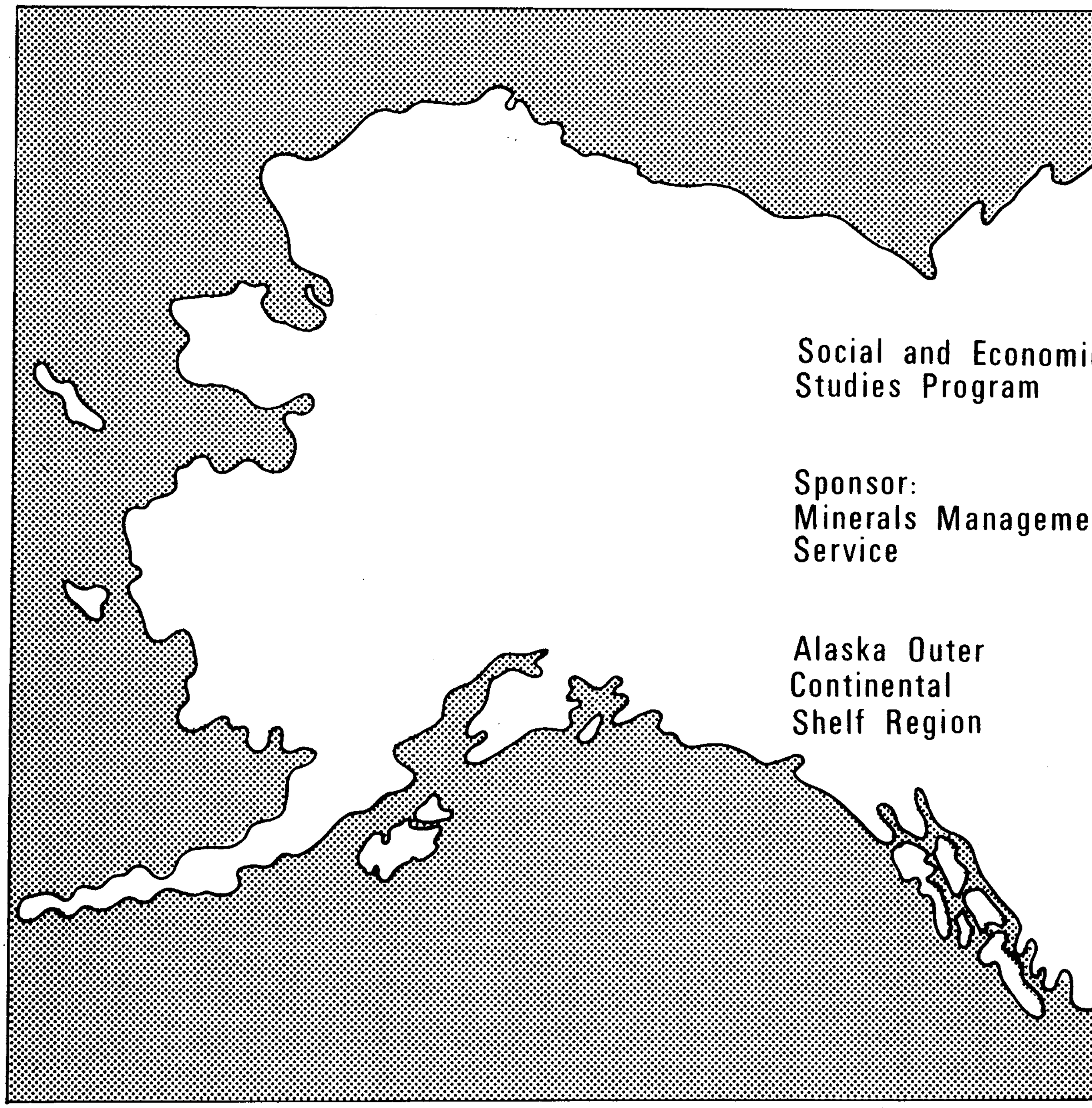
Technical Report

Number **108**



Social and Economic
Studies Program

Sponsor:
Minerals Management
Service

Alaska Outer
Continental
Shelf Region

Unimak Pass Vessel Analysis

TECHNICAL REPORT NO. 108 CONTRACT NO. AA851-CT2-34

UNIMAK PASS VESSEL ANALYSIS

Prepared for:

MINERALS MANAGEMENT SERVICE
ALASKA OUTER CONTINENTAL SHELF REGION
LEASING AND ENVIRONMENT OFFICE
SOCIAL AND ECONOMIC STUDIES UNIT

September 1984

UNIMAK PASS VESSEL ANALYSIS

Prepared by:
Louis Berger and Associates, Inc.

This report was prepared under the guidance of Karen Gibson, Minerals Mangement Service. Principal contributors to this report include Peter Cook and Jim Pederson, Louis Berger and Associates and Gary Hennigh, Gary Hennigh Associates.

ABSTRACT

This report identifies present and future marine traffic and related characteristics of vessels using Unimak Pass. This pass is the main portal in the Aleutian Islands between the Bering Sea and the Pacific Ocean. A description of the location and weather features of Unimak Pass is provided. Also, a discussion of historical collisions, navigational issues, and a recent U.S. Coast Guard study in regards to the pass are presented.

Present and future vessel traffic estimates through the year 2000 are developed for four categories: OCS activities, fishing, natural resources, and commercial shipping. Increases in OCS traffic are expected between 1985 and 2000. Between 1995 and 2000 major traffic increases in natural resource shipping activities are expected. Fishing vessels are expected to remain relatively stable throughout the period. Total annual vessel traffic for the year 2000 is estimated to increase approximately 100 percent over the base year from approximately 2290 trips to 4600 trips in 2000.

The primary focus of the report is to assess the impact, i.e. increase in collisions, of additional vessel traffic using Unimak Pass as a result of future OCS activities in northern and western Alaska. A probability model for estimating future collisions is developed. The probability of collision incidents in the year 2000 without OCS traffic is one collision every fifty-seven years and with OCS traffic is one collision every thirty-three years. The OCS traffic almost doubles the likelihood of a collision in the pass by the year 2000. However, relative to the possibility of a collision without OCS traffic, this increase is insignificant.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1.0 INTRODUCTION

1.1 Purpose

The purpose of this report is to identify and evaluate the levels of present and future vessel traffic using Unimak Pass. The pass is the principal portal through the Aleutian Islands that provides a major travel way for vessels moving between the Bering Sea and Pacific Ocean. The pass forms part of the great circle route that links the orient with the west coast of North America and is subject to passage by numerous cargo and fishing vessels. Anticipated economic growth throughout Alaska and in international trade with Asia is expected to increase traffic through the pass. A significant portion of this traffic increase may result from OCS oil and gas exploration and development activities in western and northern Alaska.

There has been some recent speculation that increases in vessel traffic using Unimak Pass may cause an increase in collisions and other related safety issues in this area. Therefore, a primary objective of this study is to determine if an increase in Unimak Pass traffic will result in a higher level of collision incidents in the pass, particularly in consideration of future OCS activities in western and northern Alaska.

This study is one of several transportation-related studies sponsored by the Minerals Management Service, Alaska OCS Region, Social and Economic Studies Unit. The overall objective of this program is to evaluate the broad range of possible socioeconomic effects of OCS activities throughout Alaska. This information can be used in the preparation of various decision making documents required by the Minerals Management Service Office for determining the effects of Federal OCS activities on Alaska's transportation systems.

1.2 Study Scope and Organization

This report contains three major chapters. Chapter 2 describes the location and weather characteristics, recent collisions and issues regarding Unimak Pass. It also discusses recent Coast Guard activities in relation to Unimak Pass. Chapter 3 provides estimates of current and future Unimak Pass vessel traffic through the year 2000. The vessel traffic data are presented in four major components: fishing vessels, natural resources vessels, OCS vessels, and commercial shipping vessels. Chapter 4 focuses on the probability of future vessel collisions in Unimak Pass. It discusses the factors affecting collisions, collision models, and evaluates the statistical probability of future collisions in the pass with and without OCS activity.

2.0 UNIMAK PASS

2.1 Location and Weather Characteristics

Unimak Pass is the first major ship passage in the Aleutian Islands southwest of the Alaska Peninsula that connects the Bering Sea with the Pacific Ocean (see Figure 2.1). The pass is part of the Fox Islands (subgroup of the Aleutian Islands) and at its narrowest distance is approximately twelve miles wide between the southwest end of Unimak Island and Ugamak Island (see Figure 2.2). Unimak Pass is the widest of the three Fox Islands passes and the one most generally used. The only navigational aids are channel marker lights located at various intervals throughout the pass (U.S. Department of Commerce, 1983).

In addition to being the major gateway into the Bering Sea, Unimak Pass is also used by many vessels on the great circle route to effect a shorter and better weather route across the North Pacific Ocean. This route connects the United States west coast ports with Asian ports, primarily in Japan, Korea, and Taiwan. The route generally follows the outer edge of the Pacific Ocean in linking the continents of North America and Asia together. The route west via the Bering Sea avoids the prevailing head winds and heavy seas that are frequently encountered south of the Aleutian Islands.

