Bay to the NOAA facilities. Coast Guard and NOAA vessels use this channel moving in and out of their facilities, and fishing boats are present in the bay during the salmon seasons. A paved road connecting Cape Chiniak with Kodiak borders the site. Kodiak is 6.6 road miles to the northeast and Cape Chiniak is 34 road miles to the east. The Kodiak Airport is two road miles northeast of the site.

Recreation activity in Womens Bay is concentrated around Russian Creek at the head of the bay and the Buskin River at the mouth where sport fishing occurs. The Coast Guard station has recreational facilities for its personnel, and some deer hunting occurs in the hills above the bay.

One potential archaeological/historical site is located in the immediate vicinity of Site C. Two others lie nearby, one approximately 1/2 mile to the north and one two miles south across Womens Bay at its head.

Site D - Old Harbor

Refer to Figure B-8.

Biology. Old Harbor, located in Sitkalidak Strait, like St. Paul Harbor, offers distinct advantages for siting a service base. The site itself is not within a major avian staging area, although sea bird colonies are present adjacent to the site. The offshore waters are considered important to the rearing of crab and shrimp; however, salmon escapement in the immediate site vicinity is low.

Socioeconomics. Old Harbor is a predominantly Native community with a population of 290, 53 miles southwest of Kodiak. The site is located within the city of Old Harbor and the core township selected by the Old Harbor Village Corporation. Residental use (54 single unit dwellings) dominates Old Harbor land use, with the Marine View Fish Cannery and store constituting some commercial use. Old Harbor is currently surrounded by the Kodiak National Wildlife Refuge, which is managed for wildlife habitat and open space. Native corporation land selection will change the ownership status of the land surrounding Old Harbor.

Commercial fishing is the primary economic base of Old Harbor. The Sitkalidak Strait is currently closed to shrimp fishing, however boats fish locally for salmon and tanner crab and travel from Old Harbor to shrimp and king crab fishing grounds. The freezer ship Sonya, representing the Marine View Fish Cannery, currently inoperable, normally employs Old Harbor residents. Several residents work in the Shearwater Bay Cannery off of Kiliuda Bay to the north. The processing industry in Old Harbor is hampered by the lack of an available industrial water supply. The community is currently 50 to 60 percent dependent on subsistence hunting and fishing.

Old Harbor infrastructure consists of a 100,000 gallon capacity water supply, 3000 gallon septic sewage disposal system, diesel fueled electricity generation, solid waste disposal, in-town telephone system, kindergarten through grade 10 education, volunteer fire department, state trooper, and a post office.

The community has a 2000 foot gravel airstrip and receives one Kodiak Western flight a day, six days a week. The Kodiak Airport is located 49 miles to the northeast. Old Harbor's dock facilities consist of a 32 foot by 64 foot dock 15 feet above mean low low water, used by fishing vessels and a tanker that delivers fuel oil to the community. A 67 foot dock extension proposal is before the Army Corps of Engineers. The community has a 12 boat capacity small boat harbor with transient floats that is not sufficient to meet current needs.

Community recreation resources consist of a pool hall and a movie theater. Subsistence hunting and fishing takes place in the vicinity of Old Harbor and out-of-town recreation use of the wildlife refuge, based out of Old Harbor, is increasing, attracted by hunting, fishing, and archaeological resources.

Old Harbor is located in an area rich in potential archaeological/historical resources. Two potential sites lie within two miles of the community to the west, and two additional sites lie approximately three miles to the northeast of Old Harbor. (For additional information on the area's archaeological resources, refer to the Site 16 and 17 descriptions.)

APPENDIX C

C.1 BIOLOGICAL IMPACTS AND MEASURES

The construction and operation of a service base, oil terminal and storage tanks, and pipeline have several types of impact producing actions: (1) surface disturbance resulting in habitat loss and/or modification; (2) water withdrawal; (3) atmospheric emissions: (4) disposal of liquid waters; (5) human presence and noise; and (6) accidents resulting in discharge of toxic material (such as oil, drill mud components). A discussion of the type of impact on individual populations of Kodiak organisms is presented in the Western Gulf - Kodiak Draft EIS prepared by the Alaska Outer Continental Shelf Office and will not be repeated here except to illustrate the reasoning for selection of certain measures.

Two types of impacts on the ecosystems of Kodiak can occur.

- Those impacts which directly affect individuals within the population, and
- Those impacts which affect the quality of habitat and indirectly affect the individual and/or population.

