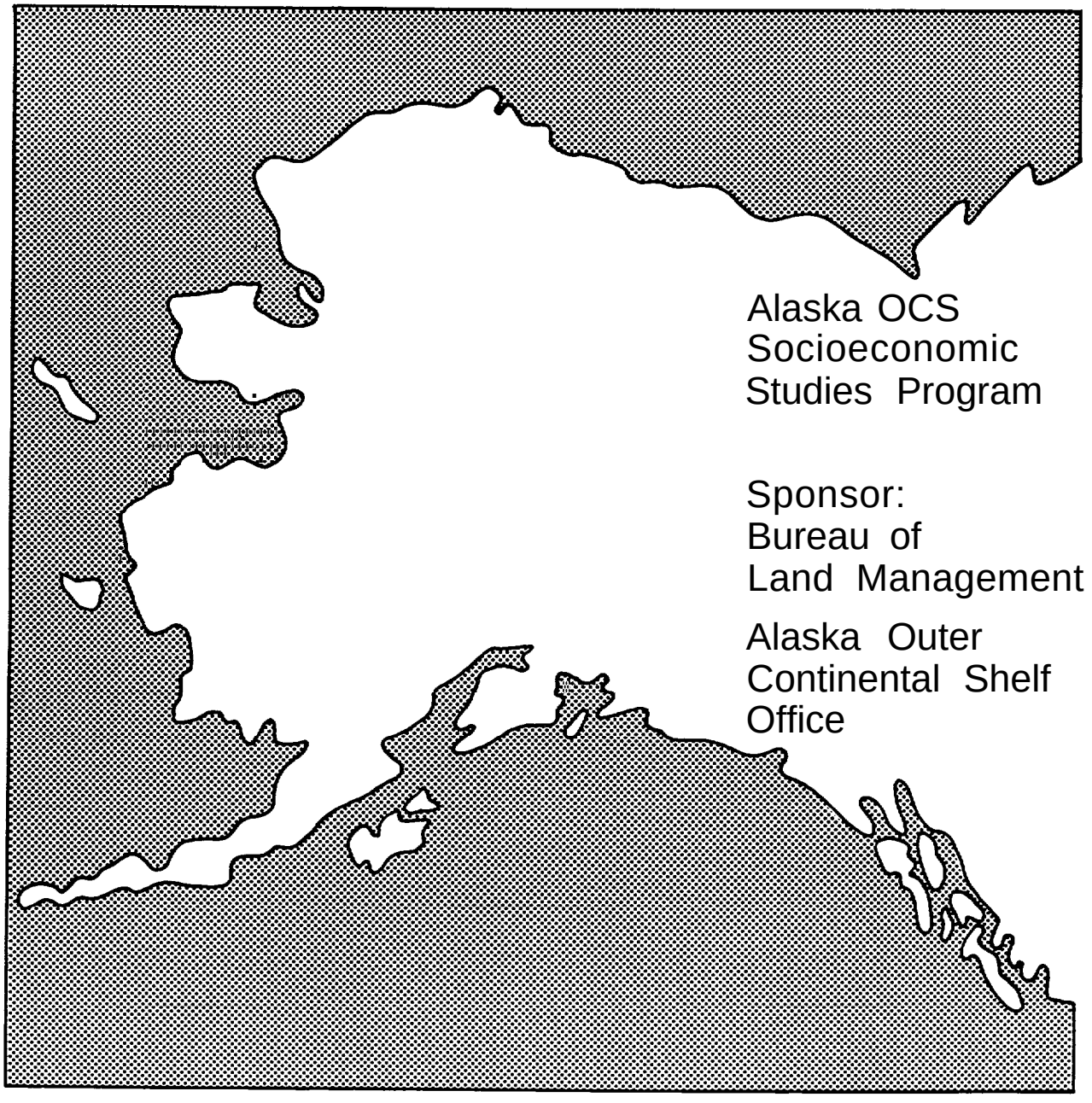
Technical Report
Number 43a



Alaska OCS
Socioeconomic
Studies Program

Sponsor:
Bureau of
Land Management

Alaska Outer
Continental Shelf
Office

Lower Cook Inlet and Shelikof Strait Petroleum Development Scenarios

Executive Summary

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

The Alaska OCS Socioeconomic Studies Program is a multi-year research effort which attempts to predict and evaluate the effects of Alaska OCS Petroleum Development upon the physical, social, and economic environments within the state. The overall methodology is divided into three broad research components. The first component identifies an alternative set of assumptions regarding the location, the nature, and the timing of future petroleum events and related activities. In this component, the program takes into account the particular needs of the petroleum industry and projects the human, technological, economic, and environmental offshore and onshore development requirements of the regional petroleum industry.

The second component focuses on data gathering that identifies those quantifiable and qualifiable facts by which OCS-induced changes can be assessed. The critical community and regional components are identified and evaluated. Current endogenous and exogenous sources of change and functional organization among different sectors of community and regional life are analyzed. Susceptible community relationships, values, activities, and processes also are included.

The third research component focuses on an evaluation of the changes that could occur due to the potential oil and gas development. Impact evaluation concentrates on an analysis of the impacts at the statewide, regional, and local level.

In general, program products are sequentially arranged in accordance with BLM's proposed OCS lease sale schedule, so that information is timely to decisionmaking. Reports are available through the National Technical Information Service, and the BLM has a limited number of copies available through the Alaska OCS Office. Inquiries for information should be directed to: Program Coordinator (COAR), Socioeconomic Studies Program, Alaska OCS Office, P. O. Box 1159, Anchorage, Alaska 99510.

Technical Report No. 43a

ALASKA OCS SOCIOECONOMIC STUDIES PROGRAM
LOWER COOK INLET AND SHELIKOF STRAIT
OCS LEASE SALE NO. 60
PETROLEUM DEVELOPMENT SCENARIOS

EXECUTIVE SUMMARY

Prepared for

BUREAU OF LAND MANAGEMENT
ALASKA OUTER CONTINENTAL SHELF OFFICE

Prepared by

DAMES & MOORE

July 1979

Contract No. AA550-CT6-61,
Task 9BB

Job No. 8699-017-20

NOTICES

1. This document is disseminated under the sponsorship of the U.S. Department of the Interior, Bureau of Land Management, in the interest of information exchange. The U.S. Government assumes no liability for its content or use thereof.

2* This executive summary is designed to provide preliminary petroleum development data to the groups working on the Alaska OCS Socio-economic Studies Program. The assumptions used to generate off-shore petroleum development scenarios may be subject to revision.

3. The units presented in this report are metric with American equivalents except units used in standard petroleum practice. These include barrels (42 gallons, oil), cubic feet (gas), pipeline diameters (inches), well casing diameters (inches), and well spacing (acres).

4. Cross referencing in this executive summary refers to the relevant chapter, section, or appendix in the final report (Technical Report No. 43) where expanded discussion of the topic may be found.

ALASKA OCS SOCIOECONOMIC STUDIES PROGRAM
Lower Cook Inlet and Shelikof Strait
OCS Lease Sale No. 60
Petroleum Development Scenarios
Executive Summary

Technical Report No. 43a

Prepared by

DAMES & MOORE

July 1979

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Purpose

In order to analyze the socioeconomic and environmental impacts of Lower Cook Inlet and Shelikof Strait petroleum exploration, development, and production, it is necessary to make reasonable and representative predictions of the nature of that development. The petroleum development scenarios in this report serve that purpose; they provide a "project description" for subsequent impact analysis. The socioeconomic impact analysis of the Lower Cook Inlet and Shelikof Strait petroleum development postulated in this report will be contained in a subsequent report of this study program.

