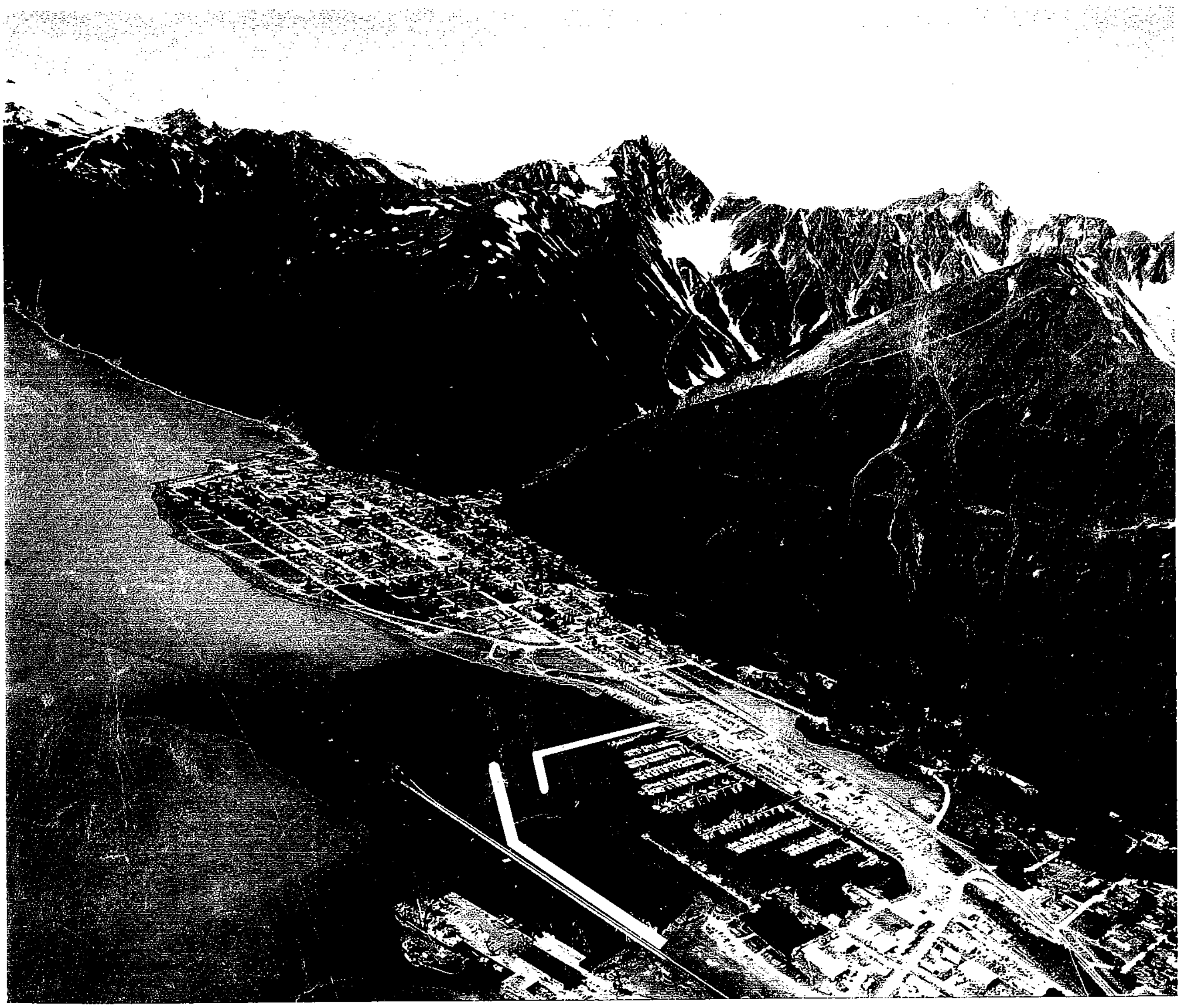
US Army Corps
of Engineers
Alaska District

Harbor Improvements
Final Interim Feasibility Report
APPENDIXES

Seward, Alaska



Volume 2

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HARBOR IMPROVEMENTS
FINAL INTERIM FEASIBILITY REPORT

SEWARD, ALASKA

VOLUME 2
APPENDIXES

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HYDRAULIC DESIGN

HARBOR IMPROVEMENTS
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SEWARD, ALASKA

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APPENDIX A
HYDRAULIC DESIGN

HARBOR IMPROVEMENTS
INTERIM FEASIBILITY REPORT
SEWARD, ALASKA

1. INTRODUCTION

1.1 Appendix Purpose

This hydraulic design appendix describes the technical aspects of the Seward harbor improvements project. It provides the background for determining the Federal interest in the major construction features including breakwater construction, dredging, and operation and maintenance.

1.2 Project Purpose

The following objectives were identified for the Seward harbor improvements project prior to initiating the engineering analysis.

a. Provide additional mooring to facilitate the present demand, which has increased since the construction of the existing harbor.

b. Maintain the existing harbor's current configuration and capacity for the original design fleet.

c. Relieve overcrowding and reduce damages to vessels in the existing harbor.

The project purpose is to provide a safe and efficient harbor in an environmentally and economically sound manner which satisfies the above objectives.

1.3 General

The Corps of Engineers first constructed a small boat harbor at Seward in 1932. This harbor, located south of the existing harbor site, was destroyed by a seismic landslide that occurred during the 1964 earthquake. The Corps completed construction of the present harbor in 1965. The existing harbor is protected by two rubblemound breakwaters, an east breakwater 1,750 feet long and a south breakwater 1,060 feet long. The harbor has a berthing capacity of 656 commercial fishing and recreational vessels, with adjacent dry storage space. The harbor includes a double launch ramp, shallow-draft cargo dock, 300-ton ship lift and marine ways, seaplane float, and fuel float.

Seward has developed all the usable area in its existing harbor. Existing moorage demands result in overcrowding, which leads to delays, overstresses the float system, and causes some vessels to anchor in exposed locations around the Seward waterfront.

The city of Seward asked the Corps to conduct a feasibility study of harbor improvements. Additional demand for moorage was identified as a critical issue facing the community.

2. CLIMATOLOGY, METEOROLOGY, HYDROLOGY

2.1 Climatology

The climate of Seward is maritime in character, with rather mild winters and cool summers. The north-south orientation of Resurrection Bay generally limits cloudy skies and precipitation to those days when winds are from the south. The mean annual precipitation for this area is 65.63 inches, based on 48 years of record. Table A-1 lists precipitation characteristics for Seward.

TABLE A-1.—*Summary of precipitation at Seward, 1949-97*

	Precipitation											Total snowfall		
	Mean	High	Year	Low	Year	1 Day max		>= 0.01 in.	>= 0.10 in.	>= 0.50 in.	>= 1.00 in.	Mean	High	Year
	in.	in.	-	in.	-	in.	dd/yyyy	# Days	# Days	# Days	# Days	in.	in.	-
January	5.73	25.43	81	0.25	96	4.1	03/1986	13	9	4	2	13.9	40	55
February	5.28	15.97	53	0.07	79	4.09	10/1996	13	9	4	1	17.5	54.5	74
March	3.63	12.29	81	0.14	89	2.95	01/1954	12	8	2	1	11.4	45	54
April	3.91	9.74	77	0.28	81	4.32	01/1977	13	8	2	1	5.5	31	56
May	4.11	15.93	85	0.42	74	6.64	18/1985	15	8	2	1	0.2	4.1	75
June	2.27	8.83	65	0.07	57	3.53	07/1965	12	6	1	0	0	0	50
July	2.54	10.28	58	0.14	82	2.91	27/1958	12	6	1	0	0	0	50
August	5.11	14.14	66	0.93	87	4.17	25/1989	15	10	3	1	0	0	50
September	10.06	29.72	95	2.1	92	9.81	20/1995	18	13	7	3	0	0	49
October	9.52	24	86	2.09	85	15.05	10/1986	16	13	7	3	1.7	15.3	76
November	6.68	25.22	76	0.21	75	3.5	22/1993	14	10	5	2	7	27.5	74
December	6.98	19.67	85	0.96	72	4.5	17/1952	15	11	5	2	19.4	57	59
Annual	65.83	96.37	81	33.38	96	15.05	19861010	168	111	43	18	76.7	173.7	74
Winter	17.99	41.99	86	6.37	57	4.5	19521217	42	29	12	5	50.8	114.7	74
Spring	11.66	21.07	84	2.21	86	6.64	19850518	40	24	7	2	17.1	49.4	71
Summer	9.92	23.14	58	2.98	68	4.17	19890825	39	22	6	2	0	0	50
Fall	26.27	54.99	76	6.95	85	15.05	19861010	48	35	18	9	8.7	39.2	74

Source: Western Regional Climate Center, NOAA.

The protected location makes possible higher summer temperatures and lower winter temperatures than observed at other Pacific Coast areas. Temperatures reach 70 °F an average of 11 days each year, usually during July and August. The prevailing northerly airflow brings cold air from the interior of the Kenai Peninsula into the

Seward area during the winter months. Temperatures drop to 0 °F or lower almost every winter. Southerly winds can bring milder temperatures in winter. Table A-2 lists temperature characteristics for Seward.

TABLE A-2.—*Summary of temperatures at Seward, 1947-97*

	Monthly averages			Daily extremes				Monthly extremes				Max. temp.		Min. temp.	
	Max.	Min.	Mean	High	Date	Low	Date	Highest mean	Year	Lowest mean	Year	>= 90 F	<= 32 F	<= 32 F	<= 0 F
	F	F	F	F	dd/yyyy	F	dd/yyyy	F	-	F	-	# Days	# Days	# Days	# Days
January	30	20.2	25.2	51	31/1963	-15	29/1989	37.4	77	13.9	71	0	14.4	25.4	1.5
February	32.4	21.7	27.1	51	02/1957	-8	15/1982	36	77	15.9	79	0	11.1	23.6	0.8
March	37	25.2	31.1	54	23/1965	-6	07/1971	37.6	84	21.8	71	0	6.2	25	0.3
April	44.2	31.8	38	65	17/1965	1	04/1985	42.2	90	31.2	72	0	0.5	15.1	0
May	51.8	38.8	45.3	76	31/1964	3	28/1971	49.6	96	39	71	0	0	1.5	0
June	58.2	45.3	51.8	84	27/1997	3	28/1971	56.1	59	47.1	71	0	0	0	0
July	62.2	49.8	56	85	10/1971	3	28/1971	60	51	52.7	71	0	0	0	0
August	61.8	49.4	55.6	95	12/1966	3	28/1971	59.4	57	52.7	86	0	0	0	0
September	55.1	43.6	49.4	73	03/1996	3	28/1971	53.1	63	44.6	92	0	0	0.5	0
October	44.4	34.3	39.4	64	01/1964	3	28/1971	43.9	57	34.8	82	0	1.4	10.7	0
November	35.7	26.4	31.1	80	01/1969	-2	30/1990	37.7	57	23.7	63	0	8.5	22.2	0.1
December	31.2	21.6	26.4	52	20/1969	-19	12/1977	35.4	85	13.9	80	0	14	25.7	1
Annual	45.3	34	39.7	95	19660812	-19	19771212	42.5	93	36.5	56	0	56.2	149.8	3.6
Winter	31.2	21.2	26.2	52	19691220	-19	19771212	35.2	77	20.6	73	0	39.5	74.7	3.3
Spring	44.3	31.9	38.1	76	19640531	-6	19710307	41.6	93	31.7	71	0	6.8	41.7	0.3
Summer	60.7	48.2	54.4	95	19960812	3	19710628	57.6	57	51.3	71	0	0.1	0.1	0
Fall	45.1	34.8	39.9	80	19691101	-2	19901130	44.1	57	36.4	55	0	9.9	33.4	0.1

Source: Western Regional Climate Center, NOAA.

The orientation of the bay and the valley at the head of the bay restricts the prevailing winds to either a northerly or southerly direction. Wind speeds of 25 miles per hour (mi/h) or higher can be expected an average of 2 or 3 days each month from October through March, about 1 day per month in April and September, and less than 1 day in 2 years in summer months. In summer, the rare occurrences of high winds may come either from the south or north; however, in the winter high winds generally blow from a northerly direction. The highest winds occur during the winter with an intense storm in the eastern Gulf of Alaska coupled with a high-pressure system over interior Alaska, which brings strong turbulent northerly flow down the valleys into the Seward area.

Fog can be expected an average of 1 or 2 days per month during the winter increasing through spring and summer to a maximum in August and September, when fog occurs an average of 8 to 10 days a month. Thunderstorms are infrequent, occurring an average of less than once every 2 years. Resurrection Bay is ice-free year-round except near the head of the bay where sheet ice forms near freshwater streams.