An example of the first category is overfishing. The fished population has the reproductive potential to recover but is inhibited from doing so because of harvest rates. With the cessation of fishing the population can begin recovering, although recovery rates may be lengthy. However, in some populations, if reduced below a certain reproductive level, recovery may not be feasible (some whale populations are thought to be in this predictament). The second type of impact is characterized by a change in habitat quality (e.g. some physical parameter changes) so that a population is reduced with no chance of recovery. A common impact to anadromous fish streams is siltation and sedimentation which alter the bottom characteristics such that spawning is not successful. From a philosophical viewpoint, impacts on populations are generally less serious than habitat alterations. The reasoning behind this is that if the habitat has biologically remained capable of supporting the population the population has the potential to recover from direct impacts to it. This consideration was incorporated into the selection of the following measures. They are discussed below relative to some of the types of expected impacts from onshore development.

Salmon Escapement

In an effort to assess the potential for impact of pipeline construction and operation on stream resources, salmonid escapement to each stream was determined from data supplied by the Alaska Department of Fish and Game.

The potential for impact to stream resources is two-fold. First, during pipeline construction impacts to individuals and habitat may occur. Common impacts to stream systems resulting from onshore pipeline construction are:

- siltation and sedimentation altering spawning and rearing habitat;
- blockage of migration routes, especially during critical periods;
- spillage of oil and other toxic materials to the system from accidents;
- water withdrawal and dewatering of the system and associated entrapment/impingement;
- material removal (gravel);
- channel changes;
- blasting; and
- debris introduction and clearing of stream bank vegetation.

Second, operational impacts to the stream system are generally reduced if proper construction techniques are utilized and operational monitoring is implemented. However, the crossing of any stream system or drainage with an oil pipeline provides some probability of the accidental introduction of toxic materials to the stream.

While salmon have been used as the index to stream impacts, it should be noted that alteration of stream habitat by any of the above will affect the total fauna of the system. Adequate data was available on salmon populations of these systems, and therefore salmonid escapement (number of fish making it to a stream to spawn after harvest) was selected as the measure for reflecting stream system impacts.

Bay Habitat

A three point scale was developed to characterize the general biological features of the potential bay sites. The following scale is intended as a relative comparison only and does not reflect the absolute productivity of these systems.

1 = A bay similar to Monashka, which has salmon escapement to the bay of less than 20,000 fish; a confined bay with around 15 miles of shoreline of which at least 50 percent is covered by organisms; a shrimp production less than 2 million pounds; and limited or no kelp beds.

2 = A bay similar to Kazakoff, which has salmon escapement near 60,000 fish; a confined bay with around 30 miles of shoreline of which at least 50 percent is covered by organisms; shrimp production between 2 and 7 million pounds, and limited kelp beds.

3 = A bay similar to Ugak, which has salmon escapement near 120,000 fish; approximately 50 miles or greater of confined shoreline, 50 percent or more which is covered by organisms; shrimp production greater than 7 million pounds (which is the historical record for Ugak), and extensive kelp beds.

The types of impacts expected to occur in the bay systems of Kodiak are varied and also result in habitat modification and impacts to individual populations. During construction of the marine pipeline and shore facilities, similar impact producing actions as those described for the onshore pipeline will occur. For example, disruption of bottom organism will be associated with gravel removal, dredging, and construction. Water withdrawal from nearby streams may be necessary and blasting at some sites may be required. The long-term effect of these activities on the bay systems is dependent on a number of variables which cannot be assessed fully at this time. However, as a general rule, we determined that it is more acceptable to locate a terminal in a bay that is less productive, if all other criteria are equal.

A consideration used in the bay habitat classification was the number of miles of confined shoreline. In general, major impacts of accidental spills of toxic materials are magnified if the material reaches a nearshore, intertidal area. Materials which remain in the open sea can be diluted and degraded at a much faster rate. Therefore, confined bays have a greater potential for serious impact from spills. However, containment of material, such as oil, is usually easier in confined protected bays. Evaluation of weather data and containment limitations of cleanup gear indicates that the bays of Kodiak are suitable for containment in most weather situations, except those storm periods when wave heights exceed six feet in the bay.

Land Mammal Concentrations

A four point scale was developed to assess the impact of locating a facility in a mammal concentration area. The scale is:

0 - no significant concentration of land mammals
1 - elk and/or deer only
2 - bear
3 - elk, deer, and bear

Location of a facility in a mammal concentration area results in the direct removal of habitat. In addition, the presence of human population and noise may result in a greater area of effect than just the immediate site area. For instance, our experience on the trans-Alaska Pipeline indicates that feeding of wild animal populations was a serious problem.