Particularly important to socioeconomic studies are the manpower, equipment, and material requirements, and the scheduling of petroleum development. The scenarios have to provide a reasonable range of technological, economic and geographic options so that both minimum and maximum development impacts can be discerned. The primary purpose of this report is, therefore, to describe in detail a set of petroleum development scenarios that are economically and technically feasible, based upon available estimates of oil and gas resources of the Lower Cook Inlet and Shelikof Strait.

It should be emphasized that this petroleum scenarios report is specifically designed to provide petroleum development data for the Alaska OCS socioeconomic studies program. The analytical approach is structured to that end and the assumptions used to generate scenarios may be subject to revision as new data becomes available. Within the study programs that are an integral part of the step-by-step process leading to OCS lease sales, the formulation of petroleum development scenarios is a first step in the study program coming before socioeconomic and environmental impact analyses.

This study, along with other studies conducted by or for the Bureau of Land Management, including the environmental impact statements produced

preparatory to OCS lease sales, are mandated to utilize U.S. Geological Survey estimates of recoverable oil and gas resources in any analysis requiring such resource data.

1.2 Scope

The petroleum development scenarios formulated in this report are for the proposed Lower Cook Inlet and Shelikof Strait OCS lease sale no. 60[1] currently scheduled for August 1981. This is a second generation lease sale following and earlier lower Cook Inlet lease sale CI[1] held on October 27, 1977. In that sale a total of 87 tracts were leased of the 135 that were offered; the leased tracts comprise 200,448 hectares (495 ,307 acres) which is approximately 22% of the total federal acreage in lower Cook Inlet.

The study area considered in this investigation (Figure l-l) is the area of the call for nominations for Sale 60 which consists of all the unleased federal tracts of lower Cook Inlet and all of the federal waters of Shelikof Strait extending from Cape Douglas in the northeast southwest about a line drawn between Middle Cape (Kodiak Island) and Cape Igvak (Alaska Peninsula) at the southwestern entrance of the strait. The lower Cook Inlet tracts are located in water depths ranging from less than 30 meters (100 feet) in the northern part of the sale area south of Kalgin Island to 183 meters (600 feet) at Kennedy Entrance; over 50% of this area lies in water depths between 46 and 76 meters (150 and 250 feet). Water depths in Shelikof Strait range from 91 meters (300 feet) in the northeast to over 303 meters (1 ,000 feet) at the southwestern entrance.

The scope of work for this study did not include an evaluation of the natural environment (oceanography, geology, geologic hazards, biology), land status and environmental regulations with which to assess the

(1) Henceforth in this report for the purpose of brevity, these lease sales are referred to as "Sale 60" and "Sale Cl" respectively.

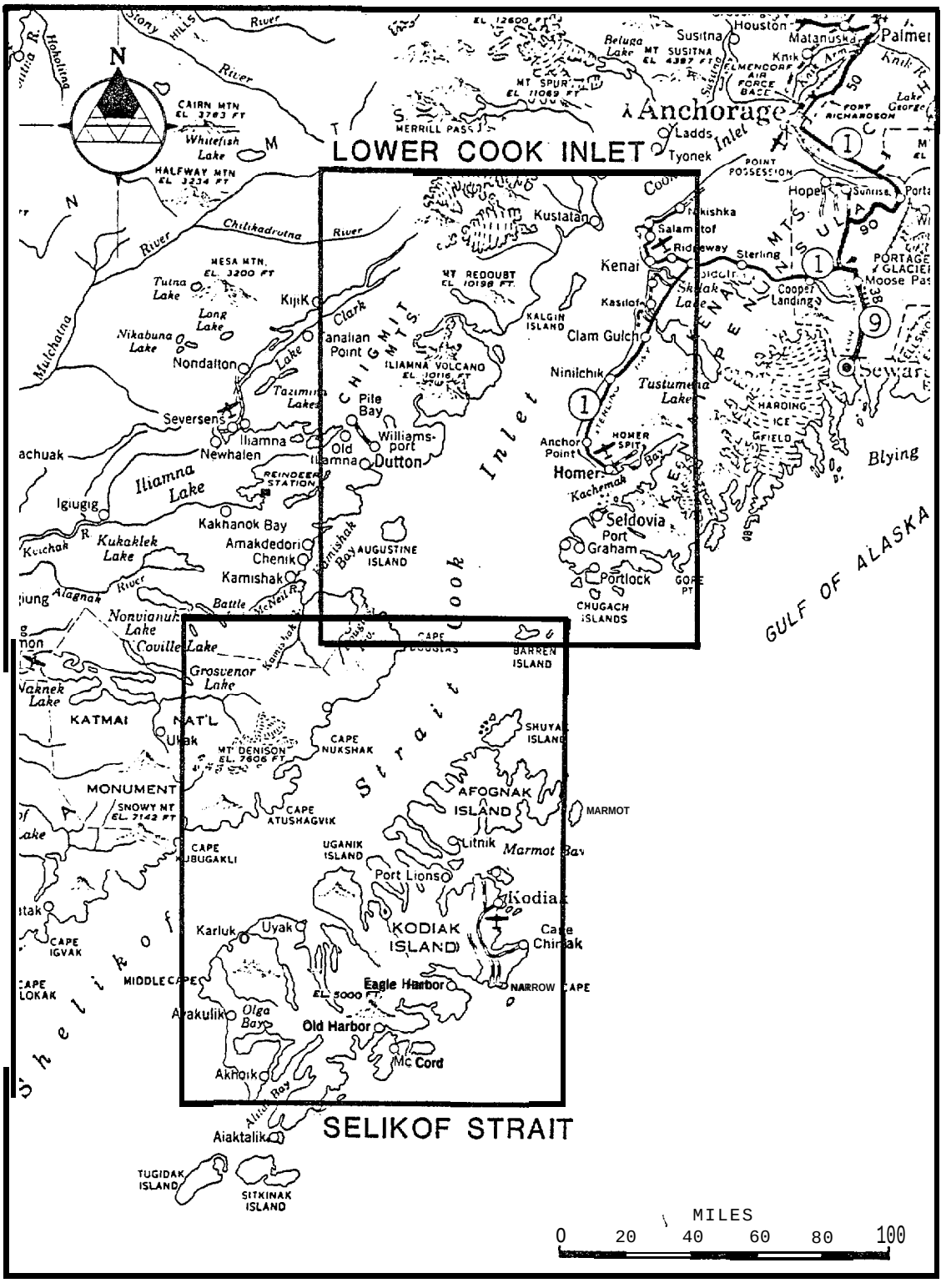


FIGURE 1-1

LOCATION OF THE STUDY AREA

environmental constraints on petroleum engineering (winds, waves, bottom sediments, geologic hazards etc.). Subsequent to completion of a draft version of this report but prior to publication of the final report, a shore facilities siting study was conducted to identify suitable sites for terminals and support bases in the northern portion of Shelikof Strait.

This study is intended to detail scenarios describing the incremental facilities, employment etc. resulting from Sale 60 so that incremental socio-economic and environmental impacts of Sale 60 can be analyzed. As such care is taken in this study to make some basic assumptions on the treatment of Sale CI in the analysis (see Section 3.2 in the final report).

The U.S. Geological Survey resource estimates, which are conditional on hydrocarbons being present, used in this study are as follows (Magoon et.al., 1978):

Lower Cook Inlet

	95 Percent Probability	5 Percent Probability	Statistical Mean
Oil (billions of barrels)	0.25	1.2	0.6
Gas (trillions of cubic feet)	0.25	1.1	0.6

Shelikof Strait

	Low	High
Oil (billions of barrels)	0.05	1.0
Gas (trillions of cubic feet)	0.05	1.0

This study details scenarios for high find and medium find resource levels derived from the U.S.G.S. estimates. In addition, a scenario specifying exploration only is detailed.