2.2 Tides and Water Levels

Tide levels at Seward, referenced to mean lower low water (MLLW), are shown in table A-3. Extreme high tide levels result from the combination of astronomic tides and rises in local water levels due to atmospheric and wave conditions.

TABLE A-3.—*Tidal data, Seward, Alaska*

Tide	Elevation (ft MLLW)
Observed Extreme High Water*	+15.09
Mean Higher High Water	+10.58
Mean High Water	+9.67
Mean Tide	+5.52
Mean Low Water	+1.36
Mean Lower Low Water	0.0 (datum)
Observed Extreme Low Water**	-4.15

* November 11, 1981.
** December 20, 1968.
Source: NOAA National Ocean Service (1984).

2.3 Currents

Alaska coastlines fronting the north Pacific Ocean are subject to two diurnal tides of relatively great range, resulting in extreme currents among the islands and inlets. Tidal currents near the existing harbor are negligible and pose no difficulty to navigation. Tidal currents at Seward, as reported in the 1982 Detailed Project Report, are as follows:

Flood		Ebb	
Direction	Ave. maximum velocity (knots)	Direction	Ave. maximum velocity (knots)
180°	1.0	355°	1.7

In Resurrection Bay, the velocity of ebb currents exceeds that of flood currents except when influenced by strong onshore winds, and then only at the surface.

2.4 Ice Conditions

Resurrection Bay remains ice-free throughout the year. The existing harbor does not freeze up, though shell ice has formed in portions of the existing harbor during the winter months. This is a result of the tidal prism being inadequate to flush freshwater dilution from the existing harbor.

2.5 Wind Data

The topography surrounding Seward causes high winds to be channeled either up Resurrection Bay from the south or down Resurrection River from the northwest. Some rather high winds also originate in the wide valley to the northeast. Figure A-1 presents wind roses developed using data from the airport at Seward. Figures A-2 and A-3 present data for maximum sustained windspeed and maximum wind gust for the period January 1994 through December 1997. Wind data recorded from 1970 to 1981 by an anemometer located at the Alaska Railroad dock at the head of Resurrection Bay were used to develop a frequency curve for three durations by Pearson Type III statistics, using criteria established in Water Resources Council Bulletin 17b. Figure A-4 presents the frequency curve developed from this data and used in the 1982 Detailed Project Report for a proposed small boat harbor project at Seward. In the report, the design wind for a recurrence interval of 50 years was determined to be 63 miles per hour for a duration of 47 minutes for winds from the southeast-to-southwest range. The 1982 report derived the design wind following procedures outlined in the *Shore Protection Manual* (SPM). The wind velocity and duration exceedance frequencies presented on figure A-4 were adjusted to overwater windspeeds at the 30-foot level. The adjusted 50-year recurrence wind, the effective fetch, and the SMB (Sverdrup Munk-Bretschneider) curves were then used to develop speed-duration curves. The effective fetch in the 1992 report was calculated as 4.7 statute miles, using procedures outlined in the SPM.

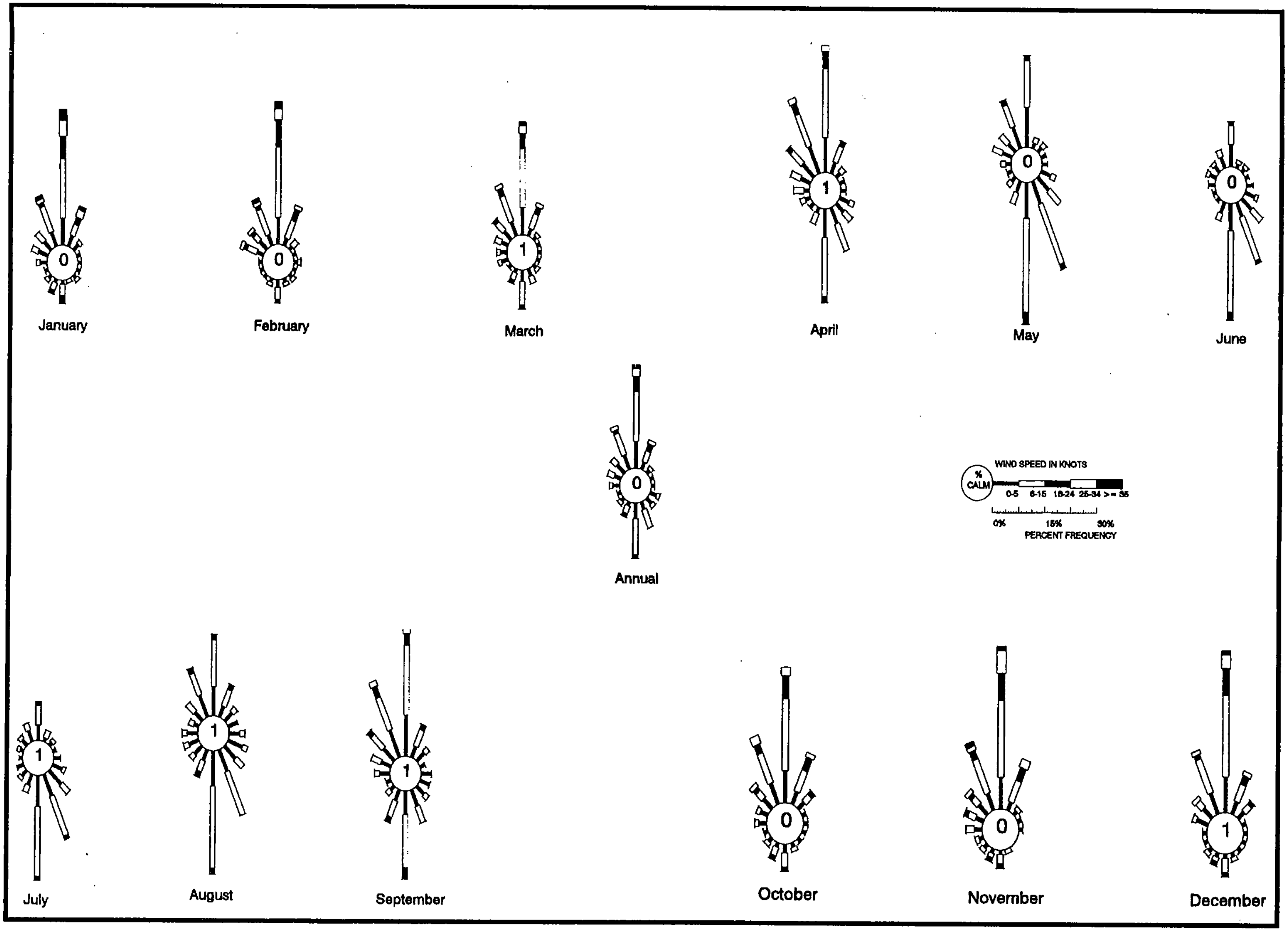
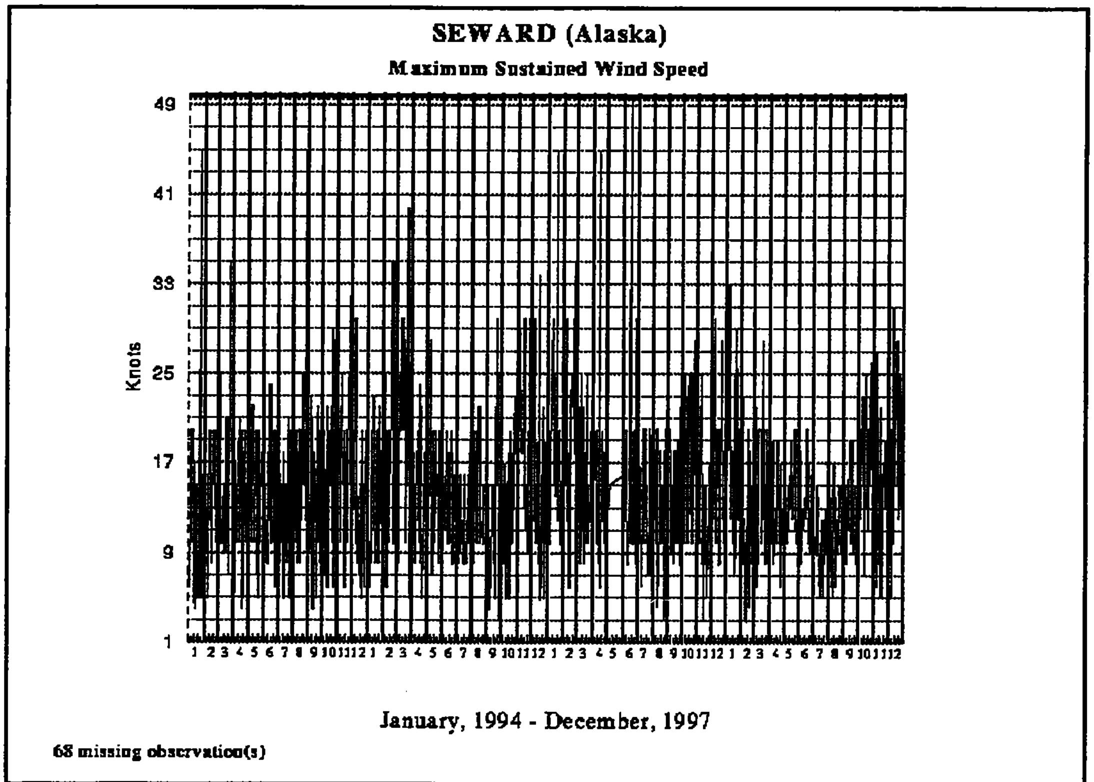
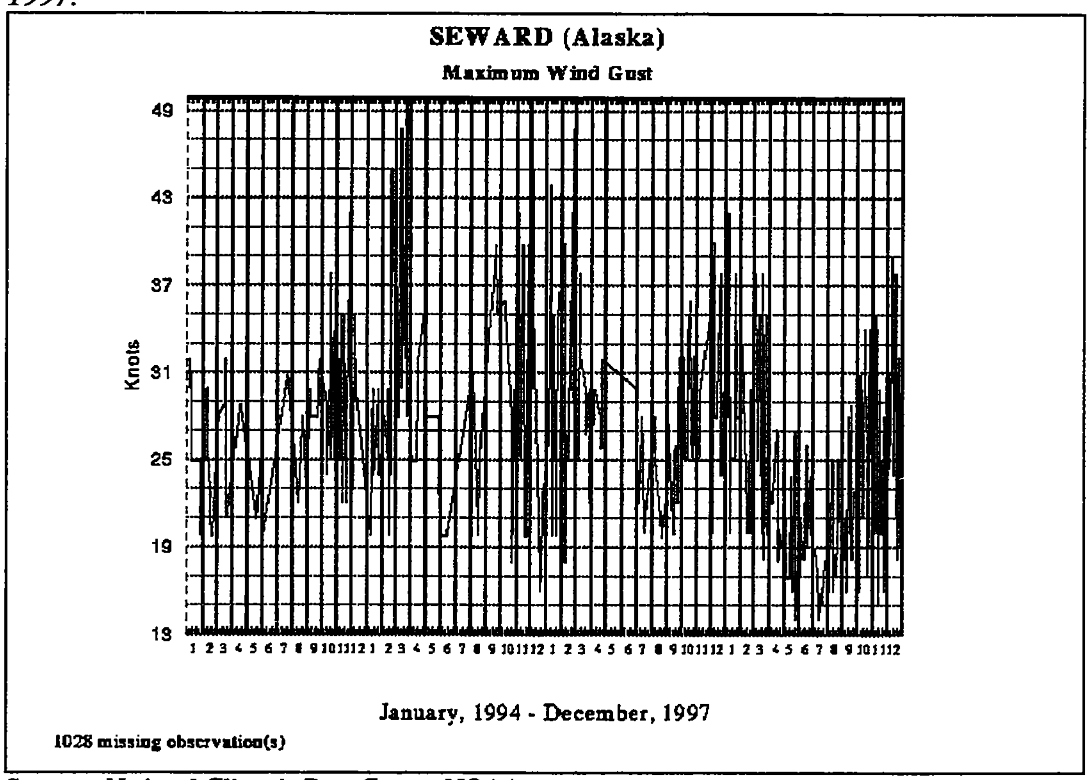


Figure A-1.- Port of Seward average monthly and annual windspeeds, 1973-96.



Source: National Climatic Data Center, NOAA.

FIGURE A-2.—Maximum sustained windspeed at Seward, January 1994—December 1997.



Source: National Climatic Data Center, NOAA.

FIGURE A-3.—Maximum wind gust at Seward, January 1994—December 1997.