It should be noted that a mammal concentration area usually indicates a vital area to the continuing maintenance of that population. In the Kodiak/Afognak area the main concentration areas for mammals are associated with over-wintering sites (deer, elk, and bear) and feeding areas (bear). In addition, deer and elk have been introduced onto the islands and therefore have received less importance in the scale than bear, a natural component of the system. While deer and elk are politically important, their role in the functioning of the natural system is questionable.

Vegetation Removed by the Pipeline

Associated with the overland pipeline is the clearing of a right-of-way. Therefore, a measure to assess the impact of this activity is the number of acres of vegetation impacted by pipeline construction and operations, assuming 100 foot right-of-way and a buried pipeline. No attempt was made to differentiate different vegetative associations. It should be recognized though that wetland areas are more sensitive than other areas and are biologically more important.

Number of Bays Crossed by the Overland Pipeline

This measure reflects the exposure of different bays to construction and operation of a pipeline from different find areas and the associated overland route. The number of bays crossed has been standardized to the equivalent crossing of a bay similar to Kazakoff (e.g. the crossing of Ugak Bay is equal to crossing the equivalent of two Kazakoff Bays).

Sea Birds

Seabird colonies and numbers were used as a general index to bay productivity and as sensitive areas. Numbers represent the maximum number of birds that could be affected as the source documents presented only a range for population estimates. The overall impact of development is not expected to be significant to these colonies. However, noise from tanker traffic may affect nesting success and accidental spills may impact individuals. Where the same number of birds are involved, it is usually better to have more colonies. With fewer colonies an impact to a single colony will affect more of the total bird population (e.g., disturbance during nesting by oil tanker traffic).

C.2 SOCIOECONOMIC IMPACTS AND MEASURES

Onshore facilities will create socioeconomic impacts on Kodiak both separate from and incremental to other OCS development and production activities. The principal impact producing actions are (1) surface disturbance, (2) water withdrawal, (3) atmospheric emissions, (4) liquid and solid waste disposal, (5) human and facility presence (asethetic, visual, noise), (7) construction and operation personnel influx, and (8) accidents resulting in a discharge of toxic materials (oil, drilling muds). Socioeconomic sectors susceptible to impacts are economic (fishing), land and water use, recreation, archaeological/historical resources, population and support facilities, and sociocultural lifestyle. In the measures used to evaluate site impact sensitivity, often a distinction will be made between short-term (1-2 years) and long-term (project life or longer, $\geq$ 20 years) impacts when constructing scales and assigning site values. Impact assessments of Western Gulf OCS development are presented by the Alaska Outer Continental Shelf Office (BLM) and Simpson Usher Jones, Inc. in their Kodiak Island Borough Outer Continental Shelf Impact Study.

The scales for each socioeconomic sector are based on a combination of categories: impact levels, impact producing actions, and socioeconomic activity levels, depending on the amount of available quantitative data. Because site specific data is lacking in several socioeconomic sectors, many of the values assigned are relative levels. For some sectors, such as land use and archaeological/historical resources, uniform data on zoning classification, land uses, and known resources can be used to differentiate between sites. In other cases, potential impacts (facility demands, sociocultural lifestyle) and impact producing actions (demographic) more accurately reflect site sensitivity for the ranking process. As conditions change (e.g. land ownership status, housing, and water supply) and more data becomes available, these scales can be revised. It should be emphasized that where impacts, both positive and negative, are the same at every site, (e.g. borough tax revenue generated) they fail to differentiate between sites and have not been used to compare sites.

Land Use

Potential land use impacts resulting from OCS facilities siting have been measured in terms of potential zoning, use and ownership (management policy) conflicts. The Kodiak Island Borough has recently finished updating Borough zoning, resulting in a large amount of previously unclassified land now zoned for conservation.

A zoning conflict is created when the proposed use does not comply with the zoning requirements. A zoning variance, however, can be granted to allow use that does not conform to current zoning. For example, land zoned conservation could be used if a variance were granted for OCS related facilities. For the purpose of ranking sites, a use conflict is defined as the proposed use being incompatible with existing use (industrial in a residential area) on or in the vicinity of a proposed site. Ownership conflicts apply to sites under the jurisdiction of federal and state governmental agencies.