2.0 SUMMARY OF FINDINGS

2.1 Petroleum Geology and Resource Estimates

The resource estimates that form the basis of this study are the U.S. Geological Survey estimates of undiscovered oil and gas resources (Magoon, et al., 1978). These estimates, which are conditional on hydrocarbons being present, are:

	Lower Cook Inlet		
	95 Percent Probability	5 Percent Probability	Statistical Mean
Oil (billions of barrels)	0.25	1.2	0.6
Gas (trillions of cubic feet)	0.25	1.1	0.6

	Shelikof Strait.	
	Low	High
Oil (billions of barrels)	0.05	1.0
Gas (trillions of cubic feet)	0.05	1.0

Allocation of the Lower Cook estimates to the Sale 60 portion of the Inlet was based on the assumption that one-third of the total resource would be located there. A mid-range resource estimate of 500 million barrels of oil and 500 billion cubic feet of gas was assumed for Shelikof Strait. High, medium, and low estimates were thus defined for Sale 60 as follows:

	Lower Cook Inlet		
	Low Find	Medium Find	High Find
Oil (millions of barrels)	83	198	400
Gas (billions of cubic feet)	83	198	363

Shelikof Strait

	Low Find	Medium Find	High Find
Oil (millions of barrels)	50	500	1,000
Gas (billions of cubic feet)	50	500	1,000

A set of reservoir and hydrocarbon assumptions were formulated for the economic analysis based on available geologic data and the need to explore the economic impact of geologic diversity. While Upper Cook Inlet serves as a producing analog for the Tertiary prospects of Lower Cook Inlet/Shelikof Strait, there is insufficient data to establish with any certainty reservoir characteristics for the Mesozoic prospects. However, the following reservoir and production assumptions have been defined for the economic analysis:

- Average reservoir depths (gas and oil) -- 1,524 and 3,048 meters (5,000 and 10,000 feet).
- Recoverable reserves per acre -- 20,000 and 50,000 bbl.
- Well spacing -- variable, consistent with ranges in known producing fields.
- Initial well productivity -- oil -- 1,000, 2,000, and 5,000 barrels per day; gas --- 15 and 25 million cubic feet per day.
- Gas resource allocation between associated and non-associated -- for scenario detailing and analytical simplification, all the gas resources are assumed to be non-associated (i.e. scenarios are detailed which include gas field(s) totaling the U.S.G.S. gas resource estimate); [1]) oil fields are implicitly

(1) It is recognized, however, that in reality some portion of the gas resource will be associated.

assumed, therefore, to have a low gas-oil ratio (GOR) and that associated gas is uneconomic and is used to fuel platforms with the remainder reinfected.

- A low gas-oil ratio is assumed for analytical simplification (see bullet above).

- No assumption was made on the physical properties of the oil; the range of prices **used** in the analysis is partly a function of the potential range in crude qualities.

2.2 Selected Petroleum Development Scenarios

Three scenarios are detailed describing exploration only (no commercial resources discovered), a high find case assuming significant commercial discoveries and a medium find case assuming modest commercial discoveries. The oil and gas resources developed in these scenarios correspond to the allocated U.S.G.S. estimates as described above. No scenario is detailed for the low find resource estimate because the resources in most discovery locations are uneconomic under the assumptions of this analysis. Similarly, the gas resources at both the low find and medium find resource levels are uneconomic.

2.2.1 Exploration Only Scenario

The exploration only scenario postulates that 19 exploratory wells are drilled over a three-year period following the lease sale with only non-commercial finds (Table 2-l). Exploration is centered in the Shelikof Strait which has a total of 11 wells drilled. With the considerable variation in water depths in the sale area, a mixture of jack-up rigs, semi-submersibles and drillships are employed in the exploration program.

2.2.2 High Find Scenario

The high find scenario assumes significant commercial discoveries of oil and gas. The total reserves discovered and developed are:

TABLE 2-1

HIGH INTEREST LEASE SALE

Basin	YEAR AFTER LEASE SALE					
	1		2		3	
	No. of Rigs	No. of Wells	No. of Rigs	No. of wells	No. of Rigs	No. of Wells
Lower Cook Sale 60	1	2	2	5	1	1
Shelikof	2	5	2	5	1	1
TOTALS	3	7	4	10	2	2
						TOTAL WELLS = 19

Assumptions:

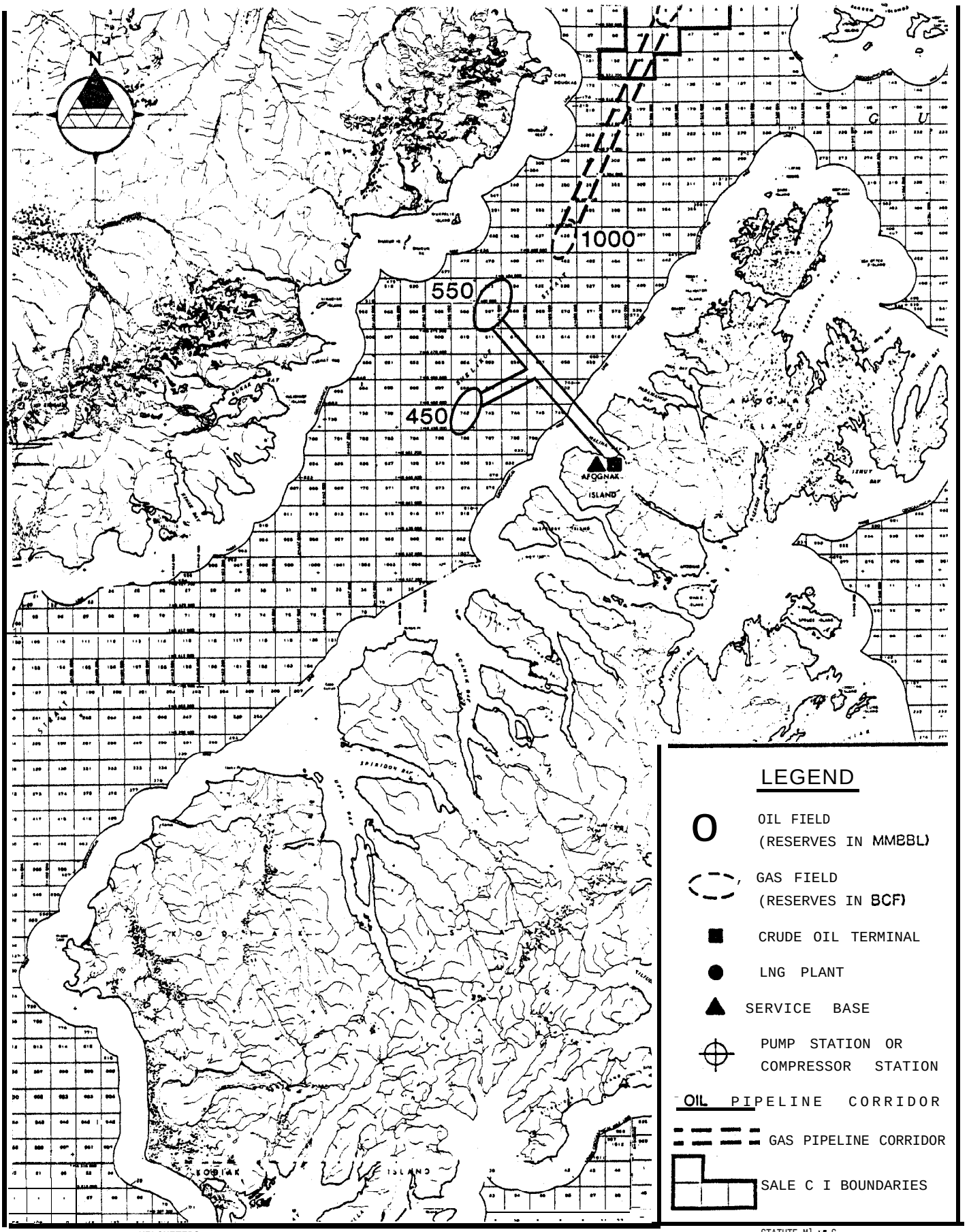
1. An average well completion rate of approximately 5 months
2. An average total well depth of 3,692 to 4,572 meters (13,000 to 15,000 feet)
3. Exploratory interest is centered in the Shelikof strait area (reflecting resource estimates)
4. Year after lease sale = 1982