The Aleutian Islands are known for their notoriously bad weather, particularly rain, fog, and strong winds. Poor visibility is often a problem that marine and aviation operators in this area must contend with. Visibility around Unimak Pass is generally best in the winter. In summer when warm air from the Pacific Ocean moves over relatively cooler waters near the Aleutians, extensive fog formation takes place. Often the sun's heat has little effect in dissipating this fog, and it takes a change in air flow to clear the region. This advection or sea fog forms most often from June through September. At its peak in July and August, it can reduce visibilities to below two miles on ten to twenty days per month throughout the chain. It is most likely to affect the southern side of the Aleutian Islands, although quite often it blankets the entire region. In winter, land fog is more local and can be expected along with snow and rain, to drop visibilities to less than two miles on one to four days per month.

2.2 Issues

As part of this study, we were required to identify existing and future navigational issues and problems relating to Unimak Pass. A literature search was initiated which proved to be of

FIGURE 2.1 REGIONAL LOCATION MAP OF UNIMAK PASS

SOURCE: The Aleutians, Volume 7, Number 3, 1980, Alaska Geographic.

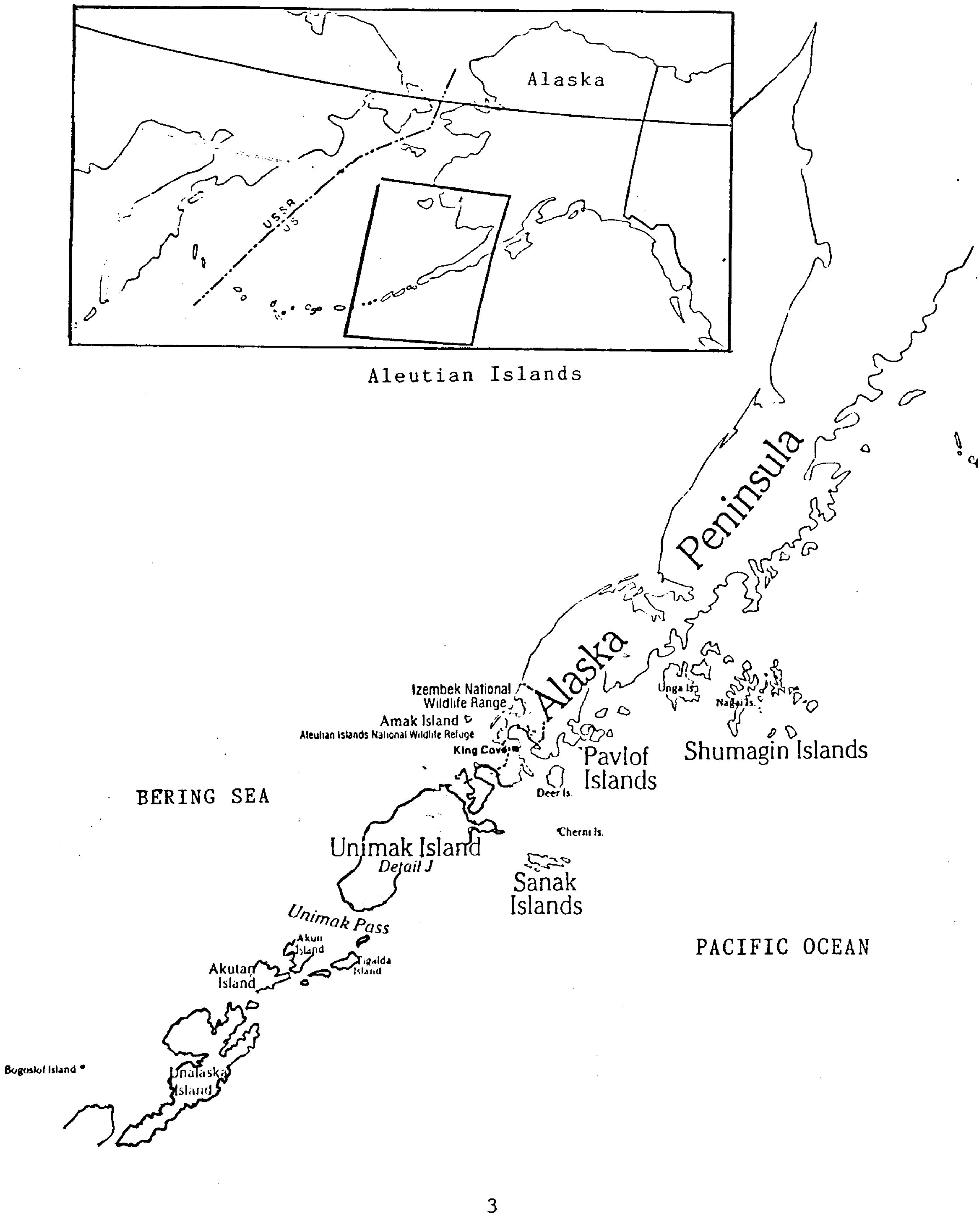
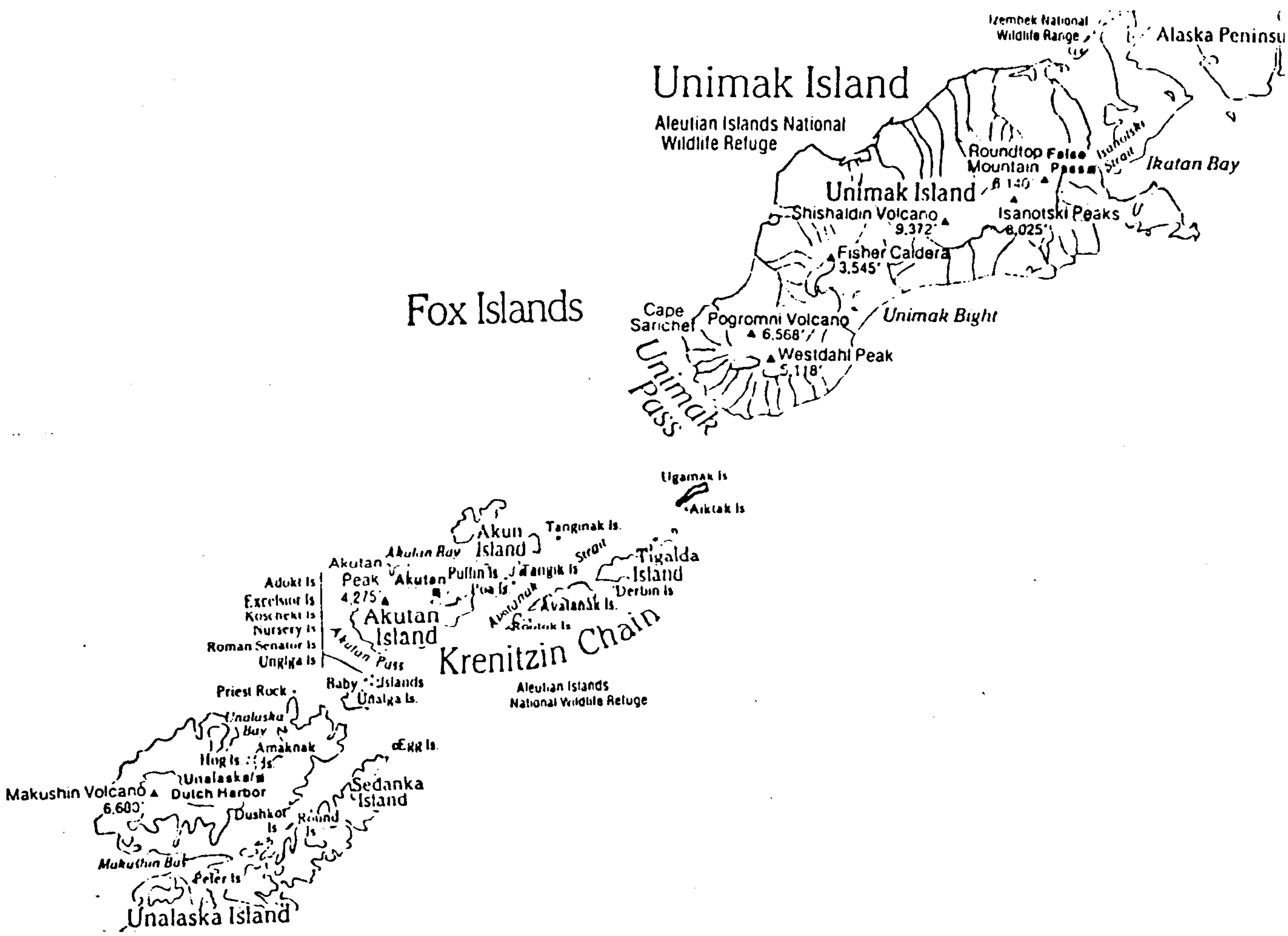


FIGURE 2.2 SUB-REGIONAL LOCATION MAP OF UNIMAK PASS



SOURCE: The Aleutians, Volume 7, Number 3, 1980, Alaska Geographic.

limited value since virtually nothing has been written about traffic levels or navigation issues in Unimak Pass. Discussions were held with various shipping and fishing vessel operators who frequently use the pass. Also, phone interviews were conducted with the U.S. Coast Guard and the Southwest Alaska Pilots Association regarding the pass.

Only one major problem was consistently perceived by the marine operators and that was a problem of weather. However, for the collisions recently reported, inclement weather does not appear to be a factor. Furthermore, weather is a typical consideration which all marine navigation activities must monitor.