Current zoning classifications were obtained from the Kodiak Borough Planning Department, and land useage and ownership was derived from data supplied by Koniag, Inc. the Bureau of Land Management Western Gulf Draft Environmental Impact Statement, the U.S. Forest Service Perenosa Timber Sale Environmental Impact Statement, and the Kodiak Island Borough Outer Continental Shelf Impact Study, supplemented by site reconnaissance. The scale is:

- 0 - no current use or ownership conflict
- 1 - zoned conservation but no current use/ownership conflicts
- 2 - zoned conservation and use conflicts in vicinity of site
- 3 - zoned conservation and use conflicts on and in vicinity of site
- 4 - ownership conflicts with regulatory procedure - U.S. Forest Service, U.S. Fish and Wildlife, U.S. Coast Guard, Alaska Department of Natural Resources, potential use conflicts.

Recreation

The entire Borough of Kodiak is a potential recreation area, and use is determined by access, population location, existing facilities, and federal and state lands management policy. In terms of user-days per activity, recreation use is concentrated around the island communities and their associated road systems. Remote but developed facilities such as the Chugach National Forest cabins on Afognak Island also receive intensive use during the summer and hunting seasons. Use of areas like the Kodiak National Wildlife Refuge is limited by lack of facilities and high transportation costs. The construction and operation of service bases and onshore oil terminals with associated pipelines, and supply boat/tanker traffic could impact recreation use in the vicinity of facility sites. The principal impacts that could occur are recreation facility loss or displacement, habitat alteration or loss (affecting fishing and hunting), and deterioration in recreation quality caused by increased use or aesthetic (visual, noise) impacts.

Because user/visitor statistics are not available on a site by site basis, measures for recreation use are based on known and proposed recreation areas and facilities, access, and population proximity. The Bureau of Land Management's Outer Continental Shelf Office, Alaska Department of Natural Resources and The Office of Community and Regional Affairs data were supplemented by site visits. The scale is:

- 0 - no recreation facilities or use
- 1 - quasi recreation (no measureable use at present but managed for recreation purposes, or use limited by lack of access)
- 2 - local use by approximately 100 people
- 3 - recreational facilities present and/or used heavily because of access to Kodiak "metropolitan" area.

Archaeological/Historical

With a documented archaeological record encompassing 6000 years of settlement on Kodiak and nearly 200 years of European presence on the island archipelago, this area is rich in known and potential archaeological/ historical resources. Many potential resource sites have been identified through a series of archaeological investigations. Other sites of historic and cultural importance to Kodiak Natives have been selected for conveyance to Native Regional Corporations under Section 14(h)(1) of the Alaska Native Claims Settlement Act of 1971. Sites which have been approved for transfer will be considered as eligible for inclusion on the National Register of Historic Places. In addition, the Department of the Interior, the National Advisory Council for Historic Preservation, and Alaska State Historic Preservation Officer have identified seven sites as being on or eligible for inclusion in the Register. Three of these are Fort Abercrombie State Historic Site, the Three Saints Bay Archaeological District, and Archaeological Site 49 AF 3; these are located within two miles of potential sites or along a potential pipeline route.

Construction and operation could have three general effects on archaeological and historical resources: accidental destruction, discovery and identification of new resources, and aesthetic impact on use and enjoyment of those resources. In turn, the presence and time needed for proper recovery of archaeological/historical sites could create delays in facility construction. For the purpose of ranking sites, the presence and density of potential historical sites, sites selected under ANCSA (14(h)(1), sites eligible for or on the National Register of Historic Places and potential archaeological/historical sites as identified by the Bureau of Land Management's Outer Continental Shelf Office in their Western Gulf Draft Environmental Impact Statement were used as indicators for resource presence and potential damage resulting from site location. Three values ranging from 0 to 2 have been chosen to approximate the range of potential impact as follows:

0 - no potential sites or areas selected under ANCSA 14(h)(1) or sites in the National Historic Register are present in the immediate vicinity

1 - a single site and/or area selected under ANCSA 14(h)(1) or a site in the National Historic Register is in the immediate vicinity of the site

2 - the site is documented as historically/archaeologically important <u>or</u> a cluster (3) of potential sites in immediate project area.

<u>Demography/Municipal Facility Demand</u>

A measure was needed that would reflect site demands made on Kodiak Island community infrastructures, city services (such as power, water, transportation), and housing created by OCS related facilities and by personnel who may reside in those communities by choice or necessity. Two measures were developed: demographic and facility demands. Demographic demands are delineated by incremental additions of population to the City of Kodiak and other communities, in order of severity on those communities. Population increase projections were extrapolated from BLM Western Gulf DEIS, Alaska Department of Community and Regional Affairs, and industry personnel requirement estimates. Site demographic increase sensitivity is measured on a 0-4 point scale:

1 - less than 100 people added to the City of Kodiak (remote service base)

2 - approximately 500 people added to the City of Kodiak (service base in city or remote oil terminal)

3 - approximately 100 people added to Old Harbor, Port Lions (local service base)

4 - 1000-1500 people potentially added to the City of Kodiak (oil terminal in city)

The second set of measures reflects the potential demands on city services, roads, and airport systems created by normal service base/oil terminal operations. It is assumed that C-130 cargo planes will be used to transport supplies and materials to all terminal sites except those where FAA regulations or economic convenience would prohibit use of a 5,500 foot airstrip. Temporary service bases would be located near existing transportation and service systems. Values assigned for service bases are not necessarily the same as values for oil terminals.