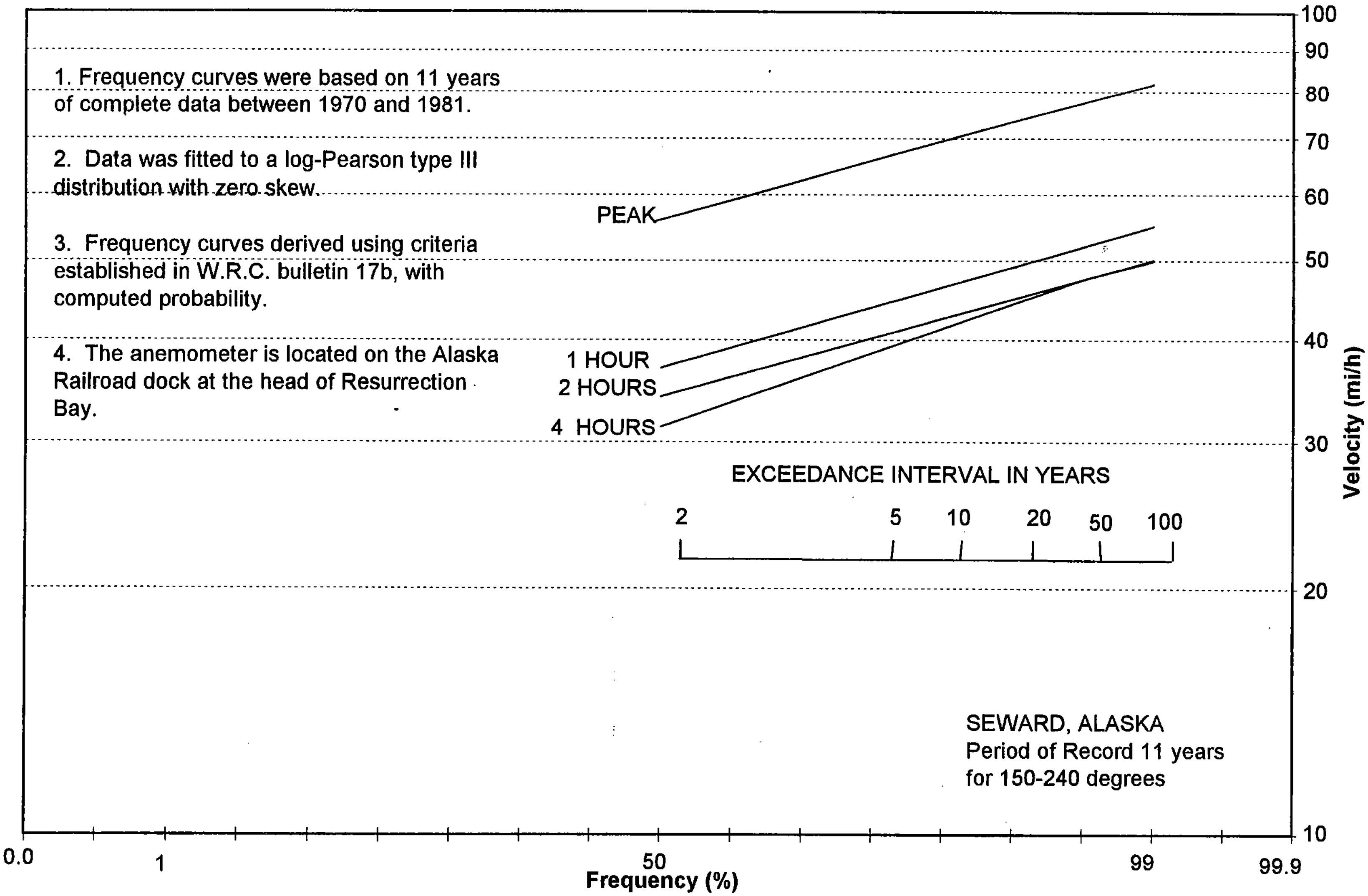


Figure A-4.-Extreme wind predictions.

3. WAVE STUDIES

3.1 Wave Exposure

The proposed project area in Seward is located at the northwest end of Resurrection Bay. The project area is exposed to waves from the southeastern quadrant. Waves generated from the south-southeast are generally predominant in both frequency of occurrence and magnitude. Waves from the east are infrequent and are limited by the much shorter fetch distance. Long-period swells from the Gulf of Alaska enter Resurrection Bay from the south and southwest. A buoy in Resurrection Bay has measured waves with periods up to 20 seconds. The narrowness of the bay, along with the landforms at Caines Head and Fox Island, limit the translation of the swell. Local observations report the presence of the longer-period swells in the vicinity of Seward Marine Industrial Center (SMIC). Long-period swells of 3 to 4 feet adversely interfere with barge operations at the north dock of the SMIC. The existing harbor does not appear to be affected by long-period wave action. During modeling of wave conditions with the STWAVE computer model, a 12-second-period wave was embedded in the model, and the results matched closely the conditions reported by local observation for swell. The model predicted the presence of long-period waves along the northeast of the bay, but not in the northwest area by the existing harbor.

Using the criteria from the SPM, an effective fetch distance was derived to correspond with the predominant wind direction. For a wind from 170°, the effective fetch is 5.1 miles. Therefore, the design wave for the proposed project is based on the fetch from the south-southeast. Figure A-5 shows fetch direction and distance affecting the project site.

3.2 Deep-Water Waves

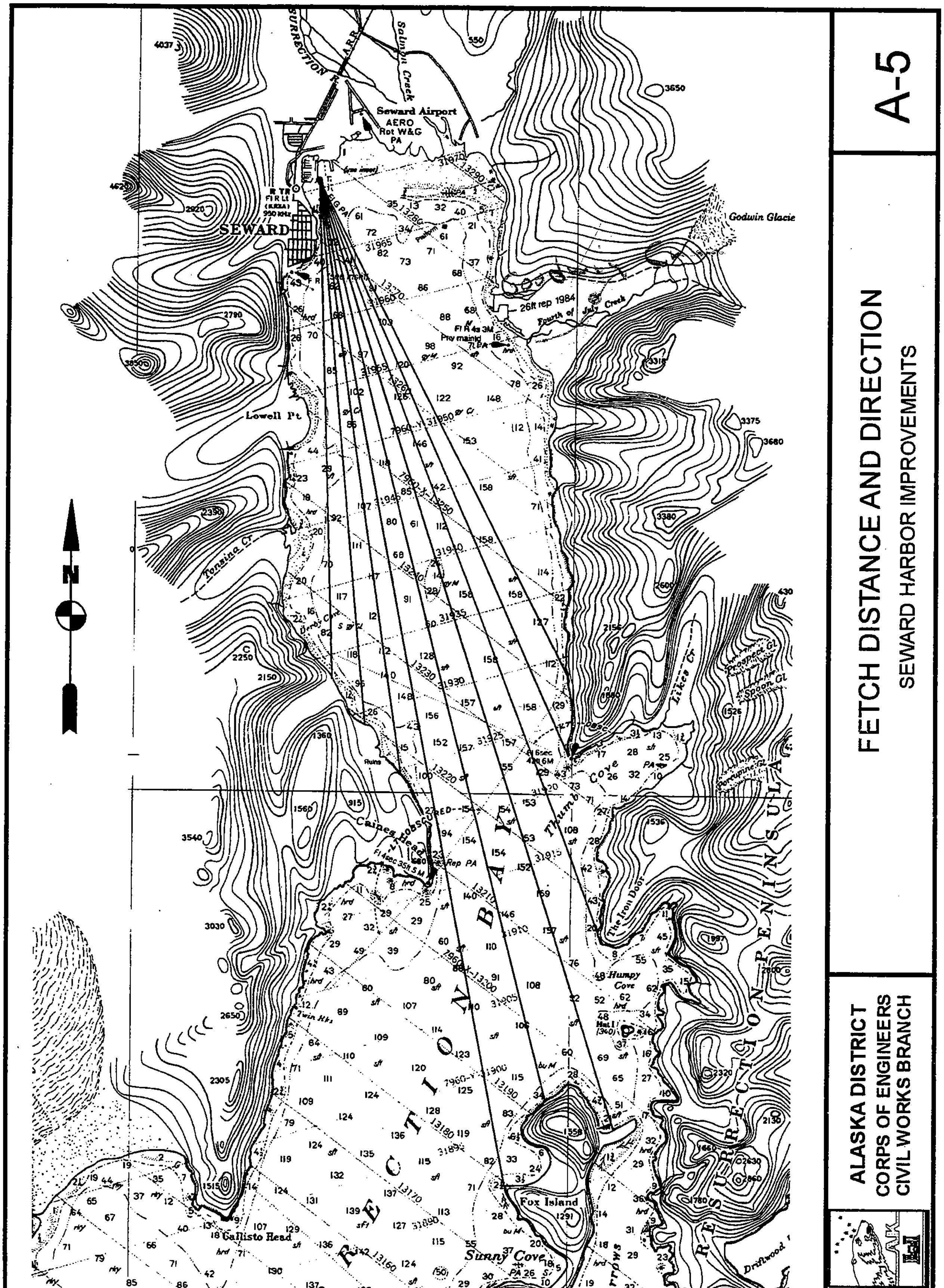
Measured wave height data is not available for Seward. However, previous studies have predicted maximum wave heights of 6.8 feet based on wind data records. The following general statements appear applicable to the deep-water wave climate in the vicinity of the proposed Seward harbor site:

a. Wave heights of 4 to 6 feet are the maximum observed by longtime local residents.

b. "Typical" wave periods range from about 3 to 6 seconds.

c. Local residents and recorded data indicate waves from the south-southeast are predominant.

d. Long-period swells from the open ocean do not impact the existing harbor area.


A-5
FETCH DISTANCE AND DIRECTION
SEWARD HARBOR IMPROVEMENTS
ALASKA DISTRICT
CORPS OF ENGINEERS
CIVIL WORKS BRANCH
N
SEWARD
Seward Airport
Salmon Creek
Godwin Glacier
Fourth of July Creek
Lowell Pt
Tonsina Cr.
Caines Head
Thumb Cove
Humpy Cove
Fox Island
Sunny Cove
Callisto Head
The Iron Door
Likes Cr.

3.3 Limiting Conditions

The proposed eastward expansion of the existing harbor is limited by the Alaska Railroad coal trestle. A geotechnical investigation performed by Golder Associates in 1997 (included in this report as appendix C) recommended a 30-foot minimum setback distance between the toe of the breakwater and the nearest trestle pile. Additional geophysical limitations result from a well-documented high-risk seismic landslide area south of the existing harbor.

The available fetch for wave generation is the limiting factor for wave height from the east, but the maximum wave from the south is limited by the duration of the design wind.

3.4 Design Wave (1982 Detailed Project Report)

To determine the design wave height and period, a statistical analysis of the available wind data was performed for the 1982 Detailed Project Report using Pearson Type III statistics. The maximum 1-hour-duration wind speed of 52 mi/h from the south was used. A frequency curve for wind data obtained was given in figure A-4.

For the 1982 report, the design wave was determined using a 63-mi/h adjusted critical windspeed with a 47-minute duration, effective fetch length of 4.7 miles from the south-southeast, and Sverdrup Munk-Bretschneider (SMB) curves. The resulting deep-water significant wave using the SMB method was 6.2 feet in height with a period of 5.3 seconds. Applying a shoaling coefficient of 0.9178 and refraction coefficient of 0.85 resulted in a design wave at the structure calculated at 4.9 feet.

A 1992 Wave Barrier Development Final Report by Peratrovich, Nottingham & Drage, Inc., calculated a mid-channel wave height of 6.8 to 7.0 feet with a wave period of 5.2 to 5.3 seconds. Accounts from local residents and the harbormaster indicated that 6-foot waves have been seen at the existing harbor. The harbormaster reports no problems due to wave heights in the existing harbor. Waves in the existing harbor are less than 1 foot in height.

3.5 New Design Wave (1998 Study)

Wind data from previous reports for Seward were reevaluated for this study. The 50-year wind velocities presented on figure A-4 were used to calculate wave heights using deep-water wave forecasting equations from Engineer Manual (EM) 1110-2-1414. Table A-4 shows the calculated results of wave height and period for the various windspeeds, including the design windspeed of 63 mi/h from the 1982 report. Using an angle of wave approach to bottom contours of 10 degrees for the south-southeast wave, and applying methods given in the SPM, a combined refraction shoaling coefficient of 0.91 was derived. Applying this coefficient to the wave height of 5.4 feet results in a wave height of 4.9 feet with a period of 4.5 seconds. Local residents have observed waves of approximately 6 feet near the project site.