One major shipping firm (name withheld by request) stated that it had a couple minor incidents with non-English speaking fishing vessels in the pass. None of the interviewed shippers said that the current traffic levels were a problem, and many stated that there could be a major increase in traffic and they would not even be aware of it. Many of the vessel operators did not appear to be aware or concerned that significant increases in Unimak Pass vessel traffic may result from future OCS activities in western and northern Alaska. None of the shippers saw a need for a traffic separation scheme. However, at the same time no one stated any opposition to such a scheme if it was deemed necessary.

2.2.1 Collisions in Unimak Pass

Limited information on collisions in Unimak Pass is available. Based on the existing literature, a review of major Alaskan newspaper files from the mid-1970s to the present time, and personal interviews, it appears that no collisions have occurred in which human lives were lost. The Coast Guard has also stated that Unimak Pass has "no strong history of collisions" (Anchorage Times, March 13, 1984). However, it is not known how well historical accidents in the pass have been reported to the Coast Guard.

At least two reported collisions occurred in 1983. These two collisions appear to be a result of pilot error and/or carelessness. In June 1983, the 300 foot Gale Wind was towing the 520 foot Resoff when a 300 foot stern trawler, Sunflower, ran through the tow line and struck the Resoff (Fairbanks Daily News Miner, June 14, 1983). The specific location of the collision was not reported. There were no reported injuries and neither vessel was damaged enough to cause a concern for sinking. The weather was reported as good.

In September 1983, two South Korean freighters collided "near" Unimak Pass (Anchorage Times, September 11, 1983). The 551 foot Pan Nova, which was carrying wheat and headed for Korea, collided with the Swibon just after midnight. There were no personal injuries, but the Pan Nova was damaged enough so that a U.S. Coast Guard cutter had to rescue its twenty-six member crew. Again, the weather was listed as good with only ten-knot winds, two-foot seas, and twelve miles visibility. According to one interviewed source (name withheld by request), this collision was a complete act of carelessness. The vessels were reported to have been on automatic pilot, and consequently, were unaware of each others' presence.

2.2.2 Coast Guard Activities

The U.S. Coast Guard (USCG) recently conducted a study in Unimak Pass to determine if a vessel separation scheme is required. The 1972 Port and Waterway Safety Act and subsequent admendments require the USCG to study navigable waterways, at least once every eight years, to determine if marine traffic levels and related navigational concerns necessitate a need for a vessel separation scheme.

Their study estimated that approximately 3400 annual trips are currently made through Unimak Pass. This estimate was developed by applying a factor to 59 days of field data collected by a combination of Coast Guard cutters and buoy tenders making trips through the pass and an air reconnaissance (one trip in a C 130 Hercules) over the pass. The Coast Guard study concluded that a range of 3,000 to 4,000 annual transits of the pass are likely (Lt. Commander J.D. Asbury, Personal Communication).

Their study suggests that the level of marine traffic using Unimak Pass does not warrant a vessel separation scheme. However, the final determination will be made in January 1985 (Lt. Commander J.D. Asbury, Personal Communication). Even if such a scheme is recommended by USCG, it will need to be ratified by the International Maritime Organization which is part of the United Nations. This course of action is necessary since maritime regulations specify that sea lanes beyond three miles of any country's land mass are available for international navigation purposes.

3.0 UNIMAK PASS VESSEL TRAFFIC

Limited vessel traffic data are available for Unimak Pass. This section provides an estimate of base year traffic data and forecasts for 1985, 1990, 1995, and 2000. The traffic estimates are divided into four categories: OCS activities, fishing, natural resources, and commercial shipping (both domestic traffic serving western and northern Alaska and international traffic via the great circle route). United States military operations (Navy and Coast Guard) using the pass for search and rescue missions, buoy tenders and international fisheries law enforcement are estimated to be less than 200 trips per year. They are not included in these traffic estimates. General assumptions associated with the estimates are based upon the review of available information and discussions with knowledgeable private industry and governmental agency representatives.

3.1 Current Traffic Estimates

Table 3.1 presents an estimate of base year vessel trips through Unimak Pass. The base year is 1982. Approximately 2300 annual trips have been estimated. Of these trips, fishing vessels account for approximately 60 percent of the total trips. The remaining trips are comprised of commercial vessels, which are primarily linehaul cargo ships, and account for approximately 25 percent of the total; natural resource vessels account for about 10 percent and OCS vessels for the remaining 5 percent of the traffic.

A recent Coast Guard study estimated the annual traffic to be approximately 30 percent more than this estimate (see Section 2.2.2). However, given the lack of a historical data base and the difference between the two methodologies in estimating the traffic levels, this was assumed to not represent a significant difference and/or concern.

The timing and distribution of vessels in the pass are not known. However, an estimate of seventy percent of the traffic occurs between April and September was assumed. This time frame generally corresponds with the seasonal periods of "better" weather (except for visibility and fog) and the major fishing seasons in the Bering Sea area (U.S. Department of Commerce, 1983).

TABLE 3.1

UNIMAK PASS VESSEL TRAFFIC BASE YEAR*

TRAFFIC CATEGORY	NO. TRIPS
OCS Vessels	
Support Traffic	120
Resource Tankers	0
Subtotal	120
Fishing Vessels	
Domestic	651
International	719
Subtotal	1370
Natural Resource Vessels	
Timber	220
Subtotal	220
Commercial Vessels	
Domestic	270
Foreign	310
Subtotal	580
TOTAL	2290

*This table was developed from the text in Section 3.1 and Tables 3.2 through 3.4.

Source: Louis Berger and Associates, Inc., Anchorage, AK.

3.1.1 OCS Traffic

At present, two types of OCS activities in northern and western Alaska result in traffic moving through Unimak Pass. The annual sealift to northern Alaska, serving Prudhoe Bay, Kuparuk River, and Beaufort Sea operations, constitutes the majority of this traffic. In 1983, 13 tugs and 26 barges made the trip (Louis Berger and Associates, 1984).

In western Alaska, exploration activities are presently occurring as a result of the Norton Sound and St. George Basin lease sales. The Norton Sound Sale No. 57 was held March 15, 1983. The St. George Basin Sale No. 70 was held April 12, 1983. Using previous OCS traffic data developed for exploration activities in these two areas, 42 annual trips through Unimak Pass have been estimated (Peat, Marwick, Mitchell & Company, 1981 and Peat, Marwick, Mitchell & Company and James Lindsay & Associates, 1980). These trips, combined with the sealift traffic of 78 roundtrips (13 tugs plus 26 barges times two), represent the total of the 120 trips shown in Table 3.1.

3.1.2 Fishing Vessels

Domestic and international fishing activities account for the majority of vessel traffic currently using Unimak Pass. Domestic vessels principally originate from Seattle and the Puget Sound area. International traffic originates primarily from Japan, Korea, the Soviet Union, and Poland. Based on discussions with a number of industry and government sources, it is estimated that approximately 1,370 fishing-related movements were made through Unimak Pass during the 1982-1983 fishing season (Tables 3.2 and 3.3). Approximately fifty-three percent of these trips are believed to have been made by the international fleet. (See Table 3.3; 719 international fleet trips out of a total of 1370 trips.)

Domestic fleet traffic through Unimak Pass is characterized primarily by crab vessels traveling to fishing grounds in the Bering Sea, joint venture and other trawlers working the rich fisheries located just north of Unimak Pass, and smaller commercial purseiners and craft pursuing the herring and salmon fisheries of Bristol Bay. It is estimated that these domestic fleet vessels currently make about 650 trips through Unimak Pass each year (Table 3.2).

The international fleet which travels through Unimak Pass is comprised of trawlers, seiners, long-liners, factory ships, cargo transport vessels, snail pot vessels, and support tankers. Based on information provided by the National Marine Fisheries Service (NMFS), it is estimated that 512 international vessels operated in Alaskan waters during the 1982-1983 fishing season. Of these vessels, 176 operated exclusively in the central Bering Sea and the western Aleutian areas. The remaining 336 vessels fished and

TABLE 3.2

DOMESTIC FLEET MOVEMENTS THROUGH UNIMAK PASS

1982-1983 FISHING SEASON

VESSEL TYPE/CLASS	FLEET SIZE	AVERAGE VESSEL TRIPS/YEAR	ESTIMATED ANNUAL VESSEL MOVEMENTS THROUGH UNIMAK PASS
Crab Vessels (85'-130')	130	1	130
Joint Venture Trawlers (85'-130')	40	2	80
Other Bottomfish Trawlers (85'-130')	25	2	50
Red Herring Purseiners (32'-48')	150	1	150
Salmon Boats (18'-32')	241	1	241
TOTAL	566		651

Sources: Alaska Department of Fish and Game, Commercial Fisheries Division, Kodiak, AK (Personal Communication with Marty Eaton)
TAMS Engineers, Anchorage, AK (Personal Communication with Gary Schneider)
Natural Resources Consultants, Seattle, WA, April 1984
Louis Berger and Associates, Inc., Anchorage, AK, April 1984

TABLE 3.3

INTERNATIONAL FISHING FLEET MOVEMENTS THROUGH UNIMAK PASS

1982-1983 FISHING SEASON

VESSEL TYPE/CLASS	FLEET SIZE* (NO. OF VESSELS)	AVERAGE VESSEL TRIPS/YEAR	ESTIMATED VESSEL TRIPS TO & FROM ALASKAN WATERS	ESTIMATED ANNUAL VESSEL TRIPS THROUGH UNIMAK PASS
Trawlers				
Less than 290 metric tons GWT	5	3	15	11
290-1399 metric tons GWT	121	3	363	272
Over 1400 metric tons GWT	55	3	165	124
Seiners	14	1	14	11
Long-liners	23	3	69	52
Factory Ships (processors)	9	1	9	7
Cargo Transport	102	3	306	230
Support Tankers	5	3	15	11
Snail Pot	2	1	2	1
TOTAL	336	2.85	958	719

* International Fleet estimates do not include approximately 176 other international vessels which operated exclusively in the central Bering Sea and the western Aleutian Chain.