0 - no effect on Kodiak/Port Lions/Old Harbor service systems, roads, minimal effect on airports (personnel transfer only)

1 - no effect on Kodiak/Port Lions/Old Harbor service systems, minimal effect on airport, some effect on Kodiak road systems, and traffic levels

2 - no effect on Kodiak/Port Lions/Old Harbor service systems, cargo storage/transfer at airports, and some increase in Kodiak area road use and traffic levels

3 - potential use of or competition with Kodiak services (water), cargo transfer/storage at airports, increase in Kodiak metropolitan area road use and traffic levels

Harbor and Bay Use

Because of its fishing based economy and a high dependence on marine transportation (for shipping goods and passengers), the use of the open seas, bays, and harbors is important to Kodiak. The communities of Kodiak, Port Lions, Ouzinkie, and Old Harbor are the centers for water based commerce and fishing activities on the east side of the Borough. Any interference caused by construction activities, offshore pipelaying, and supply boat and tanker traffic can impact the marine based economics of these communities, although proper scheduling and supply storage and availability arrangements can avoid or mitigate these impacts. Potential impacts would include increased traffic levels, temporary obstruction in navigation (pipelaying), increased demand for dock and supply storage access, and increased demand on water and fuel supplies.

Facility site sensitivity to water use impacts are measured on a three point scale. Site evaluation under this category is based on harbor facilities and current capacity levels data from the Bureau of Land Management's Outer Continental Shelf Office Western Gulf Draft Environmental Impact Statement, the Kodiak Island Borough Outer Continental Shelf Impact Study, and the Army Corps of Engineers Near Island Boat Harbor Draft Environmental Impact Statement. Traffic density rankings were extrapolated from harbor proximity and information on relative fishing levels in site areas provided by the Kodiak United Fishermans Marketing Association. The values are:

0 - no interference

1 - some interference, primarily temporary navigation obstruction and high traffic densities

2 - severe interference; navigation obstruction, higher traffic densities, and decreased access to mooring, loading docks, and fuel

Fishing Economics

In terms of landings and their commercial value the town of Kodiak is the largest fishing port in Alaska. Fishing and related industries make up over one third of the employment of the Kodiak Borough. Onshore

OCS facilities may impact Kodiak fishing in several ways. The principal impact could be destruction of habitat through facility and pipeline construction which can reduce the numbers of organisms harvested. Oil spills from pipeline and tanker accidents, while low in probability, could impact bay productivity and catch levels. Navigation obstruction, which can cause delays and interrupt gear setting, and harbor related delays are discussed under Harbor and Bay Use.

Site sensitivity to fishing use and economics is reflected by commercial species diversity and the relative intensity of fishing at a site area. Because the catch statistics of pounds landed and dollar value have not been broken down by individual bays, species occurrence (BLM and ADF&G data) and relative fishing levels supplied by the United Fishermans Marketing Association have been used to determine the scale Values range from no fishing use or commercial importance (0) to heavy use with several species commercially fished on a year around basis and high catch levels:

0 - no fishing use, or commercial importance

1 - little use - one or two species commercially fished and/or low catch levels - bay not intensively fished seasonally or year around

2 - moderate use - one or two seasonally important species with intensive seasonal fishing and/or several species commercially fished year around with moderate catch levels

3 - heavy use - several species commercially fished on a year around basis with comparatively high catch levels.

Native Lifestyle Change

Construction of an oil terminal or service base and the associated overland pipeline could have temporary and permanent impacts on Kodiak Native lifestyle, depending on facility location. Most likely to be affected would be Native communities, and subsistence hunting and fishing activities that take place in the vicinity of those communities. Oil terminal construction could result in the temporary influx of roughly

500 workers into a community, or 150 in the case of service base. Such activity could provide jobs and lease revenues for local residents, but could tax local infrastructure, entice personnel away from other jobs, and disrupt community social structure. Pipeline and terminal construction, and service boat traffic have the potential to interfere with subsistence activities by destruction of habitat, disturbance of game, and physical interference with fishing activities. Many of these potential impacts can be mitigated or avoided by careful planning and consultation with affected communities.