Source: Dames & Moore

	Oil (MMbbl)	Non-Associated Gas (BCF)
Lower Cook	400	363
Shelikof	1,000	1,000

The major portion of the oil and gas resources are discovered in the Shelikof Strait area west of Afognak Island while the Lower Cook Inlet discoveries are made immediately to the north of Sale CI (Figure 2-1 and 2-2). The Shelikof discoveries consist of two oil fields with reserves 550 million barrels and 450 million barrels, and a single non-associated gas field with reserves of one trillion cubic feet. All these discoveries are made in the northern Shelikof Strait west of Afognak Island in water depths between 152 and 183 meters (500 and 600 feet). The Shelikof oil fields share a short pipeline to a new shore terminal located of the west coast of Afognak Island. During the exploration phase, Nikiski, Seward, Kodiak, and Homer serve as support bases. A temporary construction base and permanent operations base are established adjacent to the terminal on Afognak Island. The technical specifications and infrastructure of this scenario are summarized in Tables 2-2 through 2-5.

The Lower Cook oil fields are located in shallow water approximately 80 kilometers (50 miles) south of Drift River. As such, they are well situated to use the Drift River terminal to handle their crude production. By the late 1980's, Drift River may have sufficient spare capacity to handle the incremental production from these fields, which would peak at about 150,000 bpd, although total Cook Inlet production may exceed existing capacity requiring expansion of Upper Cook refineries and/or terminals (see Appendix A, Section IV of the final report). A partial processing facility may have to be constructed onshore between the pipeline landfall and Drift River terminal. Although there are several production options for Lower Cook Inlet oil, this scenario assumes that the Sale 60 fields in Lower Cook Inlet do not share infrastructure with Sale CI fields, in particular pipelines, but rather support their own pipeline.



SOURCE: DAMES & MOORE

FIGURE 2-1

SHELIKOF STRAIT
HIGH FIND SCENARIO
FIELD AND SHORE FACILITY LOCATIONS

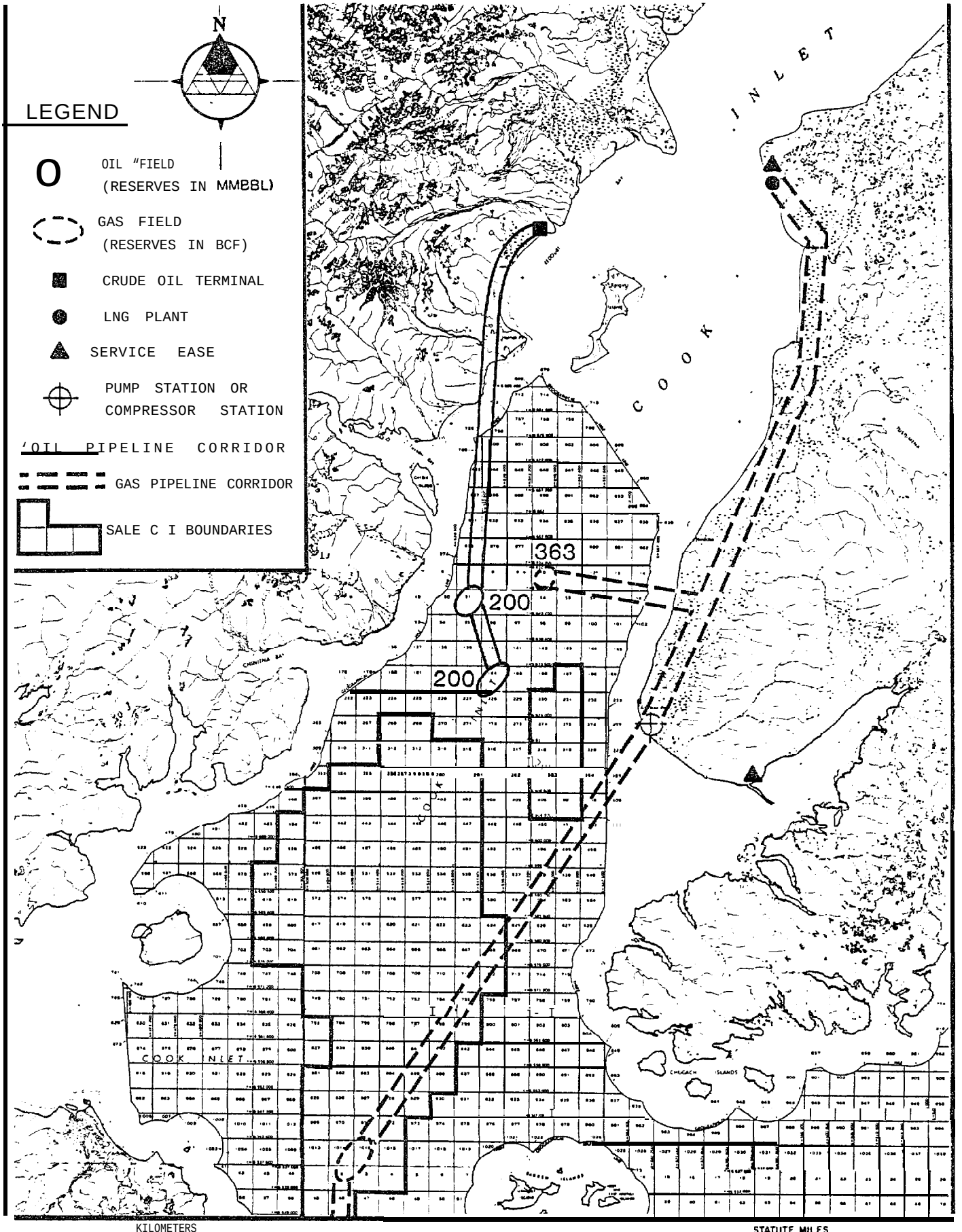


FIGURE 2-2

SOURCE: DAMES & MOORE

LOWER COOK INLET
HIGH FIND SCENARIO
FIELD AND SHORE FACILITY LOCATIONS

TABLE 2-2

HIGH FIND OIL - LOWER COOK FIELDS (BOTH FIELDS IN SALE 60) SHARE PIPELINE TO EXISTING UPPER COOK INLET TERMINAL OR REFINERY

Basin	Field Size oil (MMBBL)	Production System	Platforms No./Type[1]	Number of Production Wells	Initial Well Productivity (B/D)	Peak Production Oil (MB/D)	Water Depth Meters	Water Depth (Feet)	Pipeline Distance to Shore Terminal Kilometers	Pipeline Distance to Shore Terminal (Miles)	Trunk Pipeline Diameter (inches) Oil
Lower Cook	200	Steel platform with shared trunkline to existing shore terminal	1S	40	2,000	76.8	30-60	(100-200)	48-80	(30-50)	16
	200	Steel platform with shared trunkline to existing shore terminal	1S	40	2,000	76.8	30-60	(100-200)	48-80	(30-50)	16