Source: National Marine Fisheries Service, Juneau, AK (Personal Communication with Vicki Vaughn)
Louis Berger and Associates, Inc., Anchorage, AK

traveled throughout Alaskan waters from the central Bering Sea to Yakutat. Using average vessel trip estimates by NMFS and confidential Japanese industry sources, a total estimate of seasonal trips (958) to and from Alaskan waters was developed. Assuming that seventy-five percent of these trips were made through Unimak Pass, it is estimated that the 336 vessels made approximately 720 trips through Unimak Pass for movements to and from the Gulf of Alaska, Bristol Bay, and the Bering Sea (Table 3.3).

3.1.3 Natural Resource Shipping

The shipment of natural resources through Unimak Pass is characterized almost entirely by freighters transporting logs, cants, manufactured logs, and wood chips to Far East markets. These freighters typically transport approximately 1.5 to 4.0 million board feet of timber product per shipment. Since 1975, approximately 500,000 to 600,000 thousand board feet of timber are harvested annually in the State of Alaska (Alaska Department of Natural Resources, 1984). Approximately eighty percent of this product is shipped to Japan (Morehouse, 1984). Most of the exported timber originates from the southeast, e.g. Ketchikan.

The current level of natural resource shipping movements through Unimak Pass is approximately 225 vessel trips associated with the export of timber products to the Near East. Potential shipping movements through the Pass from other natural resource development activities in Alaska have not materialized in recent years due to changing conditions in world coal and other mineral markets.

3.1.4 Commercial Shipping

Unimak Pass is used by a number of domestic and foreign container vessels, freighters, tankers, and barges. The domestic ships predominately transport various types of freight and materials to numerous Bering Sea, Bristol Bay, and Aleutian Islands communities.

In 1982, some 680,000 short tons of waterborne freight were transported to various communities in the Bering Sea, Bristol Bay, the Aleutian Islands, and the northerly side of the Alaskan Peninsula (Table 3.4). Based on a review of past schedules, phone conversations with selected shippers, and previous transportation reports, it is estimated that approximately 80 percent of all incoming freight to the area is transported via Unimak Pass. Therefore, assuming that 544,000 short tons of freight (80 percent of 680,000 short tons) were transported on vessels carrying an average annual vessel carrying capcity of 8,000 DWT, it is estimated that 136 one-way commercial vessel trips were

TABLE 3.4

1982 DOMESTIC WATERBORNE COMMERCE

BERING SEA, BRISTOL BAY, ALEUTIAN ISLANDS, AND

NORTHERLY SIDE OF ALASKAN PENINSULA

	FREIGHT VOLUMES (SHORT TONS)						
	DOMESTIC		INTERNATIONAL		LOCAL		
PORTS OF CALL	INCOMING	OUTBOUND	IMPORT	EXPORT	INCOMING	OUTBOUND	TOTAL
Nome	42,398	2,496	---	---	---	---	44,894
Yukon River	3,111	21	___	___	___	3	3,135
Bering Sea Ports	148,708	8,788	32,097	___	___	48,127	237,720
Pribilof/ St. Matthew Islands	8,956	866	___	___	___	___	9,822
Bethel	52,930	34,384	___	___	38	8,753	96,105
Dillingham	38,294	4,540	___	___	___	___	42,834
Alaskan Peninsula (northerly side)	44,978	3,015	___	___	8,753	733	57,479
Dutch Harbor	340,634	224,375	1,819	6,658	___	172,313	745,799
TOTAL	680,009	278,485	33,916	6,658	8,791	229,929	1,237,788

Source: U.S. Army Corps of Engineers, 1984.

made through Unimak Pass in 1982. This was converted to round-trips through the pass for a total of 272 vessel movements.

Foreign vessels moving through Unimak Pass are generally providing service between United States west coast ports and Asian ports following the great circle route. These foreign sailings originate in Seattle, San Francisco, Portland, or Los Angeles and in Japan, Korea, and sometimes Taiwan. A previous estimate of 310 annual foreign vessel movements through Unimak Pass was used (Peat, Marwick, Mitchell & Company, 1981).

3.2 Future Traffic Projections

Table 3.5 presents Unimak Pass vessel traffic projections for 1985, 1990, 1995, and 2000. Total traffic is projected to double between the base year and the year 2000 (2290 to 4600 trips). Significant increases in OCS vessels and other natural resource vessels using Unimak pass are expected to occur. In the peak traffic year (2000), OCS vessels are projected to account for approximately 24 percent of the total trips compared to 5 percent in the base year. Natural resource vessels are expected to account for approximately 28 percent of the total traffic compared to 10 percent in the base year.

The number of fishing vessels using Unimak Pass are expected to remain generally constant throughout the forecast period. However, given the expected increases in other traffic components, the number of fishing vessels will represent only about 30 percent of the traffic in 2000 as compared to 60 percent estimated for the base year. For the number of commercial cargo vessels, a modest linear growth pattern is projected. This segment of the traffic is projected to account for about 18 percent of the traffic in 2000 as compared to 10 percent in the base year.

3.2.1 OCS Traffic

Vessel traffic using Unimak Pass as a result of future OCS exploration and development in western and northern Alaska is very speculative. The major factors which will affect this traffic component are the specific locations of these activities and associated support facilities, timing, and where and how the developed resources will be transported to market.

The current Federal Five-Year OCS Oil and Gas Leasing Schedule (July 1982) has thirteen lease offerings scheduled between 1982 and 1987 that could potentially result in increases in OCS traffic moving through Unimak Pass into western and northern Alaska. In order to develop an estimate of potential traffic, a

TABLE 3.5

TOTAL UNIMAK PASS VESSEL TRAFFIC PROJECTIONS*

CATEGORY	1985	1990	1995	2000
OCS Vessels				
Support Traffic	170	410	290	280
Resource Tankers	0	140	410	840
Subtotal	170	550	700	1120
Fishing Vessels				
Domestic	651	651	651	651
International	719	719	719	719
Subtotal	1370	1370	1370	1370
Natural Resource Vessels				
Coal	16	16	216	216
Timber	224	224	224	224
Other		34	34	834
Subtotal	240	270	470	1270
Commercial Vessels				
Domestic	300	340	390	460
Foreign	320	340	360	380
Subtotal	620	680	750	840
TOTAL	2400	2870	3290	4600

* This table was developed from Tables 3.6 through 3.10 and the corresponding text in Section 3.2. Subtotals were rounded to the nearest ten.

Source: Louis Berger and Associates, Inc., Anchorage, AK

"most likely" scenario of cumulative exploration and development assumptions for the six OCS planning areas from which the thirteen lease offerings originate in northern and western Alaska was developed. This included exploration only activities for the Norton Basin, Barrow Arch, and North Aleutian Basin, and a mean find scenario for the Diapir Field Basin, Navarin Basin and St. George Basin.

Tables 3.6 and 3.7 are estimates of future OCS traffic required to support the "most likely" exploration and development scenario. These estimates have been developed from previous transportation impact studies and assumptions sponsored by the Social and Economic Studies Program.

Starting in the 1990s, resource tankers serving the St. George and Navarin Basins are projected to be the major component of the OCS traffic in western Alaska (see Table 3.6). Supply vessels, barges and tugs serving these areas are projected to remain constant after commercial production begins. It is assumed that major linehaul vessels will supply the individual support bases which are assumed to be on the northern side of Unimak Pass. Smaller vessels and barges will then transship supplies to the individual sites as required. Consequently, given these assumptions, it is not likely that a significant amount of the support traffic will move through Unimak Pass on a regular basis.

The sealift traffic forecasts (Table 3.7) assume a relatively high level of demand through early 1990. This is primarily a result of the continuing demands from current production at Prudhoe Bay and Kuparuk River and the exploration activities expected for the Diapir Field and the Barrow Arch lease areas. All resource production is assumed to be transported via the Trans-Alaska Pipeline System (TAPS).

Table 3.8 presents the combined traffic projections of OCS activities in western and northern Alaska that are likely to use Unimak Pass. Between 1985 and 2000 total annual OCS traffic is expected to increase over 500 percent (170 to 1124 trips).