TABLE A-4.—*Deep-water wave forecasting**

Elevation of data collection (ft)			33	$U_{33} = (33/z)^{1/7} U_z$				
Stability correction R_T			1.1	(fig. 5-28 in EM*)				
Location effects R			1	(fig. 5-27 in EM*)				
Direction	Fetch (mi) F	Design wind (mi/h) U	Windspeed (mi/h) U_c	Duration (hr) t	Duration required for fetch limited t_f (hr)	H_s (ft)	T_p (s)	Condition
SSE	5.1	63	69	.78	1.00	6.2	4.7	Duration limited
SSE	5.1	52	57	1	1.08	5.4	4.5	Duration limited
SSE	5.1	48	53	2	1.12	5.3	4.1	Fetch limited
SSE	5.1	47	52	4	1.13	5.1	4.0	Fetch limited

*Equations from table 5-3, EM 1110-2-1414 (7 Jul 1989).

Using the STWAVE computer model, wave heights were analyzed for a range of windspeeds and directions to which the proposed site is exposed. A long-period swell was also introduced into the model to analyze effects of ocean-generated waves transmitted through Resurrection Bay to the project site. Grids were prepared from NOAA chart data to reflect the bathymetry and geometry of the Resurrection Bay area, taking into account a still water level of +10.6 ft MLLW. Additional information from a 1997 hydrographic survey was also incorporated into the construction of grids used to model wave conditions. Results indicated a wave height of 6.0 feet with a period of 4.6 seconds at the proposed eastward expansion area for a wave coming from the south-southeast. This is the result using an initial 3-foot wave height, a 12-second wave period, and a 63-mi/h wind from 10° east of south. This wind direction proved to produce the highest waves in additional model runs when the wind approach angle was varied. Wind speeds ranging from 53 to 78 mi/h were also modeled to analyze the sensitivity of the windspeed produced in the model. An additional 1.5 feet in wave height was produced at the 78-mi/h windspeed. It was also noted that the introduction of the 3-foot, 12-second-period wave as the initial condition for the modeled site did not change the peak period at the proposed expansion site and increased the wave height by only 0.2 feet.

Based on the above analyses, information, previous reports, and observations, a significant wave of 4.9 feet and a period of 4.6 seconds were selected for use in this study. This corresponds to the wave calculated for the 52-mi/h wind duration shown in table A-4, applying a refraction and shoaling coefficient of 0.91 derived using methods found in EM 1110-2-1414. Use of the 10-percent wave (H_{10}) is recommended by EM 1110-2-2904 (August 1986) to minimize repair costs. Therefore, the design wave for structural elements of the design is a 6.2-foot wave with a period of 4.6 seconds.

The design wave would be a breaking wave at the proposed structure under certain water levels for the tidal range Seward experiences. Depths for wave breaking to occur were investigated using SPM methods. Using an offshore slope of 1V:100H, with the design wave calculated above, a breaking wave would occur in water depths of approximately 8 feet. During various expected tide levels, all portions of the proposed breakwater structure would be at this depth at some time. A breaking wave stability coefficient was applied for the armor stone design for the breakwater. Use of the breaking wave stability coefficient is conservative, considering that the design wave would not be breaking on the structure during most of the tidal range for Seward.

4. EXISTING HARBOR AND THE AUTHORIZED PROJECT

4.1 General Description

The existing harbor at Seward was constructed after the original harbor was destroyed by the earthquake of March 27, 1964. Congress provided authorization and funding for construction at a different location in August 1964. The basin was completed in October 1964, and the breakwaters were completed in June 1965 with Office of Emergency Planning funds. Dredging of the basin expansion was completed in November 1965.

The harbor consists of an 8.88-acre city mooring basin dredged to −15 ft MLLW, a 17.40-acre Federal mooring basin dredged to −12.5 ft MLLW, 13.13 acres of entrance and maneuvering channel dredged to −15 ft MLLW, and two rubblemound breakwaters, 1,060 and 1,750 feet long. The existing harbor has a berthing capacity of 656 commercial fishing and recreational vessels, with adjacent dry storage space. A plan view of the harbor is shown in figure 3, main report.

4.2 Existing Harbor Construction

Information for the original design of the existing harbor could not be found to add to this report. The following information is derived from previous reports and site visits to the harbor.

4.2.1 Entrance Channel.

The 120-foot-wide entrance channel makes a 60-degree turn east from the south of the harbor and is protected from the south-southeast by the east breakwater. The channel width allows two-way passage of vessels with beams in the 20- to 25-foot range. The 15-foot design depth allows a vessel draft of 10 feet at the extreme low tide of -4.0 ft MLLW, and 1 foot of bottom clearance.

4.2.2 Harbor Basin Layout.

Seward Harbor has a berthing capacity of 656 vessels. Moorage facilities consist of a float system servicing two main basin areas. Permanent moorage stalls range in size from 18 to 75 feet. The harbor includes a double launch ramp, shallow-draft cargo dock, 300-ton ship lift and marine ways, seaplane float, and fuel float.

4.2.3 Breakwaters.

Alignment and Length. The first 1,300 feet of the east breakwater, aligned north to south, forms the east side of the basin. The remaining 450 feet of the breakwater runs southwest along the entrance channel. The south breakwater extends east from shore approximately 550 feet and serves as the southern edge of the mooring basin. The breakwater then runs northeast to form the northwest side of the entrance channel.

Height. The height of the breakwaters varies along their length. The Corps of Engineers' Civil Works Project & Index book lists the crest elevation at +18 ft MLLW for some portions of the breakwaters. A 1997 survey showed variations in the crest elevation ranging from +15.5 to +19 ft MLLW. This may have been the final condition at construction or may reflect some differential settlement over the 33-year existence of the structures. The side slopes are 1V:1.5H on both sides of the breakwaters.

Underlayer Design. The breakwaters consist of a core material berm covered by an armor layer with a 4-foot thickness. The gradation of the core material is not known.

Toe Design. Cross sections shown in the Civil Works Project & Index book indicate a toe berm "rock blanket" on both sides of the existing breakwaters. The "rock blanket" is shown to extend a minimum of 10 feet beyond the armor layer on the seaward side and 10 feet beyond the side slope of the core material on the harbor side. The thickness of the "rock blanket" is 2 to 3 feet.

Armor Stone. Measurements of the armor on the existing breakwater were taken during a site visit. Twelve stones sampled from all along the breakwater were measured, and using a unit weight of 165 lb/ft^3, weights were calculated. The weights ranged from 1,000 lb to 10,300 lb per stone. Nine of the stones weighed 1,000 lb to 3,000 lb. The average weight was 3,300 lb. The armor layer appeared to be one stone thick.

5. HARBOR DESIGN CRITERIA

5.1 Design Vessel and Design Fleet (1982 DPR)

The 1982 economic analysis was based on the existing capacity of the harbor and the additional moorage demands by transient vessels and those vessels wait-listed for moorage space. Vessel sizes from the economic analysis varied in length from 18 to 90 feet. The entrance channel is designed to allow two-way traffic for vessels with beams up to 25 feet. The entrance channel as dredged allows all-tide and design wave condition passage for vessels with drafts up to 6 feet. The majority of the vessels using the existing harbor are 35 to 40 feet in length, with a corresponding draft of less than 6 feet. The largest permanent vessel using the harbor is 115 feet in length with a 9-foot draft. The largest transient vessel in the harbor drafts 10 feet. These vessels must take into account the wave conditions and tide when using the entrance channel.

5.2 Allowable Wave Height in the Existing Entrance Channel

The existing harbor has had no problem with wave transmission into the inner harbor area through the entrance channel. The existing conditions were modeled using the computer model STWAVE. The model indicated the configuration more than adequately reduces the wave to below a 1-foot height in areas immediately inside the entrance to the harbor.

The existing entrance channel depth provides access for the existing vessels with the following allowances:

a. Vessel draft of up to 9 feet.

b. Pitch, roll, and heave = 3.3 feet.

c. Safety clearance (based on sandy bottom) = 2 feet.

d. Squat = 0.6 feet.

This combination resulted in an entrance channel depth of -15 ft MLLW. A channel outside the breakwaters is maintained at –15 ft MLLW to where the depths drop off rapidly. The –15-ft-MLLW entrance channel depth would also apply to any alternative design for the design fleet at the existing site.

5.3 Allowable Wave Height in the Moorage Area

Maximum allowable wave heights in the mooring areas within the proposed harbor would be limited to 1 foot. This criterion is outlined in EM 1110-2-1615, "Hydraulic Design Guidance for Small Boat Harbors" (USACE 1994).

severe access problems have been reported. The vessels to be added to the harbor for this study have the same dimensions as the existing fleet and should not require any additional depth in the entrance channel.

The U.S. Coast Guard cutter *Mustang* uses this harbor and will require the –15-foot-MLLW depth as a minimum to maintain unimpeded operation. Furthermore, reducing the depth for the entrance channel of the harbor improvement is not recommended, as there is enough uncertainty in wave height and ship response to encompass the + or – 1 foot of depth variation that could be involved in an attempt to optimize the project. Vessels with 9 feet of draft should continue to be able to use the existing entrance channel without significant delay. The –15-foot-MLLW entrance channel depth is adequate for the design fleet.

Channel width in the existing harbor is 120 feet. This width has been checked by applying guidance given in EM 1110-2-1613 (USACE 1994). For a two-way ship channel with 0.5- to 1.5-knot currents, the width should be approximately 4.5 times the beam of the design vessel. A channel 120 feet wide allows two-way traffic in the channel for vessels with beams up to 27 feet. Side slopes of 1V:3H are armored in the existing entrance channel in areas exposed to wave action.

The new mooring basin would be dredged to the same depths as the basins already in use in the harbor. The existing mooring basins are dredged to –15 ft MLLW and -12.5 ft MLLW. Approximately 4.5 acres of new basin would be dredged to –15 ft MLLW to accommodate the larger vessels in the design fleet; the remaining new moorage area would be dredged to –12.5 ft MLLW. This is based on 2 feet under-keel safety clearance, and a minimum low-tide elevation of -4 ft MLLW, and vessel drafts of up to 9 and 6.5 feet. The minimum tide level of -4 ft MLLW (extreme low tide) was used due to the vessel requirement to remain and maneuver in the harbor regardless of tide level. Permanent moorage of the design fleet requires that the vessels be able to stay in the harbor for the range of tides experienced at Seward. Low tides exceeding –3.5 ft MLLW occur several times throughout the year, and tide elevations are also influenced by atmospheric pressure conditions.

6. ALTERNATIVES CONSIDERED IN DETAIL

6.1 General

A range of sites and alternatives was considered for harbor improvements at Seward. These included expanding the existing harbor and building a new harbor at four prospective sites in Resurrection Bay. All of these sites are accessible by road or could be made so. Other possible sites off the road system were not considered in this study due to excessive costs and real estate requirements for providing access and infrastructure.

Physical modeling was performed to provide data for the design of wave barrier systems and measure their effectiveness. This information is contained in the 1992 Final Report completed by Peratrovich, Nottingham & Drage, Inc., to aid in the development of the alternatives. A physical model was also conducted to evaluate the water quality for the Nash Road alternative that was developed in the 1982 Detailed Project Report. This information was also used to help predict the water quality anticipated for improvements to the existing harbor. The alternatives were then evaluated using established design guidance given in the appropriate EM's and the SPM.

The sites considered for Seward harbor improvements are described in the following paragraphs. They are illustrated in figure 1, main report.

6.2 Alternative Sites

At the beginning of the feasibility study, the objectives for potential harbor sites to satisfy the additional harbor demand were identified and compiled into a matrix. The matrix is comprised of three main categories: physical characteristics, harbor uplands, and environmental compatibility, with relative weightings assigned to the elements under each category. This matrix is presented in table 3-1, main report.

6.2.1 South Expansion.

The south expansion site (North City Waterfront Plan) includes the area immediately south of the existing harbor. In the 1982 Detailed Project Report, the site was studied and designs were proposed to utilize portions of the existing harbor. Public opinion was favorable for this location. A cost/benefit analysis of the design in the 1982 report did not yield a positive project.

This site was eliminated initially from any serious consideration because it is located in a high-risk seismic classification area,. The waterfront area, which includes the south expansion site, is classified in a National Academy of Sciences report (Eckel and Schaem 1970) as having a high risk of future landslides. The report describes the findings of a task force of structural engineers, engineering geologists, and seismologists, constituted as an arm of the Federal Reconstruction and Development Planning Commission for Alaska. With regard to the Seward waterfront, the task force stated that "... No repair, rehabilitation, or new construction involving use of Federal funds is recommended, except for grading and light fill."

6.2.2 Nash Road.

The Nash Road site, although suitable for a harbor, ranks below the preferred east expansion site in the scoring. The location is a disadvantage because it is on the east side of Resurrection Bay, about 10 minutes by road from the city center and the existing harbor facilities. The site also is potentially subject to more operation and maintenance costs due to a closer proximity to the sediment-laden Resurrection River than the other sites. The site was pursued by the city of Seward previously for construction of a harbor, but was halted because of land acquisition problems.