[1]S = Steel

Source: Dames & Moore

TABLE 2-3

HIGH FIND OIL - SHELIKOF FIELDS SHARE PIPELINE TO NEW SHORE TERMINAL LOCATED ON WEST COAST OF KODIAK OR AFOGNAK ISLAND

Basin	Field Size Oil (MMBBL)	Production System	Platforms No./Type[1]	Number of Production Wells	Initial Well Productivity (B/D)	Peak Production Oil (MB/D)	Water Depth		Pipeline Distance to Shore Terminal[2]		Trunk Pipeline Diameter (inches) Oil
							Meters	(Feet)	Kilometers	(Miles)	
Shelikof	550	Steel platform with shared trunkline to shore	1S	40	5,000	192	152-183	(500-600)	24-40	(15-25)	20
	450	Steel platform with shared trunkline to shore	1S	40	5,000	192	152-183	(500-600)	24-40	(15-25)	20

[1] S = Steel

[2] No more than 8 kilometers (5 miles) of pipeline are assumed to be onshore.

Source: Dames & Moore

TABLE 2-4

HIGH FIND NON-ASSOCIATED GAS - LOWER COOK SALE 60 FIELD SHARES PIPELINE WITH SALE CI FIELDS TO LNG PLANT IN UPPER COOK INLET

Basin	Field Size Gas (BCF)	Production System	Platforms No./Type[1]	Number of Production Wells	Initial Well Productivity (MCF/D)	Peak Production Gas (MMCF/D)	Water Depth		Pipeline Distance to Shore Terminal		Trunk Pipeline Diameter (inches) Gas
							Meters	(Feet)	Kilometers	(Miles)	
Lower Cook	363	Steel platform with shared trunkline to LNG plant	1S	8	25	192	30-60	(100-200)	48-80	(30-50)	20-26

[1]S = Steel

Source: Dames & Moore

TABLE 2-5

HIGH FIND NON-ASSOCIATED GAS - SHELIKOF FIELD WITH PIPELINE TO LOWER COOK FIELD(S) THEN SHARED PIPELINE TO UPPER COOK LNG PLANT

Basin	Field Size Gas (BCF)	Production System	Platforms No./Type[1]	Number of Production Wells	Initial Well Productivity (MCF/D)	Peak Production Gas (MMCF/D)	Water Depth		Pipeline Distance to Shore Terminal		Trunk Pipeline Diameter (inches) Gas
							Meters	(Feet)	Kilometers	(Miles)	
Shelikof	1000	Steel platform with shared trunkline to LNG plant	1 S	24	25	576	152-183	(500-600)	321	(200)	24-28

[1]S = Steel

Source: Dames & Moore

2.2.3 Medium Find Scenario

The medium find scenario assumes modest commercial discoveries of oil. The total reserves discovered and developed are:

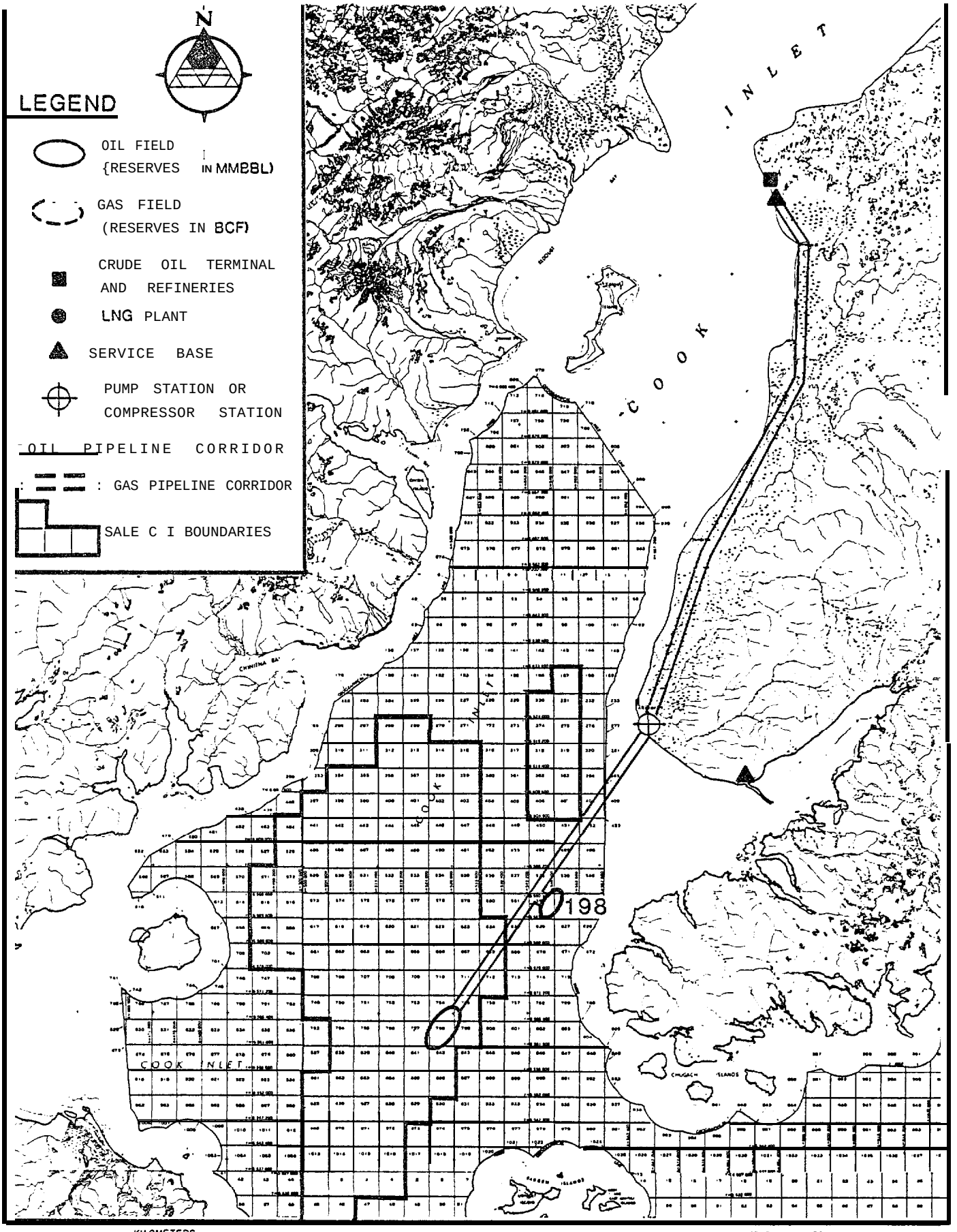
	Oil (MMBBL)
Lower Cook	198
Shelikof	500

The Lower Cook reserves are discovered in a single field located in about 76 meters (250 feet) of water 16 kilometers (10 miles) northwest of English Bay (Figure 2-3). The field produces through a short spur pipeline which connects with a trunk pipeline that takes production from a field located in Sale CI. The pipeline makes a landfall on the Kenai Peninsula near Anchor Point, where an intermediate pump station is located, and continues north to Nikiski where the crude is either shipped to the lower 48 via tanker or used in the Nikiski refineries. Nikiski is the principal support base for both the exploration and construction phases of development. Homer is utilized as a forward support base.