3.2.2 Fishing Vessels

Future fishing-related traffic using Unimak Pass through the year 2000 is expected to continue at about the same levels as occurred in 1982-1983. This trend will continue because of the continued availability of an abundant groundfish resource in Alaskan waters, and competitive economic interests desiring to harvest these resources and provide fishery products to the

TABLE 3.6

WESTERN ALASKA OCS TRAFFIC PROJECTIONS USING UNIMAK PASS

	NORTON BASIN		ST. GEORGE BASIN		NAVARIN BASIN		NORTH ALEUTIAN*** BASIN		TOTAL TRIPS****	
YEAR	SV*	RT**	SV	RT	SV	RT	SV	RT	SV	RT
1985	5		27						64	
1986	2		37		41		9		178	
1987			25		56		13		188	
1988			45		38		14		194	
1989			59		68		13		280	
1990			73	71	89		7		338	142
1991			58	239	110				336	478
1992			52	332	87				278	664
1993			49	285	78				254	570
1994			49	218	74	8			246	452
1995			49	177	74	28			246	410
1996			49	148	74	51			246	398
1997			49	128	74	87			246	430
1998			49	116	74	120			246	472
1999			49	107	74	225			246	664
2000			49	101	74	320			246	842

*SV = Supply vessels, barges, and tugs.
**RT = Resource tankers.
***Exploration scenario for the North Aleutian Basin was assumed to be similar to the St. George Basin, since a previous analysis has not been developed.
****Converts individual trips into roundtrips by multiplying by two.

Source: Peat, Marwick, Mitchell and Company and James Lindsay and Associates, 1980; and Louis Berger and Associates, 1984.

TABLE 3.7

SEALIFT TRAFFIC PROJECTIONS FOR 1985-2000 USING UNIMAK PASS

	PRUDHOE BAY & KUPARUK RIVER		DIAPER FIELDS		BARROW ARCH		TOTAL ROUND TRIPS*	
YEAR	TUGS	BARGES	TUGS	BARGES	TUGS	BARGES	TUGS	BARGES
1985	6	12	12	23			36	70
1986	6	12	12	23	2	3	40	76
1987	6	12	11	22	2	4	38	76
1988	6	12	10	20	2	4	36	72
1989	6	12	13	25	2	4	42	82
1990	6	12	4	7	3	5	26	48
1991	5	10	5	9			20	38
1992	5	10	8	16			26	52
1993	5	10	7	13			24	46
1994	5	10	3	5			16	30
1995	5	10	2	4			14	28
1996	4	8	2	4			12	24
1997	4	8	2	4			12	24
1998	4	8	2	4			12	24
1999	4	8	2	4			12	24
2000	4	8	2	4			12	24

*Converts individual trips into roundtrips by multiplying by two.

Source: Louis Berger and Associates, 1984 and ERE Systems, Ltd., 1984.

TABLE 3.8

TOTAL OCS TRAFFIC PROJECTIONS USING UNIMAK PASS*

	WESTERN ALASKA OCS TRAFFIC		NORTHERN ALASKA OCS TRAFFIC	TOTAL OCS TRAFFIC	
YEAR	SUPPORT TRAFFIC	RESOURCE TANKERS	SUPPORT TRAFFIC	SUPPORT TRAFFIC	RESOURCE TANKERS
1985	64		106	170	
1986	178		116	294	
1987	188		114	302	
1988	194		108	302	
1989	280		124	404	
1990	338	142	74	412	142
1991	336	478	59	394	478
1992	278	664	78	356	664
1993	254	570	70	324	570
1994	246	452	46	292	452
1995	246	410	42	288	410
1996	246	398	36	282	398
1997	246	430	36	282	430
1998	246	472	36	282	472
1999	246	664	36	282	664
2000	246	842	36	282	842

*Combines the traffic data from Tables 3.6 and 3.7.

Source: Louis Berger and Associates, Inc., Anchorage, AK.

international marketplace. Future changes in groundfish harvesting technology are expected to influence the quality of the product transported to the marketplace rather than the amount of trips to and from Alaskan waters.

No meaningful statistical estimates of the split between future domestic and international fleet movements through Unimak Pass can be made at this time. Decreasing harvest allocations to other nations, e.g. Japan, and the related emergence of considerable American industry interest in harvesting Alaska's groundfish resources suggest significant changes in the composition of the future fleets which will pursue fisheries resources in Alaska.

American and Japanese industry sources suggest that most, if not all, of the trawler vessels operating in Alaskan waters may be American vessels by the early 1990s. In response, much of the international fleet will likely be converted to factory (processing) ships until such time that American industry develops more factory trawlers (combined catching and processing ships). Consequently, the interim period between 1984 and the early 1990s will likely continue to be characterized by a growing number of joint ventures of American trawlers and international factory ships.

Anticipated changes in the composition of the domestic and international fleet are expected to reduce the size of the international fleet and increase the size of the American fleet. However, the amount of vessel trips through Unimak Pass is not expected to change more than plus or minus ten percent from current traffic levels.

3.2.3 Natural Resource Shipping

The future composition and volume of natural resource shipments are expected to change considerably as exports of coal and other selected mineral ores begin to emerge in the late 1980s and early 1990s. The significance of these new exports upon transportation movements through Unimak Pass will depend upon final logistical decisions which will be made for each of three anticipated resource development projects. Timber exports are generally expected to maintain present levels of both production and related vesel transport to Far East markets. More specific assumptions made in conjunction with each general type of resource are described in the following paragraphs.

3.2.3.1 Coal

Plans for four coal export projects have been identified in recent years which, if carried out, will generate coal-related shipping movements to the Near East. The four proposed projects include (1) Sun-Eel's export of coal from the Usibelli Coal Mine in Healy to the Korea Electric Company, (2) Placer Amex export of coal from the Beluga Coal Fields to a yet undetermined market source in the Near East, (3) the export of coal in adjacent Beluga Coal Field lands by Dimond-Alaska Coal Company to a yet undefined market source in the Near East, and (4) the export of bituminous coal from the Bering coal fields near Cordova by KADCO and Chugach Alaska Corporation.

After several months of uncertainty, Sun-Eel has finally arranged additional financial backing for its coal export project. Additional financing was obtained through its recent sale of half of its stock to Hyundai Merchant Marine. Sun-Eel's business move was apparently made in response to Korean government efforts to consolidate Korea's shipping industry. However, the stock sale also generated needed additional financing and/or financial leverage to Sun-Eel. Both firms finalized their agreement on March 25, 1984.

Given the recent positive actions by Sun-Eel, the State of Alaska has resumed its efforts for the construction of dock improvements at the site of the proposed coal terminal facility in Seward. The latest project schedule indicates that approximately 0.8 million tons of steam coal will be exported annually to Korea Electric Company. When in operation, three-weekly railcar loads of coal will be transported from Healy to Seward where the coal will be onloaded to transport vessels having a carrying capacity of approximately 100,000 DWT.

Plans by both Placer Amex and Dimond-Alaska Coal Company for the export of coal from adjacent fields in the Beluga area remain conceptual in nature at this time. Both investment groups have made estimates of potential quantities and quality of developable coal deposits, and have identified conceptual support requirements for the extraction and transportation of the resource. No potential customers for the potential resource have been identified for either project. However, the proximity of Alaska to the Near East, in comparison to the U.S. west coast, is one of various factors which suggest that any potential market for the resource will most likely be in the Near East. Given this circumstance and numerous other undefined considerations, both of the projects remain, at best, uncertain (Morehouse, 1984).

Preliminary estimates of the developable resource suggest that approximately 10 million short tons of coal will be recovered annually by Placer Amex while some 7.7 million short tons of coal will be extracted by Dimond-Alaska Coal Company. Respective project schedules suggest that potential export of the resource could begin sometime in the late 1980s or early 1990s.

Chugach Alaska Corporation and KADCO (a consortium of three Korean companies) are in the midst of completing their third and final year of preliminary exploration work which will indicate the size, volume and quantity of coal reserves in the Bering coal field near Cordova. Preparation of conceptual plans for required infrastructure support are expected to begin within the next two years. Agreements between Chugach Alaska Corporation and KADCO stipulate that KADCO has the first option to buy on reserves eventually developed. Consequently, the eventual market for these resources is expected to be in Korea. The timing of the proposed project is difficult to assess at this early stage of the project. It is reasonable to assume, however, that this project will generate future shipments of coal through Unimak Pass in light of current agreements between KADCO and Chugach Alaska Corporation.

For the purposes of this forecast, it was assumed that only the Sun-Eel and Placer Amex project will begin operations before the year 2000 (Table 3.9). It was assumed that both of these projects will export quantities currently estimated beginning in 1986 (Sun-Eel) and 1995 (Placer Amex).

The potential vessel traffic which will be generated through the export of coal from the Sun-Eel and Placer Amex projects over the next fifteen years is presented in Table 3.9. The Sun-Eel project is expected to generate approximately sixteen annual vessel trips during the next ten years while the Placer Amex will require some 200 annual vessel trips beginning in 1995.

3.2.3.2 Other Minerals

Although various known mineral deposits are located throughout the state, e.g. Ambler district, Admiralty Island, and the Delong Mountains, available data suggests that only three mineral development projects show promise during the forecast period. Similar to coal, numerous market and production cost considerations will continue to affect the viability of these two projects. The export of minerals from each of these projects will likely generate vessel transport movements through Unimak Pass enroute to markets in British Columbia and the Near East.

Cominco Alaska and NANA, Inc. are in the process of developing a new lead/zinc/silver mine approximately 90 miles north of Kotzebue. Red Dog deposit, the source of minerals for this project, is estimated to contain 85 million tons of ore which contains 5 percent lead, 17 percent zinc, and 2.4 ounces of silver per ton of ore (Morehouse, 1984). As proposed, this project will begin operations in early 1988. Extracted ore will be exported at a rate of approximately 500,000 short tons of ore per year (Personal Communication, Noah, 1984).