6.2.3 Lowell Point.

The Lowell Point site has limited upland area for development of harbor support facilities. Development of upland areas would require expensive blasting of rock to provide sufficient space. The site area sits upon an alluvial fan formed by Spruce Creek sediment discharges. The site would require extensive excavation and dredging to achieve a design depth for the harbor basin. The road providing access to the Lowell Point site would require extensive improvements to allow safe usage.

6.2.4 Fourth of July Creek.

The Fourth of July Creek site, just east of the Seward Marine Industrial Center, is the most distant harbor site from the city center and existing harbor. This site has the same characteristics as the Lowell Point site in that extensive dredging and excavation would be required. This site rated lower in wave exposure, too. Long-period swells create conditions at facilities near this site that cause damage to vessels. From an environmental standpoint, the site is located in a wetland area and would affect Spring Creek. Bald eagles have nests in the area as well.

6.2.5 East Expansion.

The eastward expansion site rated above the other four sites. It best satisfies the site selection objectives and optimizes the economic benefits. This site became the focus of study for potential harbor expansion and improvements. To reduce construction costs as much as possible, it was found desirable to develop a plan that would use the existing facilities most effectively and meet the need for additional moorage.

6.3 Alternatives for Site Studied in Detail – Eastward Expansion

6.3.1 General.

Various methods of wave protection were considered for the harbor improvements. Floating breakwaters have the advantage for relatively short wave periods and when the depths of water make rubblemound structures cost-prohibitive. They also have less impact on marine life and can improve water quality in the harbor. However, the shallow depths at the site and the existence of longer wave periods made this method of wave protection not suitable. Sheet piling was considered and has been modeled for use at this site as one of the alternatives. A rubblemound structure is presently used at the site and was also used for the design of the other alternatives.

6.3.2 No Action.

With no action, the existing harbor would remain as it is and continue to be used at a capacity exceeding its design. Severe overcrowding in the harbor, lack of sufficient mooring space, impacts on maneuvering in the fairways and entrance channel, excessive wear and tear on the float system, and possible degradation of water quality in the harbor would occur with the no-action alternative.

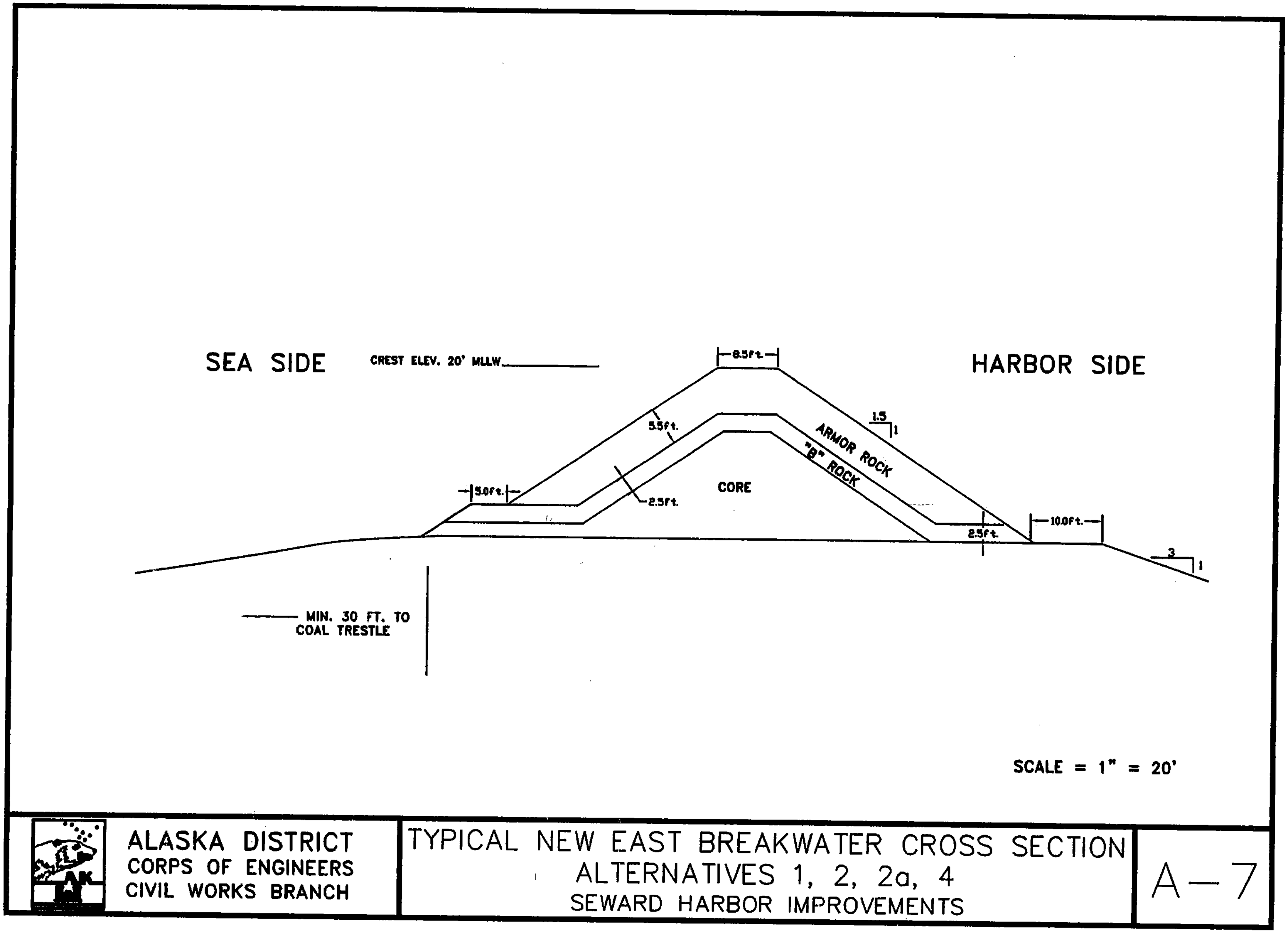
6.3.3 Alternative 1.

General. With this alternative, the existing harbor would expand to the east by removing most of the east breakwater and constructing a new breakwater approximately 450 feet to the east. The existing entrance channel would not be altered and would be used to provide access to the new moorage area. A plan view of alternative 1 is in figure 4, main report.

This alternative would accommodate the additional moorage demand by providing 10.5 acres of additional basin. The existing mooring basins would not require any alterations to their layout or fairways.

Harbor Basin. The new harbor basin would be dredged at two design depths to optimize the requirements of the fleet based on drafts of the vessels. Approximately 4.5 acres would be dredged to -15 ft MLLW to accommodate vessels drafting 9 feet. The remainder of the harbor would be dredged to –12.5 ft MLLW for the fleet with drafts less than 6.5 feet. Both depths of dredging allow for 2 feet safety clearance and a minimum low-tide elevation of –4 ft MLLW. A total combined harbor basin and maneuvering area of approximately 10.5 acres would be required for alternative 1.

Wave Height Criteria and Harbor Operation Plan. Because there would be no change in the configuration of the existing entrance channel, the existing moorage areas could expect no change in the wave conditions experienced in the channel and inner harbor basin. The harbor as it exists has been used for more than 30 years and has performed satisfactorily during that time. The new moorage basin was analyzed


SEA SIDE
CREST ELEV. 20' MLLW
HARBOR SIDE
8.5ft.
5.5ft.
2.5ft.
5.0ft.
CORE
1.5
1
ARMOR ROCK
"B" ROCK
2.5ft.
10.0ft.
3
1
MIN. 30 FT. TO
COAL TRESTLE
SCALE = 1" = 20'
ALASKA DISTRICT
CORPS OF ENGINEERS
CIVIL WORKS BRANCH
TYPICAL NEW EAST BREAKWATER CROSS SECTION
ALTERNATIVES 1, 2, 2a, 4
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A total of 28,600 cubic yards of armor rock, 17,300 cubic yards of secondary rock, and 33,350 cubic yards of core rock would be required for breakwater construction.

Dredged Material Disposal. Some of the dredged material would be disposed of in an intertidal area adjacent to the proposed harbor. The area would provide approximately 4 acres of uplands by filling in subtidal areas along the south side of the existing harbor and along the north side of the new basin area. Existing bottom conditions are sand, gravel, and cobbles. A total of 79,800 yd^3 of dredged material would be deposited in the new upland disposal areas. The balance of the remaining material could be disposed of in deep water in an area near the project site previously used for dredged material disposal by the railroad.

6.3.4 Alternative 2.

General. With this alternative, the existing harbor would be expanded to the east by removing 1,100 feet of the east breakwater and constructing a new breakwater approximately 450 feet to the east. The existing entrance channel would be relocated to the east side of the remaining east breakwater, maintaining the same alignment, width, and depth. 475 feet of the existing south breakwater that now forms the west side of the entrance channel would be removed to provide additional moorage basin within the existing harbor. The 330-foot existing entrance gap would be filled with a rubblemound structure. Approximately 5.2 acres of upland area would be created south of the existing harbor to allow access to the new basin in this area. An additional 0.8 acres of uplands would be filled north of the new eastward expansion basin. A 175-foot-wide fairway dredged to –15 ft MLLW would allow access from the entrance channel to the new and existing mooring basins.

As in alternative 1, this plan would provide additional moorage east of the existing harbor. Relocating the entrance channel reduces the haul distance from vehicle access areas to the farthest moorage stalls while providing greater additional moorage area. This alternative would accommodate the additional moorage demand by providing 11.7 acres of additional basin. A plan view of alternative 2 is in figure 5, main report.

The 120-foot-wide entrance channel allows two-way traffic for vessels with beams up to 27 feet. Side slopes of 1V:3H would be armored in the entrance channel in areas exposed to wave action. The entrance channel width would be about 4.5 times the beam width of the design vessel. A cross section of the proposed entrance channel is shown in figure 10, main report.

Harbor Basin. The harbor basin of alternative 2 would be dredged at two design depths to optimize the requirements of the fleet based on drafts of the vessels. Approximately 4.5 acres would be dredged to -15 ft MLLW to accommodate vessels drafting 9 feet. The remainder of the harbor would be dredged to –12.5 ft MLLW for the fleet with drafts less than 6.5 feet. Both depths of dredging allow for 2 feet safety clearance and a minimum low-tide elevation of –4 ft MLLW.

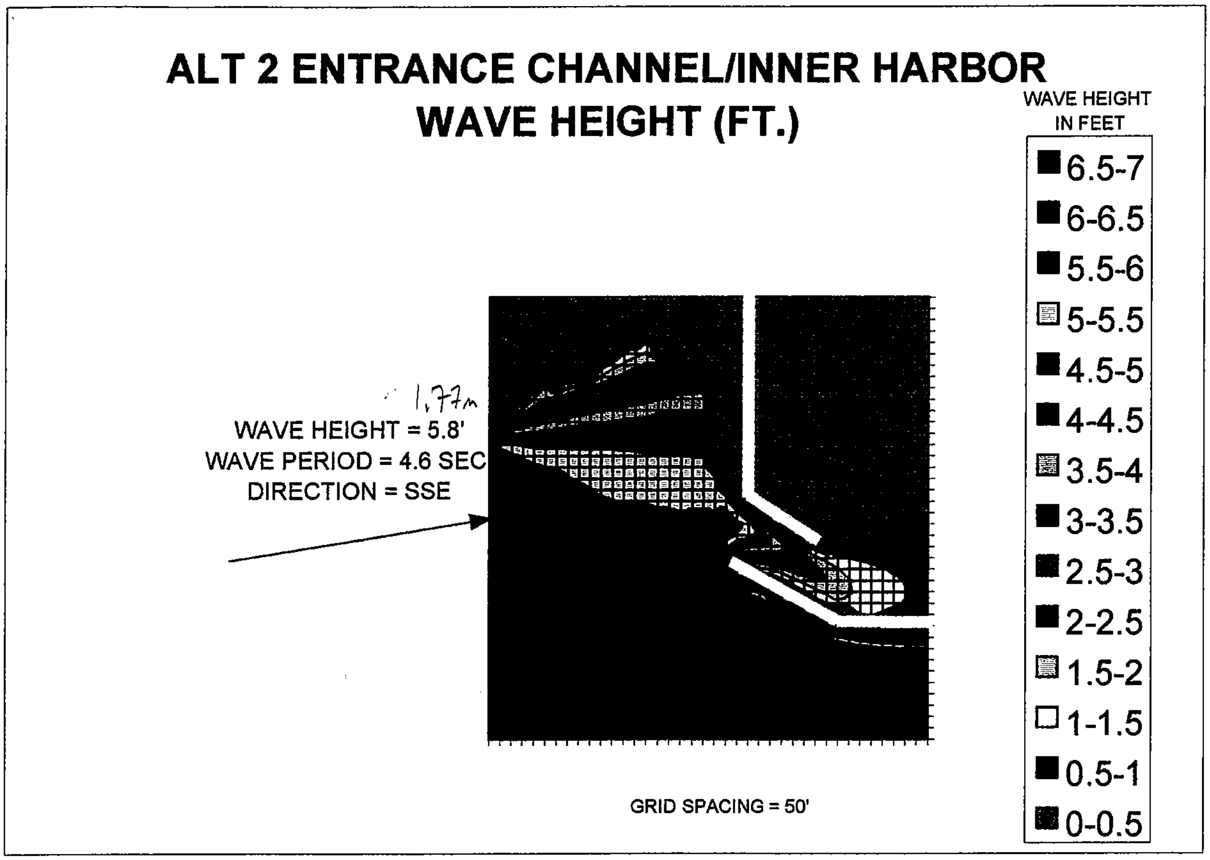
Wave Height Criteria and Harbor Operation Plan. The alternative 2 plan would have wave heights in the entrance channel similar to or slightly less than those in the existing harbor entrance for the design wave from the south-southeast. The new breakwater would use the same alignment as the existing structure, but it would be extended an additional 50 feet. This extension provides protection to the new harbor entrance that would be more exposed to wave conditions from due south than the existing harbor. A wave diffraction analysis was performed using the computer model STWAVE. The results were compared to results from methods prescribed in the SPM to confirm the validity of STWAVE's estimations. Results indicated that the maximum wave height in the closest mooring area to the entrance channel would be less than the 1-foot criterion. The breakwaters were positioned, taking into account the estimated waves, to ensure wave height criteria for the floats would be met for the new expanded basin and entrance channel. Figure A-8 shows the results from the STWAVE runs for winds from the south and from the south southeast.