The single Shelikof field is located in the northern Shelikof Strait in about 183 meters (600 feet) of water west of Afognak Island (the island is currently a national forest) (Figure 2-4). The field is developed using a single steel platform which produces to a short pipeline that connects with a new terminal constructed on the west coast of Afognak Island. During the exploration phase, Nikiski, Seward, and Homer serve as support bases. A temporary construction base and permanent operations base are established adjacent to the terminal on Afognak Island. The technical specifications and infrastructure of this scenario are summarized in Tables 2-6 and 2-7.

2.3 Employment

Offshore employment exceeds onshore employment in every year of all three scenarios. In the high find scenario, peak employment occurs in



SOURCE: DAMES & MOORE

FIGURE 2-3

LOWER COOK INLET
MEDIUM FIND SCENARIO
FIELD AND SHORE FACILITY LOCATIONS

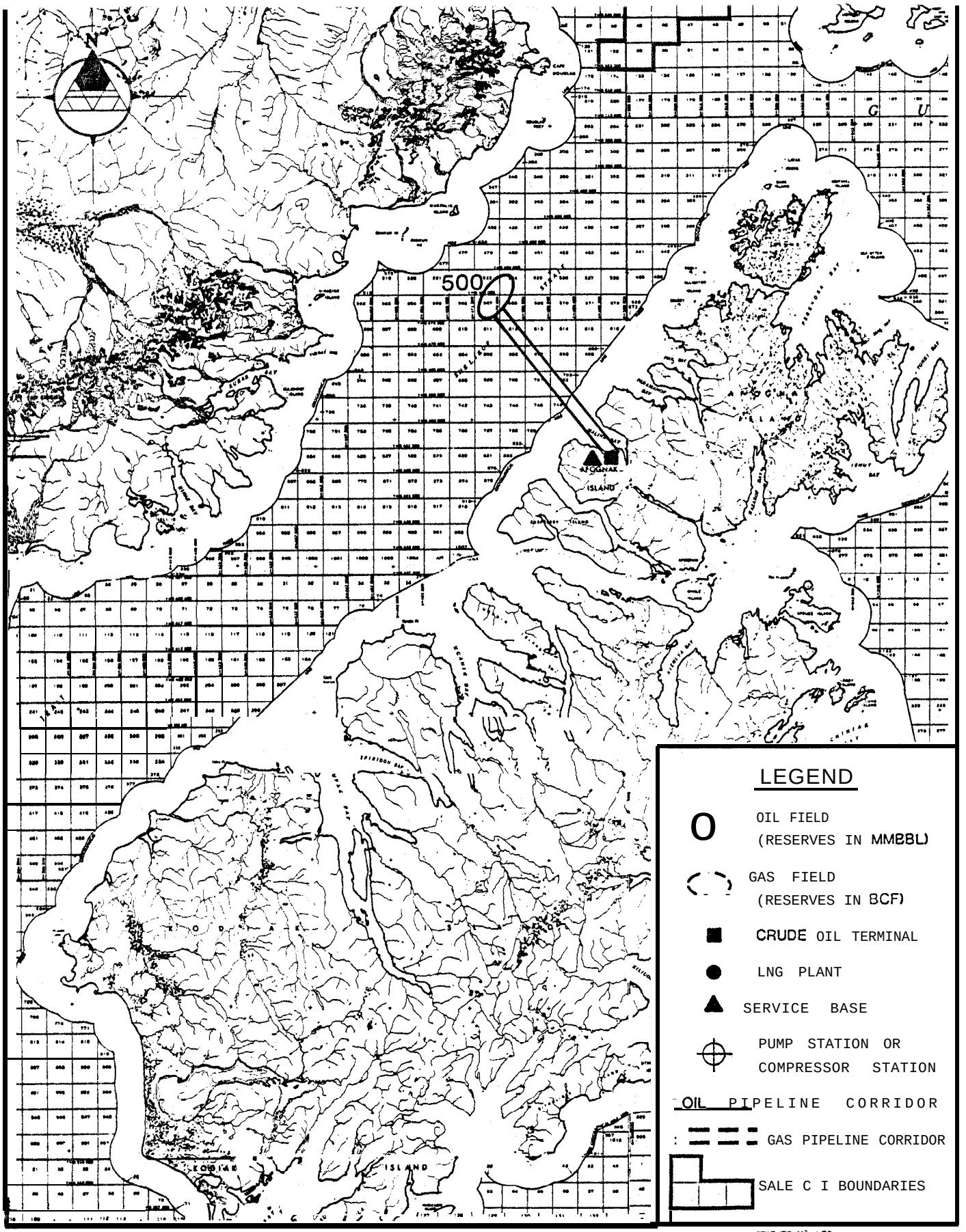


FIGURE 2-4

SOURCE: DAMES & MOORE

SHELIKOF STRAIT
MEDIUM FIND SCENARIO
FIELD AND SHORE FACILITY LOCATIONS

TABLE 2-6

MEDIUM FIND OIL - LOWER COOK SALE 60 FIELD SHARES PIPELINE WITH COOK INLET SALE CI FIELD(S) TO EXISTING TERMINAL OR REFINERY IN UPPER COOK INLET

Basin	Field Size Oil (MMBBL)	Production System	Platforms No. /Type]	Number of Production Wells	Initial Well Productivity (B/D)	Peak Production Oil (MB/D)	Water Depth Meters	Water Depth (Feet)	Pipeline Distance to Shore Kilometer:	Pipeline Distance to Shore (Miles)	Trunk Pipeline Diameter (inches) Oil
Lower Cook	198	Steel platform with shared trunkline to shore	1S	40	2,000	76.8	61-91	(200-300)	160	(100)	12-16

1S = Steel

Source: Dames & Moore

TABLE 2-7

MEDIUM FIND OIL - SHELIKOF FIELD WITH PIPELINE TO SHORE TERMINAL ON WEST COAST OF KODIAKOR AFOGNAK ISLAND

Basin	Field Size Oil (MMBBL)	Production System	Platforms No./Type[1]	Number of Production Wells	Initial Well Productivity (B/D)	Peak Production Oil (MB/D)	Water Depth		Pipeline Distance to Shore Terminal[2]		Trunk Pipeline Diameter (inches) Oil
							Meters	(Feet)	Kilometers	(Miles)	
Shelikof	500	Steel platform with pipeline to new shore terminal	1S	40	5,000	192	152-183	(500-600)	24-40	(15-25)	16

[1]S = Steel

[2]Single field, pipeline not shared; maximum of 8 kilometers (5 miles) of onshore pipeline.

Source: Dames & Moore

year 8 with an average of 2,740 workers per month (2,740 man-years); in the medium find scenario, peak employment occurs in year 7 with an average of 1104 workers per month (1104 man-years); in the exploration only scenario, maximum employment occurs in year 2 with an average of 699 workers per month. Manpower estimates in Tables 2-8 through 2-10 and in the tables presented in Chapters 4.0, 5.0, and 6.0 of the final report reflect assumptions made in this report regarding the shared use of existing and anticipated facilities in Upper Cook Inlet. Shared use of facilities -- pipelines, marine terminals, LNG plants, compressor stations and processing plants -- means that construction and operational manpower requirements, especially onshore manpower requirements, are significantly lower than would have been the case if new facilities were constructed. Only incremental manpower requirements associated with this lease sale area are estimated in the report.