TABLE 3.9

NATURAL RESOURCE SHIPPING MOVEMENTS THROUGH UNIMAK PASS

ESTIMATED ANNUAL VESSEL TRIPS

YEARS 1985, 1990, 1995, AND 2000

TYPE OF RESOURCE	ESTIMATED EXPORT VOLUME (MILLION SHORT TONS) 1985	1990	1995	2000	UNIT TRANSPORT SIZE (DWT)	POTENTIAL VESSEL TRIPS VIA UNIMAK PASS 1985	1990	1995	2000
Minerals									
Coal	0.8	0.8	10.8	10.8	100,000 DWT	16	16	216	216
Other Minerals	-	0.5	0.5	40.5	30,000 DWT and 100,000 DWT*		34	34	834
Timber	0.002	0.002	0.002	0.002	20 DWT	224	224	224	224
TOTAL						240	274	474	1274

* Should the U.S. Borax Mine in Ketchikan go into production, it is assumed that a larger 100,000 DWT vessel will be used.

Source: Louis Berger and Associates, Inc., Anchorage, AK

Cominco officials estimate that approximately sixty percent of the ore will be shipped to Cominco's smelter in Trail, British Columbia. The remaining forty percent will be transported to yet undefined markets in Japan.

Approximately eighteen miles southwest of Juneau is a mineral deposit known as Greens Creek. This deposit, estimated to have some three million tons of reserves, contains ores with nine to ten percent zinc, three percent lead, and nine to ten ounces of silver per ton (Morehouse, 1984). Proposed plans call for mine production to begin in late 1986. Export quantities are estimated to be approximately 0.2 million ton per year over a fifteen-year period. The ultimate market for these resources has not been determined. For the purposes of this report, it is assumed that a future market will be found in the Near East.

The U.S. Borax "Quartz Hill" molybdenum mine near Ketchikan is tentatively scheduled for production sometime in 1988. Proposed plans indicate that the mine will produce approximately 40,000 million tons of ore per year (Alaska Information Service, 1984). Even though the eventual market for the ore has not been identified, it is expected that the future market will be in the Near East as U.S. Borax will continue to have serious competition from a crowded American market (Alaska Information Service, 1984).

Assuming that each of the three mineral projects come into production and are marketed as suggested, future vessel traffic in Unimak Pass would increase only slightly during the next ten years (Table 3.9). In the event that the U.S. Borax projects come on line by the year 2000, a significant additional traffic flow will be generated independently by this project (Table 3.9).

3.2.3.3 Timber

State forestry officials expect that future timber exports to the Near East will occur at the present rate of approximately 440,000 million board feet per year to the year 2000 (Alaska Department of Natural Resources, Division of Forestry, 1984). Assuming an average freighter capacity of 3.75 million board feet (20 DWT) per load (based on discussions with the forestry officials), the continued annual export volume of 440 million board feet of timber will generate approximately 225 vessel trips through Unimak Pass each year.

3.2.4 Commercial Shipping

Future domestic commercial shipping can be estimated by assuming that such shipments will increase at the average annual rate of population growth. From 1970 to 1980, the average annual growth rate of population in the Aleutian Islands was approximately 2.9 percent. Using this growth factor in conjunction with other assumptions made concerning current shipping activity, future shipping movements through Unimak Pass were calculated (Table 3.10). Application of the 2.9 percent annual growth rate to the 1982 year estimate of 544,000 short tons of freight via Unimak Pass formed the basis for the 1985 estimate.

Table 3.10 suggests that future domestic commercial shipping movements through Unimak Pass will not increase significantly during the next fifteen years. By the year 2000, it is estimated that 460 annual domestic commercial shipping trips will be made through the pass.

For foreign commercial vessels, previous estimates developed by Peat, Marwick, Mitchell and Company (1981) were assumed to be reasonable. These estimates are as follows: 320 foreign vessels in 1985; 340, in 1990; 360, in 1995; and 380, in 2000.

TALBE 3.10

FUTURE DOMESTIC COMMERCIAL SHIPPING MOVEMENTS

THROUGH UNIMAK PASS

1985, 1990, 1995, AND 2000

YEAR	ESTIMATED SHIPPING VOLUMES TO ALEUTIANS, BRISTOL BAY, AND WESTERN ALASKA (SHORT TONS)	ESTIMATED SHIPPING VOLUMES VIA UNIMAK PASS AT 80% OF TOTAL VOLUME (SHORT TONS)	AVERAGE VESSEL CARRYING CAPACITY (DWT)	ESTIMATED* VESSEL ROUNDTRIPS VIA UNIMAK PASS
1985	740,892	592,714	8,000	300
1990	854,736	683,789	8,000	340
1995	986,072	788,858	8,000	390
2000	1,137,589	910,071	8,000	460

* Eighty percent shipping volumes (short tons) divided by 8,000 DWT (average vessel carrying capacity) multiplied by 4 = estimated roundtrips via Unimak Pass. Rounded off.

Source: Louis Berger and Associates, Inc., Anchorage, AK

4.0 PROBABILITY OF FUTURE COLLISIONS

4.1 Factors Affecting Collisions

There are a variety of factors which determine whether or not a vessel collision will occur in a given location. These include the physical restrictions on vessels in the location, the number of vessels which come into the area, the speed of the vessels, the weather conditions (particularly visibility), the mechanical condition of the vessels, and the training and alertness of the crews.

According to Devanney (1979) the single most complete analysis of vessel collisions was carried out for the English Channel in the area of the Dover Straits. A study by Wheatley (1972) examined 174 collisions in this area between 1958 and 1971. Another study covered a worldwide sample of data over a seventeen-year period (Cockroft, 1976) for collisions where a large vessel was involved, and the National Transportation Safety Board in 1979 examined all large vessel accidents in U.S. waters over a five-year period.

These analyses all point out the importance of local characteristics and hazards which contribute to collisions, and the large variability in the physical condition and training of the ships' crews. Most collisions are caused by several contributory factors rather than a single factor. The most common contributory factor was rules violations, followed by judgment errors, environmental conditions (especially fog), and other human errors.

However, there were several significant points discovered by these researchers which could be generalized to other locations. These were:

1. Most accidents occur in conditions of poor visibility (eighty percent of the Dover Straits and seventy percent of worldwide accidents occurred in poor visibility).

2. The majority of accidents take place when vessels are crossing or overtaking each other.

3. Most of the ships that were involved in collisions were aware of the other ship, usually through radar contact.

The visibility issue is even more of a collision factor when the frequency of low visibility conditions is taken into account.

In the Dover Straits poor visibility (less than 4000 m.) occurred only six percent of the time, yet these time periods accounted for eighty-two percent of the accidents. This relationship is particularly important in the case of Unimak Pass which has frequent fog.

Another way to evaluate ship collisions in low visibility conditions has been used in both Japan and England where the accident rate in conditions of either good or poor visibility has been compared to the probability of random collisions with no avoidance maneuvers. In clear weather and good visibility the accident rate is 1/10,000 of the random probability. However, in poor visibility the rate is only 1/10 of the random probability (Devanney, 1979).

According to Devanney, the main reason for the high collision rate in poor visibility conditions, even when the vessels are aware of each other, is a basic ambiguity in the "rules of the road." These rules call for a turn to starboard by both ships when they are approaching on a crossing course in a potentially dangerous situation. This works well when the ships approach each other head on or to port; but when they are approaching slightly to starboard, a starboard turn could make the situation more dangerous. This situation causes the pilots to make an unpredictable choice of port or starboard turns.

The situation is made worse in poor visibility when the pilots cannot visually observe the actions of the other vessel. In this circumstance a greater number of avoidance maneuvers are taken by approaching vessels and this tends to increase the probability of collisions rather than decrease it.

4.2 Collision Models

As described above, the peculiarity of the data on vessel collisions and the variability of human behavior has made it difficult to model collisions between vessels. There is an attempt to correct this problem by the Coast Guard through simulation of specific sites with a Traffic Management Model now under development at the DOT Transportation Systems Center, based on previous port traffic research in the Netherlands. This model will allow the simulation of ship maneuvers with very site-specific data on hazards and other conditions. This reseaarch is being complemented by simulation of ship behavior at the DOT Computer Aided Operations Research Facility (CAORF) at Kings Point, New York and by the Marine Institute of Training and Graduate Studies in Baltimore. These research operations examine the crew's behavior under simulated conditions on the ship's bridge.

The most pertinent research on vessel collisions now available has been carried out on a more general level. This includes research by Draper and Bennett (1972) for the Dover Straits and generalized by Operations Research Inc. (1974) and applied by Earl R. Combs (1981) for Alaskan conditions. The approach of these models is to define the probability of collision as the product of the probabilities of two separate events: (1) two vessels encounter each other and (2) the vessels collide in the encounter zone.

The probability of encounter is a function of traffic levels, size of the passage or channel, speed and length of the vessels. The probability of collision given that two ships have an encounter is a function of visibility, condition of the ships and training of the crew, communications between ships and a set of random events that might cause a ship to deviate from its course.