Circulation. Circulation in the existing harbor is driven primarily by the tidal prism in the basin. Strong winds drive surface water currents within the harbor and contribute to mixing in the water column. Wave action is an insignificant factor in driving circulation in the harbor.

Tides would cause most of the circulation in the harbor. An exchange coefficient of 0.42 was calculated based on the difference in volume of water in the proposed basin between MHHW and MLLW compared to the volume at MHHW. Values greater than 0.20 have been cited as providing good circulation. The aspect ratio for alternative 1 is approximately 1.3:1. This is considered close to optimum.

Shoaling. Visual observations, condition surveys, and historical accounts of conditions at the existing harbor indicate that shoaling is minimal at the existing harbor. The maintenance dredging that has occurred over the last 30 years has been due to flood events when the Resurrection River overflowed its banks. Prior to this event in 1995, no maintenance dredging had been required. The relocation of the entrance channel to an area with greater natural depths will reduce the footprint of the entrance channel and the potential for maintenance dredging.

Construction Dredging. Initial construction dredging quantities were derived from the September 1997 Corps of Engineers survey and the geotechnical survey performed in October 1997 by Golder Associates (appendix C). Initial construction would involve dredging material consisting of sands, gravels, and cobbles to the project limits. A total of 200,000 cubic yards (yd^3) of dredging would be required for the mooring area, and an additional 86,900 yd^3 would be dredged for the new entrance channel. Dredged materials would be placed along the shore south of the existing basin to create uplands for parking and harbor operations. Dredged material could be disposed of at the upland area designated for dredged material disposal on Alaska Railroad property. Additional deep-water disposal could occur in the area near the project site previously used by the railroad.



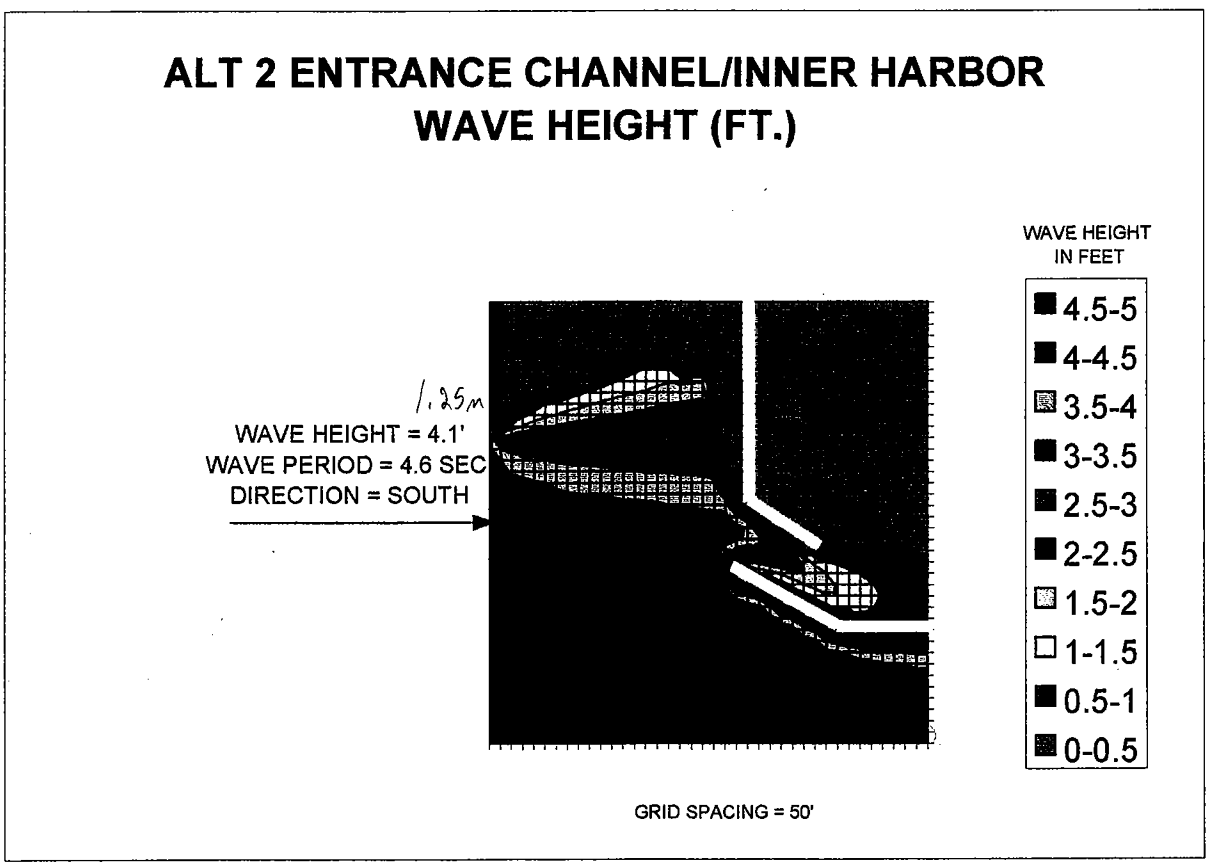


Figure A-8.-Wave diffraction analysis.

Alternative 2 requires the removal of 1,575 feet of the existing breakwaters. An estimated 30,000 yd^3 of core material would need to be removed. This material could be used for portions of the new construction. The gradation of the material is not known. An estimated 10,700 yd^3 of armor rock would also be removed from the existing breakwaters. This material could be reused for the new breakwater and revetment construction. A sampling of the rock revealed weights ranging from 1,000 lb to 10,000 lb, with the average weight at 3,300 lb.

Work inside the harbor could be accomplished with a hydraulic cutterhead and suction pipeline, or an excavator could be used if necessary. Dredging equipment and methods would be left as an option for the contractor.

Side slopes for the basin would be dredged to 1V:3H. Armor protection would be required to prevent the newly dredged entrance channel from shoaling due to wave and tidal action.

Maintenance Dredging. Based on historical information on conditions in the existing harbor, the project would present few sedimentation problems. Project condition surveys are performed every 3 to 4 years at the existing harbor. Over a period of 29 years prior to1994, surveys revealed 12,600 yd^3 of material had accumulated since construction of the existing harbor. Project depth was still available for most of the existing basin and channels. It is estimated that project condition surveys would continue to be performed every 3 to 4 years, and 4,100 yd^3 of material would have to be removed every 25 years from the additional moorage area.

Breakwaters. A 1,700-foot-long rubblemound breakwater would be constructed approximately 400 feet east of the existing harbor in a north-south alignment for a length of 1,070 feet. The seaward toe of the breakwater would maintain a minimum distance of 30 feet from the existing piles supporting the coal trestle. The remainder of the new breakwater would then change to a southwest alignment to form the eastern side of the new entrance channel. 1,160 feet of the existing east breakwater would be removed. Maximum depth of water is –7 ft MLLW along the alignment of the breakwater. Foundation materials are silty sand, gravel, and cobbles, which would serve as a suitable base for the rubblemound structure.

30' CONSTRAINT

Methods described in the SPM using Hudson's equation were used to determine stone sizes. For 1V:1.5H side slopes, a breaking wave, rough angular quarry stone, and the wave height determined in section 3.5, a K_d value of 2.0 is applicable for the entire structure to determine stone sizes for the breakwater. Application of Hudson's equation resulted in armor stone with a range of sizes from 2,500 lb minimum to 4,200 lb maximum. Secondary stone would range from 250 lb minimum to 1,000 lb maximum. Core material would be 1 lb minimum to 250 lb maximum. Armor stone thickness would be 5.5 feet, and secondary rock thickness would be 2.5 feet. A typical breakwater section is shown in figure A-7.

	MAX	MIN	LAYER THICKNESS
ARMOR	4200	2500	5.5
B	1000	250	2.5
CORE	250	1	VARIED

A wave runup calculation was performed to determine the crest elevation of the breakwater. Based on the criteria set forth in the SPM, the runup of the design wave on the breakwater was calculated to be 5.4 feet. The runup added to the highest observed tide of +15.1 ft MLLW gave a calculated breakwater crest elevation of +20.5 ft MLLW. The existing harbor breakwaters at elevation +18 ft MLLW have sustained no significant damage since construction in 1965 but have experienced incidents of overtopping due to wave runup. Considering past performance and the calculated values, a crest height of +20 ft MLLW with a crest width of 8.5 feet will be used for the new construction. This increase in height will reduce the potential for overtopping, provide an adequate core crest width at MHW to facilitate construction of the breakwater, and provide allowance for potential long-term settlement.

A total of 23,300 cubic yards of armor rock, 14,300 cubic yards of secondary rock, and 26,200 cubic yards of core rock would be required for breakwater construction.

The 330-foot gap for the existing entrance would be closed by the construction of a rubblemound structure armored on both sides. Dredged material or material removed from the existing breakwaters would be used to fill in the area between the armoring to create a causeway for access to the new moorage area created by removal of approximately 415 feet of breakwater that lined the existing entrance channel. Additional uplands would be created along the south of the harbor using dredged materials. The revetment of this structure would require 6,100 yd^3 of armor stone with an average weight of 1,500 lb, 9,100 yd^3 of secondary stone, and 30,000 yd^3 of core material. 157,400 yd^3 of dredged fill could be used to construct the new uplands at the south breakwater.