2.4 Technology and Production Systems

While not as severe as the Gulf of Alaska, the operating environment in Lower Cook Inlet and Shelikof Strait nevertheless presents significant engineering constraints to offshore petroleum development. The Lower Cook Inlet tracts are located in water depths ranging from less than 30 meters (100 feet) in the northern part of the sale area south of Kalgin Island to 183 meters (600 feet) at Kennedy Entrance; over 50 percent of this area lies in water depths between 46 and 76 meters (150 and 250 feet). Water depths in Shelikof Strait range from 91 meters (300 feet) in the northeast to over 303 meters (1,000 feet) at the southwestern entrance. The design wave for the northern part of Lower Cook Inlet can be considered to be essentially the same as that considered for Upper Cook Inlet, i.e. about 8.5 meters (28 feet) while in the southern portion of Lower Cook Inlet the design wave is considerably greater, probably in excess of 20 meters (65 feet). The technology review of the Gulf of Alaska conducted for a companion study (Dames & Moore, 1979a and b) was utilized as the basis for selection of production systems to be evaluated in the economic analysis of Lower Cook Inlet and Shelikof Strait. These systems included conventional steel jacket platforms, concrete gravity

TABLE 2-8

SUMMARY OF MANPOWER REQUIREMENTS - HIGH FIND SCENARIO
TOTAL LABOR FORCE[1]

Year After Lease Sale[4]	Monthly Average Number of People[2] Offshore	Onshore	Total[3]
1[5]	470	56	525
2	785	93	877
3	780	92	872
4	785	93	877
5[6]	623	334	957
6	634	111	745
7	1,298	573	1,871
8[7]	2,011	730	2,740
9	1,981	372	2,353
10	1,669	306	1,975
11	1,329	295	1,624
12	965	276	1,240
13	861	281	1,142
14	883	302	1,185
15	929	310	1,239
16	929	310	1,239
17	854	294	1,148
18	794	286	1,080
19	749	275	1,023
20	660	263	922
21	660	263	922
22"	660	263	922
23	554	247	801
34	389	223	612
25	254	204	458
26	165	192	357
27	90	180	269

[1] Includes onsite and offsite workers.
[2] Yearly peak employment may exceed these averages (see manpower tables in Chapter 5.0); the figures in this column are equivalent to the number of man years of employment.
[3] Discrepancies due to rounding.
[4] Year after lease sale = 1982.
[5] Exploration starts.
[6] Field construction starts.
[7] Production commences.

Source: Dames & Moore Estimates

TABLE 2-9

SUMMARY OF MANPOWER REQUIREMENTS - MEDIUM FIND SCENARIO
TOTAL LABOR FORCE[1]

Year After Lease Sale[4]	Monthly Average Number of People[2]		
	Offshore	Onshore	Total[3]
1[5]	472	56	528
2	629	74	703
3	632	75	706
4	315	236	550
5[6]	0	62	62
6	634	149	783
7	769	.335	1,104
8[7]	53a	100	637
9	686	120	805
10	686	120	805
11	294	99	392
12	238	96	333
13	330	112	441
14	330	112	441
15	330	112	441
16	330	112	441
17	330	112	441
18	330	112	441
19	330	112	441
20	330	112	441
21	330	112	441
22	241	104	344
23	181	96	277
24	181	96	277
25	181	96	277
26	106	20	125

[1] Includes onsite and offsite workers.
[2] Yearly peak employment may exceed these averages (see manpower tables in Chapter 6.0); the figures in this column are equivalent to the number of man years of employment.
[3] Discrepancies due to rounding.
[4] Year after lease sale = 1982.
[5] Exploration starts.
[6] Field construction starts.
[7] Production commences.

Source: Dames & Moore Estimates

TABLE 2-10

SUMMARY OF MANPOWER REQUIREMENTS - EXPLORATION ONLY SCENARIO
TOTAL LABOR FORCE[1]

Year After Lease Sale[4]	Monthly Average Number of People[2]		Total[3]
	Offshore	Onshore	
1	468	56	523
2	625	74	699
3	130	16	146

[1] Includes onsite and offsite workers.
[2] Yearly peak employment may exceed these averages (see manpower tables in Chapter 4.0); the figures in this column are equivalent to the number of man years of employment.
[3] Discrepancies due to rounding.
[4] Year after lease sale = 1982.

Source: Dames & Moore Estimates

platforms and floating platforms (e.g. converted semi-submersibles) which can either produce to pipelines or directly to tankers offshore via single point mooring buoys; the offshore loading systems could have storage capability using internal storage (which is a design feature of concrete platforms), storage buoys or permanently moored tankers. All of these systems could have application in Lower Cook Inlet and Shelikof Strait.

The production systems to be screened in the economic analysis were selected in consultation with the petroleum engineering departments of the major lease holders in Lower Cook Inlet. These consultations included discussion of the results of our technology review conducted for the Gulf of Alaska studies and our evaluation of oceanographic conditions of Lower Cook Inlet/Shelikof Strait that would affect production system selection, platform design, etc., The consensus of opinion was that steel jacket platforms with a pipeline to shore terminal(s) or existing terminals/refineries in Upper Cook Inlet would be the production system generally adopted. Only minor interest was expressed in the use of gravity platforms, offshore loading systems and subsea completions. The relatively short distances to suitable shore landfalls and the petroleum facilities in Upper Cook Inlet were factors in the preference for platform pipeline systems. In Lower Cook Inlet, water depths of generally less than 91 meters (300 feet) favor fixed platforms over floating systems. In some parts of Lower Cook Inlet and Shelikof Strait, platforms may have to be designed for sea ice, in particular, location of wells within platform legs.

It is the deeper waters (200 to over 305 meters or 650 to over 1,000 feet) comprising the southern half of Shelikof Strait that present the most significant engineering challenges of lease Sale 60. While conventional steel jacket platforms may still have a role in this area, the development of marginal or deep water fields in areas such as Shelikof Strait in the late 1980's may involve the use of hybrid, compliant and floating platform designs. No attempt, however, was made in this study to predict the technologies and their costs for production systems in

water depths greater than 200 meters (650 feet) because: (1) production systems other than the conventional steel jacket platform such as the guyed tower or tension leg platform have not been utilized beyond the prototype stage and no firm cost data or experience is available to evaluate such systems; and (2) conventional steel jacket platforms have not been installed in such water depths with comparable oceanographic conditions to provide a historic cost data base. Rather than predict the petroleum technologies and their development costs for the deeper Shelikof waters, it was decided to use the results of the economic analysis for the 183 meters (600 feet) production systems to establish the threshold of various economic sensitivities for petroleum development in greater water depths.

The production systems that were considered in this analysis are:

- Single steel jacket platform. Pipeline to a new shore terminal. Water depths: 30.5 to 183 meters (100 to 600 feet).

- Single steel jacket platform. Pipeline (offshore and onshore) to existing shore terminal/refinery in Upper Cook Inlet. Water depths: 30.5 to 183 meters (100 to 600 feet).

- Single steel jacket platform. Pipeline shared with other producing fields to shore terminal. Water depths: 30.5 to 183 meters (100 to 600 feet).

- Multiple steel jacket platforms. Pipeline to a new shore terminal. Water depths: 30.5 to 183 meters (100 to 600 feet).

- Multiple steel jacket platforms. Pipeline (offshore and onshore) to existing shore terminal/refinery in Upper Cook Inlet. Water depths: 30.5 to 183 meters (100 to 600 feet).

- Single or multiple steel platforms. Gas pipeline to shore, gas converted to LNG at new plant. Water depths: 30.5 to 183

meters (100 to 600 feet).

- Single or multiple steel platforms. Gas pipeline (offshore and onshore) to existing LNG plant or petrochemical plant in Upper Cook Inlet. Water depths: 30.5 to 183 meters (100 to 600 feet).

In Lower Cook Inlet (Sale 60) in the case of significant discoveries of oil, an operator has two principal options:

- A long pipeline (approximately 200 kilometers or 120 miles -- assuming a discovery in the central portion of Lower Cook Inlet) to existing or expanded Upper Cook Inlet petroleum facilities; a portion of this pipeline may be shared with other fields located in Lower Cook Inlet Sale CI or Sale 60, or Shelikof Strait Sale 60.