In the case of two ships proceeding in opposite directions through a navigation channel such as Unimak Pass, the number of possible encounters per year is given by Combs as:

$$E = N^2 \; L/2KV$$

Where N = the number of vessel passages per year

L = the length of the waterway in nautical miles

K = a constant equal to the number of hours in a year

V = the average velocities of vessels in knots

This equation gives the number of times per year that two vessels moving in opposite directions will be in the channel at the same time. This is defined as an encounter. From this equation it can be seen that the number of encounters increases with the square of the traffic level and in proportion to the length of the waterway. It decreases as average vessel speed increases (and ships spend less time in the waterway).

The probability of a collision was then expressed as:

$$C = P(C/E)Eb/W$$

Where P(C/E) = the probability of a collision given an encounter

E = the number of encounters per year

b = the average clearance requirements of vessels in miles

W = the average width of the waterway navigation channel in miles

The probability of a collision given an encounter depends on the alertness, behavior patterns, and avoidance maneuver expectations of ship crews, and must be estimated from appropriate research. This is then multiplied by the number of encounters (as given from the first equation) and adjusted to take into account vessel clearance requirements and channel width. The larger the channel, the lower the probability of collision. The larger the vessel and its clearance requirements, the greater the probability of collision.

The Combs model described above was modified to take into account the difference in collision rates under poor visibility cited by Devanney, et al. and to take into account traffic variation over the year. The first adjustment was accomplished by using a linear equation related to visibility rather than a constant for the conditional probability of collisions. The constant used by Combs assumes that the occurrence of poor visibility in other locations is the same as that where the research was done (Dover Straits). This assumption does not hold for Unimak Pass where more frequent fog conditions are found. Therefore, the Dover data was converted to an equation which increases the probability of collisions in relation to the occurrence of poor visibility.

The resulting equation, derived from the Dover research* is:

$$P(C/E) = .002F + 2.85 \times 10^{-5}$$

where F is the fraction of the year when fog or other poor visibility conditions are present.

The second adjustment was accomplished through dividing K by a factor which reflects variation in traffic on a daily and seasonal basis over the year. The Combs model assumes that the traffic through the waterway is distributed evenly over all the hours of the year. In fact, we know that much of this traffic occurs in fishing seasons that are more active in summer months than in winter. Also many ships will time their passage through the pass to occur in daylight conditions when possible. The effect of these factors is significant in that it concentrates traffic into certain hours and increases the chances of a collision as a result.

---

*This was derived by ascribing Dover accidents to either poor visibility or good visibility conditions, then taking the poor visibility accident rate and dividing by the fraction of time when poor visibility occurred (.06). Rounded figures are used to indicate the level of accuracy.

While the exact distributions of vessels in the pass is not known, it is estimated that seventy percent of the traffic occurs in six months of the year, and that eighty percent of the traffic during each day occurs in daylight hours. This is the mathematical equivalent of traffic being concentrated in a 12 to 14 hour period per day over the year, and therefore an adjustment factor of K/1.85 was used instead of K in the Combs model.

The resulting adjusted model takes the following form:

$$C = \frac{(.002F + 2.85 \times 10^{-5})N^2 Lb}{2KVW/1.85} = \frac{(.002F + 2.85 \times 10^{-5})N^2 Lb}{9470VW}$$

4.3 Collisions in Unimak Pass

Based on the estimates of marine traffic presented in the previous sections, the present probability of collisions in Unimak Pass is approximately one every 132 years. This calculation is based on the following characteristics for the two segments of the Unimak Pass waterway that we identified. Segment 1 begins approximately a mile east of the northeast tip of Ugamak Island at the southern entrance to the pass (see Figure 2.1 and 2.2).

SEGMENT*	WIDTH (W)	LENGTH (L)
1	6-12 mi.	8 mi.
2	20-26 mi.	20 mi.

We have calculated the probability of collisions for each segment and added them together to determine the total collision probability for the entire pass. (See Appendix A for details of this calculation.)

The total vessel traffic, average length of all vessels, and average vessel speeds that are expected to use the pass are presented in Table 4.1. The average clearance required to avoid maneuvers was assumed to be 800 feet (b = .13 nautical miles).

*Unimak Pass is approximately 28 miles in length and varies in width from approximately 12 miles (between Unimak and Ugamak Islands, see Figure 2.1) to 26 miles. The range of widths depend on whether the entire area of the pass is considered or just the portion of the pass in international waters. In order to show the highest collision probabilities the narrowest widths are used.

TABLE 4.1

SUMMARY OF VESSEL TRAFFIC FORECASTS FOR UNIMAK PASS

VESSEL TYPE	AVERAGE LENGTH*	ANNUAL NUMBER OF PASSAGES			
		1985	1990	1995	2000
OCS Vessels**					
Supply Vessels & Barges	500'	150	370	260	250
Tugs	100'	20	40	30	30
OCS Tankers	800'	0	140	410	840
Subtotal		170	550	700	1120
Fishing Vessels					
Small Boats	35'	391	391	391	391
Large Boats & Trawlers	115'	679	679	679	679
Processors & Long-liners	250'	59	59	59	59
Other	200'	241	241	241	241
Subtotal		1370	1370	1370	1370
Natural Resource Vessels					
Resource Freighters	750'	240	270	470	1270
Subtotal		240	270	470	1270
Commercial Vessels					
Domestic & Foreign	350'	620	680	750	840
Subtotal		620	680	750	840
TOTAL		2400	2870	3290	4600

* Estimate of the average length for vessel types by category. Average length of all vessels passing through Unimak Pass in the year 2000 is 478 feet. Estimate of average speed for all vessel types through Unimak Pass is 10 knots.

** It is assumed that 90 percent of all OCS vessels are either supply vessels or barges. The remaining 10 percent are tugs.

Source: Louis Berger and Associates, Inc., Anchorage, AK

The probability of poor visibility in Unimak Pass was determined from U.S. Department of Commerce, National Oceanic and Atmospheric Administration data which is derived from the reports of private vessels using the pass. These ships reported ten to fourteen percent poor annual visibility (less than two nautical miles). This data is biased toward better weather conditions and was therefore adjusted to reflect actual conditions. In addition the weather in peak traffic months (which is worse than the yearly average ten to twenty days per month poor visibility in the summer) was weighted more heavily to reflect conditions encountered by the average vessel in Unimak Pass. These adjustments result in an estimate of twenty-one percent poor visibility conditions for all vessels using the pass. (F = .21)

The resulting probability of collisions in Unimak Pass with and without OCS activities is summarized in Table 4.2. This table confirms our initial readings that there is a very low probability of collisions even at the highest traffic levels in 2000. The presence of OCS traffic only raises the probability of a collision from one in fifty-seven years to one in thirty-three years.

This model can also be used to calculate a traffic threshold which would show when OCS marine traffic through the pass would create a significant increase in the probability of a collision. It is up to the MMS to determine what probability of collision would constitute a significant impact. However, one possible definition could be an increase in OCS traffic which would lead to the probability of one collision per year (P = 1.0) or one collision every two years (or P = 0.5).

The traffic levels that would lead to these levels of probability are as follows:

PROBABILITY PER YEAR	TOTAL VESSEL TRIPS REQUIRED	EXTRA TRAFFIC OVER FORECASTS LEVELS WITHOUT OCS TRAFFIC	
		1990	2000
0.5	18,630 per year	15,760	13,030
1.0	26,350 per year	23,480	21,750

The extra traffic needed to reach even the 0.5 probability level is more than twelve times the maximum OCS traffic expected through Unimak Pass through the year 2000.

TABLE 4.2

FORECAST OF COLLISIONS IN UNIMAK PASS

	1983	1990	2000
A. Without OCS Activity			
Probability of collision in one year	.0068	.0078	.0174
Number of years for one collision to be expected	147	128	57
B. With OCS Activity			
Probability of collision in one year	.0076	.0119	.305
Number of years for one collision to be expected	132	84	33

Source: Louis Berger and Associates, Inc., Anchorage, AK (See Appendix A for calculations).

4.4 Relation of Model Results to Recent Experience

The model used to describe the probabilities of collisions is a model based partly on theory and partly on experimental evidence gathered in the Dover Straits and analyzed by Devanney, Cockroft, and others. It has been adjusted to correspond to conditions in Unimak Pass. However it still contains some basic assumptions which affect its usefulness as a predictor of reality. These are:

1. Crew alertness and competence in Unimak Pass is the same as in other places (i.e., Dover Straits).

2. Vessel equipment and detection ability is on average, the same as in other locations (i.e., Dover Straits).

3. Accidents are a result of errors and equipment failures, not intentional.

4. The navigation conditions in Unimak Pass are not unusual.

In so far as we can determine, these assumptions are accurate for Unimak Pass in normal circumstances. In certain circumstances, however, it is possible to have a combination of events which greatly increase the probability of an accident (i.e., several vessels converging on the narrow part of the pass in poor visibility). The model does not take these unlikely events into account, except in so far as they occurred in the Dover Straits. In addition, intentional accidents will not be predicted by this model.

It is also clear that cases of extreme fatigue, such as fishing crews experience in the Bering Sea, can affect alertness and competence and could lead to accidents. There are currently about 1500 encounters per year in the Unimak Pass and possibly 300 in poor visibility. Despite the low odds, a really fatigued crew could cause an accident if they happened to meet these conditions.

The laws of probabilty and the estimates used here do not rule out the additional accidents these unusual circumstances may encourage.

If there continues to be more accidents than this model predicts, then specific research will be required to identify the special elements of the Unimak Pass environment or its vessel traffic that make it more dangerous than other locations of a similar type.