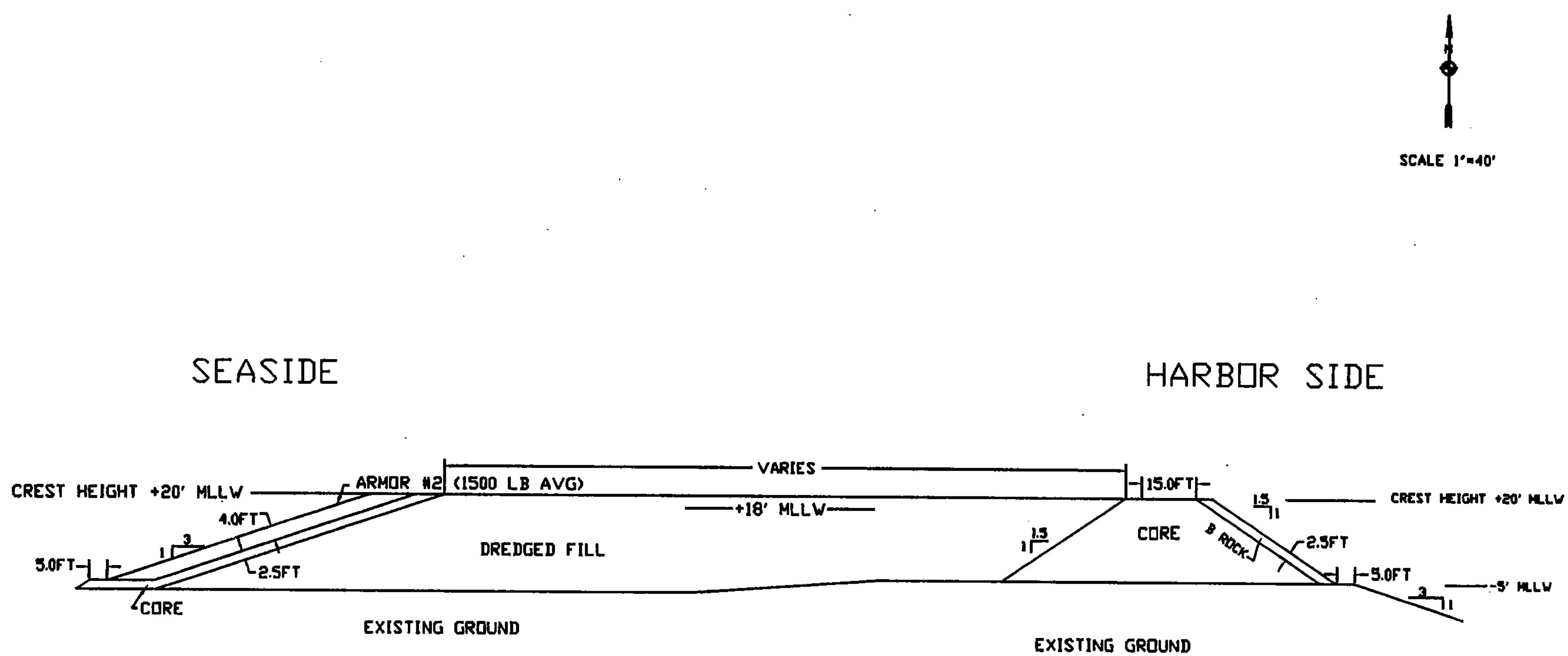
REVETMENT

Methods described in the SPM using Hudson's equation were used to determine stone sizes. Using 1V:3H side slopes, a K_d value of 2.0 for quarry stone on the entire east breakwater structure with a breaking wave, and the wave height determined in section 3.5, stone sizes were determined for armoring the side slopes of the fill area where the gap is to be closed. Armor stone with a range of sizes from 1,200 lb minimum to 2,000 lb maximum would be used on the sea-side face. Secondary stone would range from 100 lb minimum to 200 lb maximum. Filter material would be the same as is used for the core of the rest of the breakwater construction, 1 lb minimum to 200 lb maximum. Typical cross sections of the south breakwater are shown in figure A-9.

250 max, for breakwater

Dredged Material Disposal. The dredged material would be disposed of in an intertidal area adjacent to the proposed harbor. The area would provide approximately 6 acres of uplands by filling in intertidal areas along the south side of the existing harbor and along the north side of the new basin area. Existing bottom conditions are sand, gravel, and cobbles. A total of 162,000 yd^3 of dredged material would be deposited in these disposal areas. Additional dredged material would be disposed of in water filling the existing entrance channel. Approximately 86,900 yd^3 would be deposited there to create a shoal for environmental enhancement.

	MAX	MIN
A Rock	2000	1200
B Rock	200	100
Core Rock	200	1



ALASKA DISTRICT
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SOUTH BREAKWATER
TYPICAL CROSS SECTION FOR ALTERNATIVES 2, 2a
SEWARD HARBOR IMPROVEMENTS

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6.3.5 Alternative 2a.

Alternative 2a is essentially the same as alternative 2, except that none of the dredged material is used to create an upland area adjacent to the south breakwater. Instead, this material would be used to fill the existing entrance channel as in alternative 2, with the balance of the remaining material being disposed of at the deep-water disposal location previously used by the railroad for dredged material disposal. The existing entrance would be closed by the construction of a 330-foot rubblemound breakwater structure with the same dimensions and materials as the rest of the new breakwater designed for alternative 2. A plan view of alternative 2a is in figure 6, main report.

6.3.6 Alternative 3.

General. With this alternative, the existing harbor would be expanded to the east by removing 1,470 feet of the east breakwater and constructing a new breakwater approximately 400 feet to the east. Road access is provided on the crest of the new breakwater. The existing entrance channel would not be altered and would be used to provide access to the new moorage area. A plan view of alternative 3 is in figure 7, main report.

This alternative would accommodate the additional moorage demand by providing 10.4 acres of additional basin. The existing mooring basins would not require any alterations to their layout or fairways.

Dredged material from the adjacent new moorage basin would be used in the construction of the new breakwater. The structure is designed for no overtopping due to the road access designed on the crest of the structure; therefore, no primary armor is needed inside the basin.

Harbor Basin. The new harbor basin would be dredged at three design depths to optimize the requirements of the fleet based on drafts of the vessels. Approximately 3.4 acres would be dredged to -15 ft MLLW to accommodate vessels drafting 9 feet. The next third of the harbor would be dredged to –12.5 ft MLLW for the fleet with drafts less than 6.5 feet. The last third would be dredged to –10 ft MLLW to accommodate vessels drafting 4 feet or less. All depths of dredging allow for 2 feet safety clearance and a minimum low-tide elevation of –4 ft MLLW. A total combined harbor basin and maneuvering area of approximately 10.4 acres would be required for alternative 3.

Wave Height Criteria and Harbor Operation Plan. Because there would be no change in the configuration of the existing entrance channel, the existing moorage areas could expect no change in the wave conditions experienced in the channel and inner harbor basin. The harbor as it exists has been used for more than 30 years and has performed satisfactorily during that time. The new moorage basin was analyzed using the computer model STWAVE and methods set forth in the SPM. Both revealed a predicted wave of less than 1 foot in the new moorage area. Maximum allowable wave heights in the mooring areas within the proposed harbor improvements would be limited to 1 foot. This criterion is outlined in EM 1110-2-1615, "Hydraulic Design Guidance for Small Boat Harbors" (USACE 1994). Therefore, wave height criteria for the floats would be met for the new moorage basin.

Circulation. Circulation in the existing harbor is driven primarily by the tidal prism in the basin. Strong winds drive surface water currents within the harbor and contribute to mixing in the water column. Wave action is an insignificant factor in driving circulation in the harbor.

Tides would cause most of the circulation in the harbor. An exchange coefficient of 0.44 was calculated based on the difference in volume of water in the proposed basin between MHHW and MLLW compared to the volume at MHHW. Values greater than 0.20 have been cited as providing good circulation. The aspect ratio for alternative 1 is approximately 1.3:1. This is considered close to optimum.

Shoaling. Visual observations, condition surveys, and historical accounts of conditions at the existing harbor indicate that shoaling is minimal there. The maintenance dredging that has occurred over the last 30 years has been due to flood events when the Resurrection River overflowed its banks. Prior to the flood in 1995, no maintenance dredging had been required.

Construction Dredging. Initial construction dredging quantities were derived from the September 1997 Corps of Engineers survey and a geotechnical survey performed by Golder Associates in October 1997 (appendix C). Initial construction would involve dredging material consisting of sands, gravels, and cobbles to the project limits. A total of 230,000 yd^3 of dredging would be required for the mooring area. Dredged materials would be placed along the shore south of the existing basin to create uplands for parking and harbor operations, and would be used in the new breakwater construction. Dredged material could be disposed of at the upland area designated for dredged material disposal on Alaska Railroad property. Additional deep-water disposal could occur in the area near the project site previously used by the railroad.

Alternative 3 requires the removal of 1,470 feet of the existing breakwaters. An estimated 28,000 yd^3 of core material would need to be removed. This material could be used for portions of the new construction. The gradation of the material is not known. An estimated 8,300 yd^3 of armor rock would also be removed from the existing breakwaters. This material could be reused for the new breakwater and revetment construction. A sampling of the rock revealed weights ranging from 1,000 lb to 10,000 lb, with the average weight at 3,300 lb.

Work inside the harbor could be accomplished with a hydraulic cutterhead and suction pipeline, or an excavator could be used if necessary. Dredging equipment and methods would be left as an option for the contractor.

Side slopes for the basin would be dredged to 1V:3H and would not require armoring.

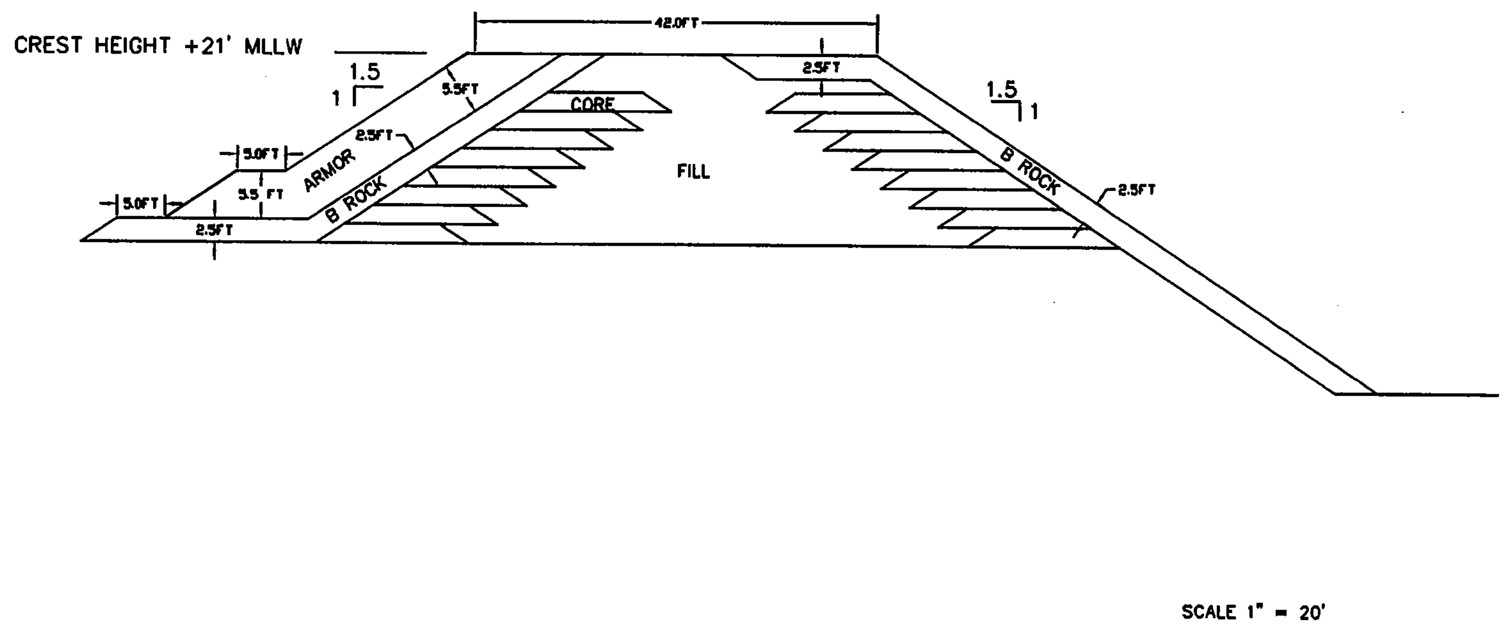
Maintenance Dredging. Based on historical information on conditions in the existing harbor, the project would present few sedimentation problems. Project condition surveys are performed every 3 to 4 years at the existing harbor. Over a period of 29 years prior to1994, surveys revealed 12,600 yd^3 of material had accumulated since construction of the existing harbor. Project depth was still available for most of the existing basin and channels. It is estimated that project condition surveys would continue to be performed every 3 to 4 years, and 4,200 yd^3 of material would have to be removed every 25 years from the additional moorage area.

Breakwaters. A 2,000-foot-long rubblemound breakwater would be constructed approximately 400 feet east of the existing harbor in a north-south alignment. The seaward toe of the breakwater would maintain a minimum distance of 30 feet from the existing piles supporting the coal trestle. The new breakwater would then change to an east-west alignment at the depth of about –6 ft MLLW and connect to the existing east breakwater approximately 100 feet from the breakwater head. 1,470 feet of the existing east breakwater would be removed from shore to the point of the new breakwater connection. Maximum depth of water is –7 ft MLLW along the alignment of the breakwater. Foundation materials are silty sand, gravel, and cobbles, a suitable base for the rubblemound structure.

Methods described in the SPM using Hudson's equation were used to determine stone sizes. For 1V:1.5H side slopes, a breaking wave, rough angular quarry stone, and the wave height determined in section 3.5, a K_d value of 2.0 is applicable for the entire structure to determine stone sizes for the breakwater. Application of Hudson's equation resulted in armor stone with a range of sizes from 2,500 lb minimum to 4,200 lb maximum. Secondary stone would range from 250 lb minimum to 1,000 lb maximum. Core material would be 1 lb minimum to 250 lb maximum. Armor stone thickness would be 5.5 feet, and secondary rock thickness would be 2.5 feet. A typical breakwater section is shown in figure A-10.

A wave runup calculation was performed to determine the crest elevation of the breakwater. Based on the criteria set forth in the SPM, the runup of the design wave on the breakwater was calculated to be 5.4 feet. The runup, added to the highest observed tide of +15.1 ft MLLW, gave a required breakwater crest elevation of +20.5 ft MLLW. The existing harbor breakwaters are at elevation +18 ft MLLW and have sustained no significant damage since construction in 1965. To ensure no overtopping onto the road on the breakwater, the crest height for the new breakwater would be +21 ft MLLW.