For development of the measure of this impact, the Kodiak Island Borough Outer Continental Shelf Impact Study, BLM Western Gulf DEIS, and site reconnaissance were used as data sources. A five point scale was utilized:

0 - no impact on village proper or on subsistance hunting and fishing

1 - no impact on village proper but short term (pipeline construction) impact on subsistance hunting and fishing

2 - no impact on village proper but long term impact (terminal) on subsistance hunting and fishing

3 - social impact on village proper (terminal or service base) but no impact on subsistance hunting and fishing

4 - impact on village proper and short or long term impact on subsistance hunting and fishing.

C.3 ENGINEERING/COST IMPACTS AND MEASURES

Several engineering considerations were used to compare the alternative sites: topography, foundation conditions, proximity and alignment of active faults, subsidence potential, land slide potential, volcanic activity, material availability, and water availability. An evaluation of each of these factors was made using available reports, aerial photographs, and aerial and ground inspection of the sites. Because all of these factors influence site development costs, cost was utilized as the measure of engineering impact. The important aspects of each of these factors are discussed below.

In the construction of a dock, open and covered storage areas, and fuel oil/water storage for a service base it is not as critical to consider these engineering factors in siting. Therefore, we have assumed that the service base cost will not vary significantly due to these engineering factors because of the smaller acreage and nature of the facilities involved.

The major criterion for selecting a terminal site is distance from the oil find (pipeline costs will probably exceed the differences in construction costs). A secondary criterion from the construction feasibility standpoint is the topography at a site, which is related to the amount of soil and rock which must be examined.

There are many natural features at each oil terminal site that will require special considerations during the design of the facilities. In general, however, most of these considerations are applicable to each of the sites. The following paragraphs will discuss each of the factors considered in this comparison.

Topography

The topography at each site was examined. With careful planning it appears possible that slopes in excess of 15 percent can be avoided at all sites. Most sites have low, relatively flat areas which could be developed into an airstrip. All of the sites contain areas on which tank farms could be developed at an elevation of 50 feet above sea level or higher. To evaluate topography at each site, estimates were made of the earthwork that would be necessary to prepare tank sites and to prepare an airstrip.

To make these estimates the following assumptions were made: (1) earthwork costs would be \$5.00 per yard for soil and \$15.00 per yard for rock, (2) all tanks would be at an elevation of at least 50 feet above mean sea level, and (3) tank sites would require three flat benches 400 feet in width and 2000 feet in length.

Using these assumptions, the chart shown in Figure 3-3 was developed to relate earthwork volume and costs to percent slope. Templates representing an area 2000 by 2000 feet were used to represent a tank farm. The templates used in conjunction with aerial photographs and USGS topographic maps, were used to estimate the amount of earthwork that would be required in the tank farm areas. Flat areas at each site were designated as airstrip areas. Using the aerial photographs and the results of our field inspection, the percent of rock that would require excavation at each site was estimated.

Pipeline Length

To assess the cost of building a pipeline to a terminal at any of the sites evaluated, a find location was established as described in Chapter 2. Using the locations the pipeline was routed from each of the three locations to each of the potential terminal sites. Pipeline lengths are shown in Chapter 2.

To evaluate the effect of the pipeline routing on each site, the construction cost of each pipeline route was estimated. A rough estimate of the cost per mile on ground was one million dollars, and the estimated average cost per mile offshore was three million dollars. Using these numbers, the costs were calculated for each site from each of the three locations.

Foundation Conditions

Based on field inspections and review of available data, it is believed that, at any of the sites, the variation from site to site in foundation conditions probably would be no greater than the variation in coast of Kodiak. All of the sites which have been evaluated were at least one mile from these faults, and thus from the standpoint of ground rupture all sites are roughtly equivalent.