4.5 Conclusion

Based on the traffic forecasts, our stated assumptions and the modified collision model developed as part of this research, we have concluded that the expected levels of future OCS demands on western and northern Alaska will not cause a significant increase in the occurrence of vessel collisions in Unimak Pass.

APPENDIX A
COLLISION PROBABILITY CALCULATIONS

1. Constant Parameters

a) Fraction of time poor visibility; F = .21
b) Average vessel clearance; b = .13 nautical miles
c) Average vessel speeds; V = 10 knots
d) Channel length — segment 1: L = 8 nautical miles; segment 2: L = 20 nautical miles
e) Minimum channel width — segment 1: W = 6 nautical miles; segment 2: W = 20 nautical miles

2. Reduced Equations

Segment 1:

$$C = \frac{[.002(.21) + 2.85 \times 10^{-5}]\, N^2 \times 8 \times .13}{9470 \times 10 \times 6} = 8.2 \times 10^{-10}\ N^2$$

Segment 2:

$$C = \frac{[.002(.21) + 2.85 \times 10^{-5}]\, N^2 \times 20 \times .13}{9470 \times 10 \times 20} = 6.2 \times 10^{-10}\ N^2$$

3. Probability of a Collision in Either Segment $= 14.4 \times 10^{-10}\ N^2$

$$(P_T = P_1 + P_2)$$

4. Probability by Key Year

	ANNUAL TRAFFIC*		PROBABILITY PER YEAR**		EXPECTED YEARS FOR ONE COLLISION***	
	WO/OCS	W/OCS	WO/OCS	W/OCS	WO/OCS	W/OCS
Base Year	2170	2290	.0068	.0076	147	132
1985	2230	2400	.0071	.0082	141	122
1990	2320	2870	.0078	.0119	128	84
1995	2590	3290	.0097	.0156	103	64
2000	3480	4600	.0174	.0305	57	33

*From Table 4.1.
**Using traffic as N in equation 3 above.
***1 divided by the probability per year.

BIBLIOGRAPHY

Alaska Consultants, Inc./PRC Harris, Inc. January 1981. South-central Region of Alaska Deep-Draft Navigation Study. Anchorage. (Prepared for U.S. Army Corps of Engineers, Alaska District).

Alaska Department of Natural Resources, Division of Forestry and the U.S. Department of Agriculture, Forest Service. 1984 (unpublished preliminary draft). Alaska 1983-1984 Forest Industry Directory. Alaska Department of Natural Resources. Anchorage, Alaska.

Alaska Geographic, The Aleutians, Volume 7, Number 3, 1980.

Alaska Information Service. 1984. The Alaska Economic Report "Quartz Hill Faces Tough World Markets" (February 16, 1984 edition). Volume No. 3/84. Anchorage, Alaska.

Anchorage Times. March 13, 1984. Coast Guard Studies Pass in Aleutians.

Anchorage Times. March 20, 1984. Coast Guard Facility Proposed for Unalaska.

Anchorage Times. September 11, 1983. South Korean Ships Collide.

CAORF. 1977. Proceedings of First CAORF Symposium, June 23 and 24, 1977. National Marine Research Council, Kings Point, New York.

Cockroft, A. N. 1976. "Statistics of Collisions at Sea." Journal of Institute of Navigation. Volume 29, Number 3.

Devanney, J. W., Protopapa, S., and Klock, R. 1979. "Tanker Spills, Collisions, and Groundings." MIT Sea Grant Report 1979-14.

D.M.J.M. October 1980. Draft Aleutian and Southwest Alaska Multi Modal Transportation Study. Anchorage (Prepared for the Alaska Department of Transportation and Public Facilities.

D.M.J.M. Forssen. June 1980. Draft Aleutian and Southwest Alaska Coastal Ferry Study. Anchorage. (Prepared for the Alaska Department of Transportation and Public Facilities.)

Draper and Bennett. 1972. "Modelling and Counter Rates in Marine Traffic Flows with Particular Application to Dover Straits." Journal of Institute of Navigation. Volume 25, Number 3.

Earl R. Combs, Inc. October 1981. St. George Basin and North Aleutian Shelf Commercial Fishing Analysis. Alaska OCS Social and Economic Studies Program Technical Report No. 60 Mercer Island, Washington. (Prepared for Minerals Management Service, Alaska Outer Continental Shelf Office.)

Energy Resources Co., Inc. and E.G. Frankel, Inc. 1978. Study to Assess the Impact of Alaska Petroleum Development on the Coast Guard through the Year 2000. Task 2, Marine Vessel Activity. Cambridge, MA (Prepared for U.S. Coast Guard.)

ERE Systems, Ltd. May 1984. Barrow Arch Transportation Systems Impact Analysis, Draft Final Report. Arlington, VA. (Prepared for Minerals Management Service, Alaska Outer Continental Shelf Office.)

Fairbanks Daily News Miner. June 14, 1983. Vessels Collide in Unimak Pass.

Government of Canada. 1980. Arctic Pilot Project (Northern Component.) Report of the Environmental Assessment Panel. Ottawa, Ontario, Canada.

Hargreaves, E. R. 1973. "Safety of Navigation in the Channel." Papers of the International Congress of the European and American Institute of Navigation; Collisions Avoidance and Rendezvous Navigation, October 2-6, 1973. Hanover, Germany.

Louis Berger and Associates, Inc. February 1984. Diaper Field (Sale 87) Transportation Systems Impacts Analysis. Alaska OCS Social and Economic Studies Program Technical Report No. 105. Anchorage. (Prepared for Minerals Management Service, Alaska Outer Continental Shelf Office.)

Louis Berger and Associates, Inc. May 1983. Navarin Basin (Sale 83) Transportation Systems Impact Analysis. Alaska OCS Social and Economic Studies Program Technical Report No. 84. Fairbanks. (Prepared for Minerals Management Service, Alaska Outer Continental Shelf Office.)

Louis Berger and Associates, Inc. with Philleo Engineering & Architectural Services, Inc. January 1982. Western and Arctic Alaska Transportation Study. Fairbanks. (Prepared for State of Alaska Department of Transportation and Public Facilities.)

Morehouse, Thomas, ed. Contributing authors: Berman, Matthew; Codey, Richard; Morehouse, Thomas; Tuck, Bradford; Tussing, Arlon; and Weeden, Robert. 1984. Alaskan Resources Development: Issues of the 1980s. Westview Press. Boulder, Colorado.

Natural Resources Consultants. 1984. Projections of Domestic Fleet and Effort Required to Harvest the Alaska Groundfish Optimum Yield. North Pacific Fishery Management Council. Anchorage, Alaska.

Operations Research Incorporated. 1974 Spill Risk Analysis Program, Phase II; Methodology Development and Demonstration. U.S. Coast Guard Technical Report CG-D-15-75.

Pacific Fishing 1984 Yearbook. "A Look Back at '83 and Ahead to '84." Pacific Fishing. Seattle, Washington.

Peat, Marwick, Mitchell & Company. September 1981. St. George Basin Petroleum Development Scenarios Transportation Systems Analysis. Alaska OCS Socioeconomic Studies Program Technical Report No. 58. Anchorage. (Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office.)

Peat, Marwick, Mitchell & Company and James Lindsay & Associates. March 1980. Bering-Norton Petroleum Development Scenarios Transportation Systems Analysis. Alaska OCS Socioeconomic Studies Program, Technical Report 65. Anchorage. (Prepared for Bureau of Land Management, Alaska Outer Continental Shelf Office.)

U.S. Army Corps of Engineers. 1984. Waterborne Commerce of the United States, CY 1982, Part 4, Waterways and Harbors, Pacific Coast, Alaska and Hawaii. Department of the Army.

U.S. Department of Commerce, National Oceanic and Atmospheric Administration. January 1983. U.S. Coast Pilot Number 9 Pacific and Arctic Coasts Alaska: Cape Spencer to Beaufort Sea. Eleventh Edition. Washington.

U.S. Department of Transportation, Coast Guard. 1979. Draft EIS for Puget Sound Vessel Traffic Service Tank Vessel Operations Regulations. Seattle, Washington.

Wheatley, J. H. 1972. "Circumstances of Collisions and Strandings." Marine Traffic Engineering. Proceedings of the Royal Institute of Navigation and Naval Architect Conference.

Personal Communications

Personal Communication. 1984. Confidential Japanese fishing industry representative temporarily based in Anchorage, Alaska.

Personal Communication. 1984. Mr. Gene Fine, superintendent, Southeast Stevedoring Company. Ketchikan, Alaska.

Personal Communication. 1984. Mr. Steve Hughes, Natural Resources Consultants. Seattle, Washington.

Personal Communication. 1984. Mr. Harry Noah, Cominco Alaska. Anchorage, Alaska.

Personal Communication. 1984. Ms. Vicki Vaughn, National Marine Fisheries Service. Juneau, Alaska.

Personal Communication. 1984. Lt. Commander J. D. Asbury, Chief, Coast Guard's Marine Port Safety Branch. Juneau, Alaska.

Personal Communication. 1984. Captain Thurston, Foss Alaska Lines. Anchorage, Alaska.

Personal Communication. 1984. Mr. Bob Bradley, President, Southwest Alaska Pilots Association. Homer, Alaska.

Personal Communication. 1984. Captain Larkin, American President Line. Oakland, California.