- A short to medium length pipeline (less than 80 kilometers or 50 miles) to a new oil terminal located on the lower Kenai Peninsula or west shore of Lower Cook Inlet.

In the case of significant discoveries of oil in the Shelikof Strait, an operator has three principal production options:

- A long pipeline (approximately 322 kilometers or 200 miles) to existing Upper Cook Inlet petroleum facilities; a portion of this pipeline may be shared with other fields located in Lower Cook Inlet Sale CI or Sale 60.

- A short pipeline (less than 32 kilometers or 200 miles) to a new oil terminal located on the east or west coast of Shelikof Strait.

- A medium length pipeline (approximately 160 kilometers or 100 miles) to a new shore terminal located in Lower Cook Inlet shared with Lower Cook Inlet fields.

Gas production options from offshore Lower Cook Inlet or Shelikof fields are limited to pipelines to either existing Upper Cook Inlet LNG plant(s), petrochemical plants or local markets, or to new LNG or petrochemical plants located along the shores of Shelikof Strait or Lower Cook Inlet.

2.5 Resource Economics

The economic characteristics of several likely oil and gas production systems suitable for the harsh conditions of Lower Cook Inlet and Shelikof Strait are analyzed in this report with the model described in Appendix A of the final report. The model is a standard discount cash flow algorithm designed to handle uncertainty among the variables and driven by the investment and revenue streams associated with a selected production technology.

The analysis focuses attention on (1) the engineering technology required to produce reserves in Lower Cook Inlet and Shelikof Strait, and (2) the uncertainty of the interrelated values of the economic and engineering parameters. In view of the uncertainty, it is important to emphasize that there is no single-valued solution for any calculation reported in the analysis. Field development costs associated with the different production systems as well as oil and gas prices have been estimated as a range of values. Sensitivity and Monte Carlo procedures have been used to bracket rather than pin-point the decision criteria calculated with the model.

Two vital pieces of information are estimated in this analysis:

- The minimum economic field size to justify development of a known field with a selected technology in Lower Cook Inlet.
- The minimum required price to justify development of a field in Lower Cook Inlet.

Both are very sensitive to water depth, and to the value of money used

to discount cash flows. At water depths of 30.5 meters (100 feet), 91 meters (300 feet), and 183 meters (600 feet), the calculated minimum prices and field sizes are bracketed between 10 percent and 15 percent discount rates. Table A-1 (Appendix A of the final report) shows the results. The minimum required price for the most economic oil production system is bracketed between 30.5 and 183 meters (100 and 600 feet) assuming a 15 percent discount rate on Figure A-1 (Appendix A). Figure A-2 (Appendix A) shows the gas price.

The essential findings of this report are summarized below. The single value calculations discussed are based on the mid-range parameter values. Monte Carlo distributions showing the range of values for the after tax return on investment are discussed in the final report in Section 11.7 of Appendix A. The technology, financial, reservoir and production assumptions of the analysis are detailed in Section III of Appendix A in the final report.

- The economic decision to pipeline oil to an existing terminal in Upper Cook Inlet or build a new terminal will depend on the location of a discovered field and whether or not there are other fields that can share either the pipeline to the existing terminal or the construction cost of building a new terminal.

- The economic results are very sensitive to assumptions about shared infrastructure. A large gas production platform in deep water with an assumed pipeline distance of 225 kilometers (140 miles) of onshore and offshore pipeline will earn 10 percent with 1.0 tcf recoverable reserves if the pipeline is shared; but requires 1.5 tcf to support the entire pipeline.

- Long pipelines from Lower Cook to Upper Cook are either the single largest element of development cost or the second most costly element after platform fabrication and installation. The relative shares depend on water depth which dramatically affects platform cost and offshore pipeline distance. Even

one-half shared, a 225 kilometer (140 mile) gas pipeline with 97 kilometers (60 miles) offshore can range between 25 percent and 36 percent of development cost depending on water depth.

- Even in shallow water, no oil productions systems are able to earn 15 percent return on investment with fields of any size in Lower Cook Inlet with a wellhead price of $12.50 and initial production rate assumed to be 1000 B/D. Only fields of 150 to 210 MMb with reservoirs deep enough to allow production with 40 deviated wells are able to earn 10 percent. This is significant if geological conditions in Lower Cook Inlet suggest that initial production rates in the 1000 B/D range are reasonable expectations.

Assuming initial productivity of 2000 B/D different production systems in shallow water are able to earn 10 percent with fields in the 90-130 million barrel range. Fields ranging in size from 175 to 235 million barrels are required to earn 15 percent. The range in size is a function of reservoir target depth and production system.

In deep water 183 meters (600 feet) no oil production system is able to earn 15 percent in Lower Cook Inlet or Shelikof Strait assuming 2000 B/D initial production rate (and other assumptions of the analysis).

- An initial well productivity higher than 2000 13/D is required to earn the 15 percent hurdle rate in 183 meters (600 feet) of water in Lower Cook. Assuming 5000 B/D initial well productivity the minimum field size for development for a deep reservoir target is in the range of 250-300 million barrels depending on field location and production system.

- Relatively large 24-well production systems and large gas fields are required to justify development in Lower Cook Inlet/Shelikof Strait at even shallow water depths, assuming $2.10 for the wellhead price and 15 MMcfd for the initial production rate.

- The minimum sized gas field for development ranges between 1.0 and 2.0 Tcf in 91 meters (300 feet) of water and 15 percent discount rate depending on reservoir target depth. In shallower water slightly smaller fields would earn 15 percent.

- In deep water 183 meters (600 feet) an initial production rate in excess of 15 MMcfd is required to earn 15 percent for a gas field only large enough to justify a single platform. Assuming 25 MMcfd wells a 1.5 Tcf field will earn 15 percent even supporting an entire pipeline. A giant field capable of supporting two gas platforms will earn 15 percent with recoverable reserves of 3.8 Tcf.

- The minimum required price in 1978 dollars to justify development varies principally with field size, water depth, production system, initial production rate, and value of money. The calculated minimum oil price is slightly lower under the assumptions of the analysis for an existing terminal system than for a new terminal system. In shallow water minimum price at 15 percent discount rate and 2000 B/D declines from nearly $17.50 BBl for 100 million barrels of recoverable reserves to about $10.00 for 300 million barrels or more. In deep water, the minimum price declines from nearly $22.00 to $15.00 bbl at 300 million barrels. Reserves larger than 300 million barrels are recovered beyond 25 years from start-up; their present value is nearly zero.

- The minimum required gas price declines from nearly $2.25 Mcf to $1.65 Mcf for recoverable reserves of 900 billion cubic feet to 2.0 Tcf in 91 meters (300 feet) water depth. In deep water, the price is nearly $3.00 for the 900 Bcf field and declines to about $2.25 for 2.0 Tcf.

REFERENCES

Dames & Moore, 1979a. Northern Gulf of Alaska Petroleum Development Scenarios. Alaska OCS Socioeconomic Studies Program, Technical Report No. 29, Report Prepared for the Bureau of Land Management, Alaska OCS Office, February 1979.

Dames & Moore, 1979b. Western Gulf of Alaska Petroleum Development Scenarios. Alaska OCS Socioeconomic Studies Program, Technical Report No. 35, Report Prepared for the Bureau of Land Management, Alaska OCS Office, February 1979.

Magoon, L. B., et al., 1978. Summary Report for Proposed OCS Sale No. 60 Lower Cook Inlet - Shelikof Strait. U.S. Geological Survey, unpublished resource report.