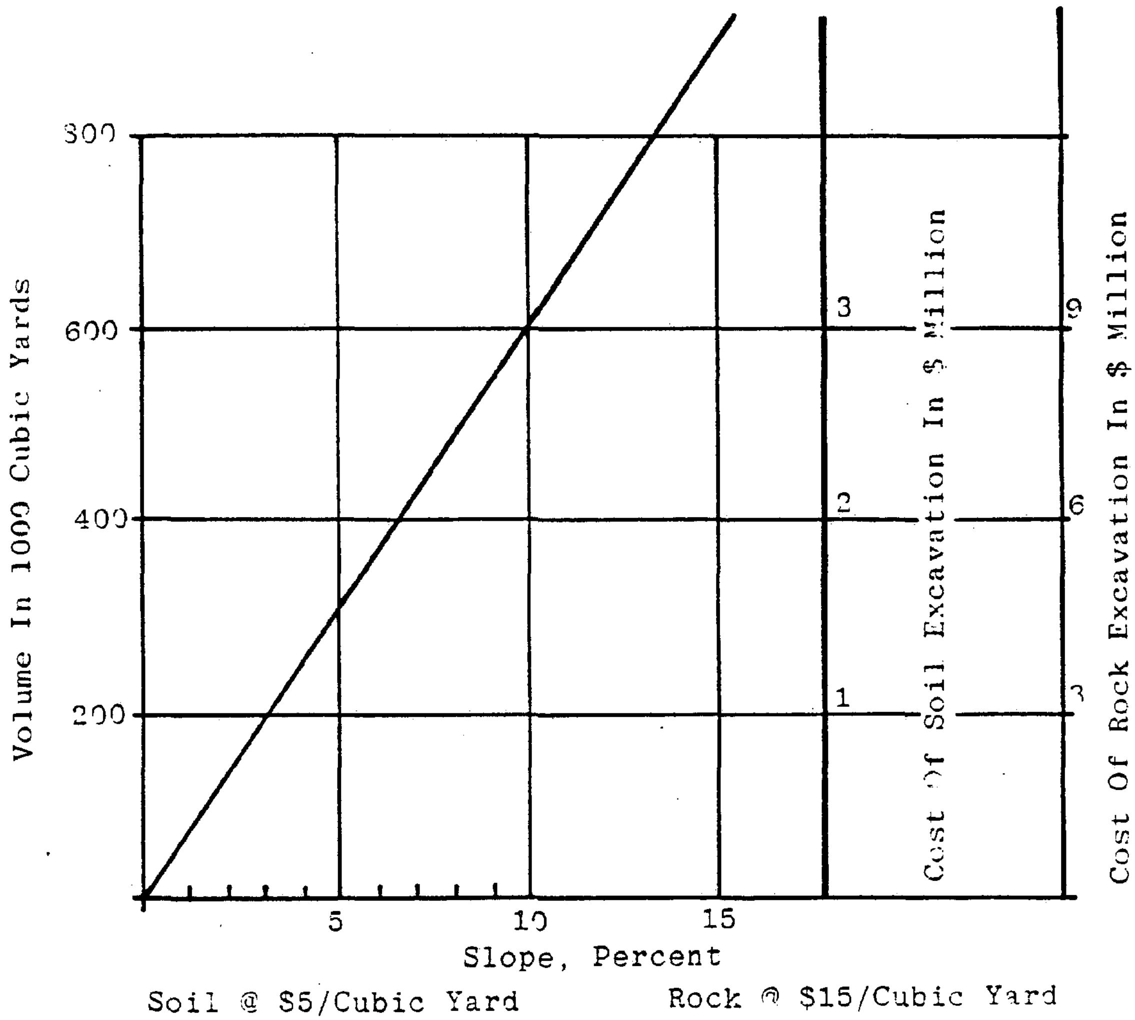
Ground motion effects on structures are based primarily on the energy released during the earthquake and the proximity of the structure to the epicenter. The epicenters are usually located along the faults, and the larger epicenters are usually associated with the longer faults. Therefore, the effects from local short faults can be far less then the effects from larger more distant faults. The entire island of Kodiak is in a very active seismic area, which is probably controlled more by movements along local short faults. For this reason it is not practical to differentiate between sites based on ground motion.

The primary type of ground failure that might be anticipated at some of the sites on Kodiak would be liquefaction. This would be especially possible in the sites in which deltaic deposits are found. Thus sites could be compared on the basis of these earthquake effects. But it is believed that during oil terminal design areas with a high probability of liquefaction can be avoided.

In general, the effect of a tsunami can be avoided by placing structures on ground higher than the tsunami itself. At all sites land foundation conditions at a given site (e.g., each of the sites contain areas in which reasonable foundations could be designed). Any additional costs that may be required at particular sites because of foundation conditions are anticipated to be much lower than the excavation cost at the site, and therefore probably insignificant in the comparison of the sites.

Earthquake Effects

In general, there are four earthquake effects that should be considered when siting a structure: ground rupture, ground motion, ground



SLOPE AND EARTHWORK COSTS

Figure C-1

failure, and tsunami. Ground rupture is usually associated with sites within several hundred feet of a fault which moves during an earthquake. Ground motion is the shaking that occurs as a result of an earthquake epicenter which could be many miles from the site. Ground failure refers to such phenomena as liquefaction during which soil loses its supportive strength and settles rapidly. Tsunami are the tidal waves that are generated by earthquakes at sea. These can be moving seawalls tens of feet in height.

To compare the potential terminal sites on the basis of earthquake effects one must consider each of the effects as they would impact each of the sites. As noted above, ground rupture is usually associated with sites close in to faults which rupture during an earthquake. To avoid such faults sites are usually selected away from faults which are known to be active, that is, faults that have moved in recent geologic time. For the purposes of this study, sites more than a mile from a known active fault or potentially active fault were determined to be adequate. The determination of the activity of a fault requires detailed study. No such study was conducted during this evaluation; and to our knowledge, no such study has been completed by others. In the Western Gulf - Kodiak Draft EIS, graphic 12, younger faults were shown on the southeast is available at an elevation is excess of 50 feet above sea level. It was felt that if tank farms were located on this higher ground the effects of tsunami would be minimized. Therefore it was assumed that all the tank farms would be above fifty feet and effective costs as a result of tsunami would be those generated by the extra earthwork that would be necessary to prepare tank sites on this higher ground. This factor has been taken into account in the earthwork cost measure.

Water Availability

It was assumed that a one hundred gallon per minute water source would be adequate to supply an oil terminal since the cost of a well or series of wells capable of producing a hundred gallons per minute would be less than 25 thousand dollars.

Volcanic Activity

The entire island of Kodiak is subject to volcanic activity. Probably the most significant effect from a volcano on Kodiak was in 1912 when the Katmai Volcano erupted and deposited approximately one foot of volcanic ash in the area. Each of the sites is equally subject to such an effect in the future, and therefore volcanic activity cannot be used as a descriminatory criteria in comparing the sites.

C.4 SUMMARY OF SELECTED MEASURES

Table C-1 summarizes the measures used in this study. For each measure, a range is provided indicating some of the impact levels which a site may have. The set of measures in this table has certain properties which aided the formal analysis. The measures effectively reflect the impacts relevant to comparing sites from the original list of areas of concern. The total number of measures is manageable, thus simplifying the problem. They are in fairly distinct and separate areas which made it easier to decompose the problem, work on the separate parts, and combine the results. The measures are operational in being practical to use and reasonably well defined (e.g., not ambiguous). None of the measures appear redundant by double counting an impact which has already been accounted for by another measure.

Each measure is given a symbolic label X_i. The symbolic notation will be useful later in referring to measures and impact levels (see, especially, Appendix A).

Table C-1 SUMMARY OF MEASURES USED TO COMPARE SITES

General Concern	Measures	Good Level*	Poor Level*
Cost (Minimize cost beyond base cost of facility)	X_1 Cost of pipeline and excavation beyond a base site (millions of dollars)	$0	$500
Biological	X_2 Bay Habitat	1 (Monashka)	3 (Ugak)
(Minimize biological impact)	X_3 Salmon escapement in thousands	14	250
	X_4 Land Mammals	0 (none)	3 (bear, deer, elk)
	X_5 Vegetation removal due to overland pipeline in acres	0	1400
	X_6 Number of "standard" bays crossed by pipeline (excluding bay with oil terminal)	1	5
	X_7 Number of seabirds in thousands	10	400
	Number of seabird colonies	30	5

* Relatively speaking. Impacts for the most part fall within those ranges. Extrapolation outside these ranges is permitted. See measure descriptions for more complete explanation of the levels on the subjective scales.

Table C-1 (continued)

General Concern	Measures	Good Level*	Poor Level*
Socioeconomic			
(minimize socio-economic impact)	X_9 Recreation	0 (no facilities)	3 (heavy use)
	X_{10} Archaeological historical	0 (no areas near site)	2 (important area on site)
	X_{11} Land Use	0 (no conflict)	4 (ownership conflict)
	X_{12} Lifestyle	0 (no impact)	4 (impacts on village and subsistence activity)
	X_{13} Harbor (water) Use	0 (no interference)	2 (severe navigational and mooring interference)
	X_{14} Fishing Economics	0 (no fishing)	3 (heavy catches and fishing year round)
	X_{15} Demographic (Demands on housing, schools, lifestyle)	1 (relatively small induced population increase)	4 (relatively large induced population increase)
	X_{16} Special demands on local facilities	0 (no effect on roads, water, airport)	3 (significant use of roads, water, airport)