A total of 17,000 cubic yards of armor rock, 28,800 cubic yards of secondary rock, and 123,400 cubic yards of core rock would be required for breakwater construction. The core would consist of 98,000 yd^3 of dredged material and 25,400 yd^3 of core



ALASKA DISTRICT
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ALTERNATIVE 3 TYPICAL
BREAKWATER CROSS SECTION
SEWARD HARBOR IMPROVEMENTS

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material with gradation as stated above, used to construct dikes. The dikes would contain the dredged material during construction.

Dredged Material Disposal. Some of the dredged material would be disposed of in an intertidal area adjacent to the proposed harbor. The area would provide approximately 6 acres of uplands by filling in intertidal areas along the south side of the existing harbor and along the north side of the new basin area. Existing bottom conditions are sand, gravel, and cobbles. A total of 67,800 yd^3 of dredged material would be deposited in these intertidal disposal areas. Additional dredged material would be disposed of in water at the location previously used by the railroad, near the project site.

6.3.7 Alternative 4.

General. With this alternative, the existing harbor would be expanded to the east by removing 1,470 feet of the east breakwater and constructing a new breakwater/ sheet-pile wall wave barrier approximately 450 feet to the east. The existing entrance channel would not be altered and would be used to provide access to the new moorage area. A plan view of alternative 4 is in figure 8, main report.

This alternative would accommodate the additional moorage demand by providing 12.1 acres of additional basin. The existing mooring basins would not require any alterations to their layout or fairways. The layout of the new breakwater and sheet-pile wall wave barrier is approximately the same as in alternative 1. A sheet-pile wall with a scour rock toe extending 1,350 feet from shore heading south would be constructed. A 650-foot-long rubblemound structure would connect the sheet-pile wall to the remaining end of the breakwater at the entrance to the harbor.

Harbor Basin. The new harbor basin would be dredged at three design depths to optimize the requirements of the fleet based on drafts of the vessels. Approximately 3.8 acres would be dredged to -15 ft MLLW to accommodate vessels drafting 9 feet. The next third of the harbor would be dredged to –12.5 ft MLLW for the fleet with drafts less than 6.5 feet. The last third would be dredged to –10 ft MLLW to accommodate vessels drafting 4 feet or less. All depths of dredging allow for 2 feet safety clearance and a minimum low-tide elevation of –4 ft MLLW. A total combined harbor basin and maneuvering area of approximately 12.1 acres would be required for alternative 4.

Wave Height Criteria and Harbor Operation Plan. Because there would be no change in the configuration of the existing entrance channel, the existing moorage areas could expect no change in wave conditions in the channel and inner harbor basin. The harbor as it exists has been used for more than 30 years and has performed satisfactorily during that time. The new moorage basin was analyzed using the computer model STWAVE and methods set forth in the SPM. Both revealed a predicted wave of less than 1 foot in the new moorage area. Maximum allowable wave heights in the mooring areas within the proposed harbor improvements would be limited to 1 foot. This criterion is outlined in EM 1110-2-1615, "Hydraulic Design

Guidance for Small Boat Harbors" (USACE 1994). Therefore, wave height criteria for the floats would be met for the new moorage basin.

Circulation. Circulation in the existing harbor is driven primarily by the tidal prism in the basin. Strong winds drive surface water currents within the harbor and contribute to mixing in the water column. Wave action is an insignificant factor in driving circulation in the harbor.

Tides would cause most of the circulation in the harbor. An exchange coefficient of 0.42 was calculated based on the difference in volume of water in the proposed basin between MHHW and MLLW compared to the volume at MHHW. Values greater than 0.20 have been cited as providing good circulation. The aspect ratio for alternative 1 is approximately 1:1. This is considered close to optimum.

Shoaling. Visual observations, condition surveys, and historical accounts of conditions at the existing harbor indicate that shoaling is minimal at the existing harbor. The maintenance dredging that has occurred over the last 30 years has been due to flood events when the Resurrection River overflowed its banks. Prior to the flood of 1995, no maintenance dredging had been required.

Construction Dredging. Initial construction dredging quantities were derived from the September 1997 Corps of Engineers survey and a geotechnical survey performed in October 1997 by Golder Associates (appendix C). Initial construction would involve dredging material consisting of sands, gravels, and cobbles to the project limits. A total of 255,000 cubic yards (yd^3) of dredging would be required for the mooring area. Dredged materials would be placed along the shore south of the existing basin to create uplands for parking and harbor operations. Dredged material could be disposed of at the upland area designated for dredged material disposal on Alaska Railroad property. Additional deep-water disposal could occur in the area near the project site previously used by the railroad.

Alternative 4 requires the removal of 1,470 feet of the existing breakwaters. An estimated 28,000 cubic yards of core material would need to be removed. This material could be used for portions of the new construction. The gradation of the material is not known. An estimated 8,300 yd^3 of armor rock would also be removed from the existing breakwaters. This material could be reused for the new breakwater and scour toe construction. A sampling of the rock revealed weights ranging from 1,000 lb to 10,000 lb with the average weight at 3,300 lb.

Work inside the harbor could be accomplished with a hydraulic cutterhead and suction pipeline, or an excavator could be used if necessary. Dredging equipment and methods would be left as an option for the contractor.

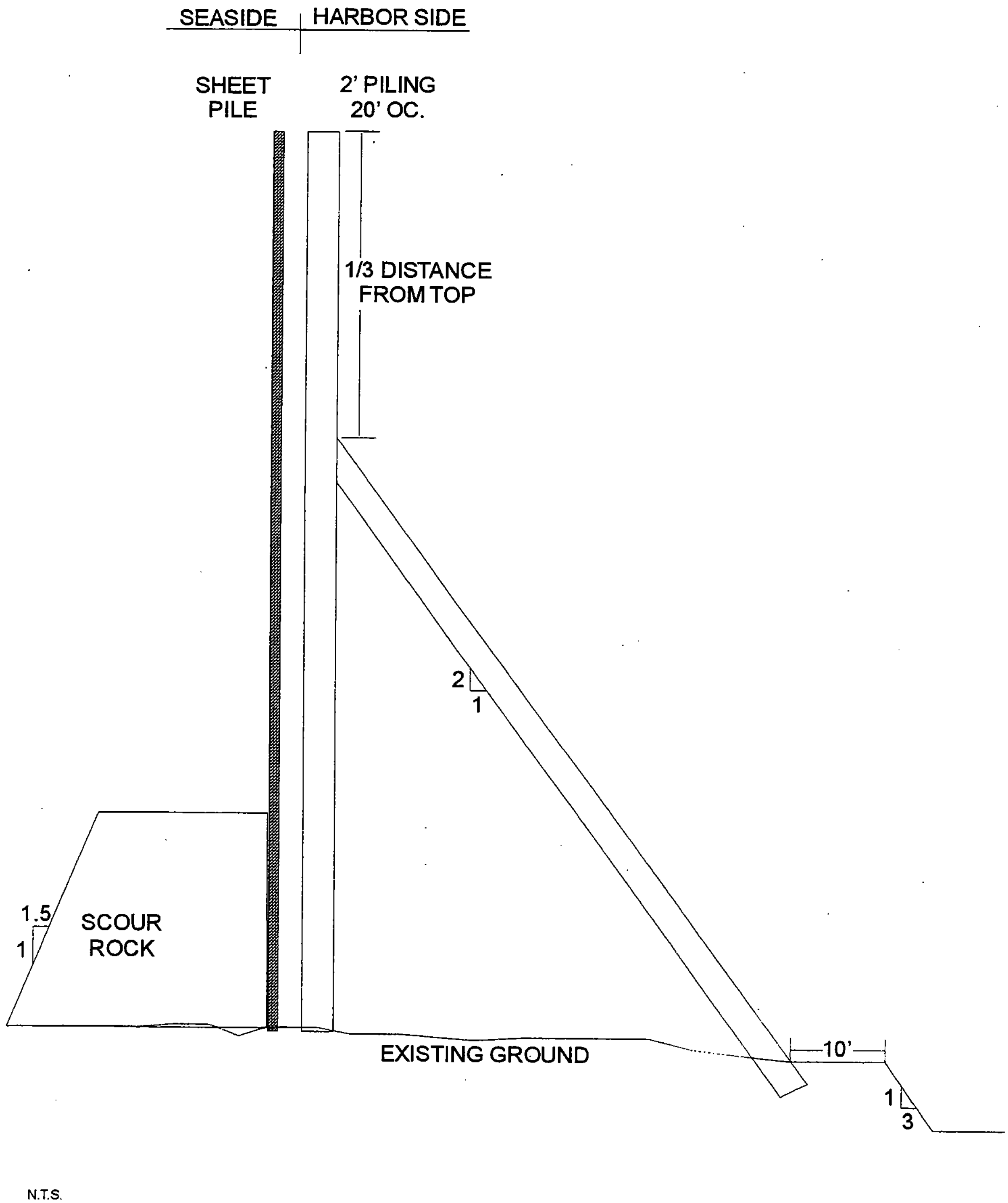
Side slopes for the basin would be dredged to 1V:3H and would not require armoring.

Maintenance Dredging. Based on historical information on conditions in the existing harbor, the project would present few sedimentation problems. Project condition surveys are performed every 3 to 4 years at the existing harbor. Over a period of 29 years prior to1994, surveys revealed 12,600 cubic yards of material had accumulated since construction of the existing harbor. Project depth was still available for most of the existing basin and channels. It is estimated that project condition surveys would continue to be performed every 3 to 4 years, and 4,000 yd^3 of material would have to be removed every 25 years from the additional moorage area.

Breakwaters. A 1,350-foot-long sheet-pile wall wave barrier with scour toe would be constructed approximately 450 feet east of the existing harbor in a north-south alignment. The seaward toe of the scour toe would maintain a minimum distance of 30 feet from the existing piles supporting the coal trestle. The sheet-pile wall is designed through the entire depth of the water column. A study performed by Peratrovich, Nottingham & Drage, Inc. (PN&D), for the city of Seward recommended a "permeable wave barrier" through a portion of the water column. Model testing by The Ocean Engineering Centre, British Columbia Research Corporation, in January 1991 indicated the structure must be constructed through the entire water column to attenuate the wave to a 1-foot inner harbor wave criterion. The design for the sheet-pile wall wave barrier is derived from the Wave Barrier Development Final Report (February 1992), prepared by PN&D. The sizing for the scour rock material was determined using the design wave and methods described in the SPM. The rock size was then reduced 50 percent because the design wave is oblique to the structure. Structural bracing and piling would be required for the entire length of the wall. The wall height would be +20 ft MLLW. A cross section of the breakwater is shown in figure A-11.

The sheet-pile wall wave barrier would tie into a rubblemound structure for the next 650 feet in an east-west alignment at the depth of about –6 ft MLLW and connect to the existing east breakwater approximately 100 feet from the breakwater head. 1,470 feet of the existing east breakwater would be removed from shore to the point of the new breakwater connection. Maximum depth of water is –7 ft MLLW along the alignment of the breakwater. Foundation materials are silty sand, gravel, and cobbles, a suitable base for the rubblemound structure.

Methods described in the SPM using Hudson's equation were used to determine stone sizes. For 1V:1.5H side slopes, a breaking wave, rough angular quarry stone, and the wave height determined in section 3.5, a K_d value of 2.0 is applicable for the entire structure to determine stone sizes for the breakwater. Application of Hudson's equation resulted in armor stone with a range of sizes from 2,500 lb minimum to 4,200 lb maximum. Secondary stone would range from 250 lb minimum to 1,000 lb maximum. Core material would be 1 lb minimum to 250 lb maximum. Armor stone thickness would be 5.5 feet, and secondary rock thickness would be 2.5 feet. A typical breakwater section is shown in figure A-7.



ALASKA DISTRICT
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CIVIL WORKS BRANCH

ALTERNATIVE 4 CROSS SECTION

SEWARD HARBOR IMPROVEMENTS

A-11

A wave runup calculation was performed to determine the crest elevation of the breakwater. Based on the criteria set forth in the SPM, the runup of the design wave on the breakwater was calculated to be 5.4 feet. The runup added to the highest observed tide of +15.1 ft MLLW gave a required breakwater crest elevation of +20.5 ft MLLW. The existing harbor breakwaters are at elevation +18 ft MLLW and have sustained no significant damage since construction in 1965. The crest height for the new breakwater would be +20 ft MLLW. This increase in height would reduce the potential for overtopping, provide an adequate core crest width at MHW to facilitate construction of the breakwater, and provide allowance for potential long-term settlement.

A total of 9,600 cubic yards of armor rock, 6,600 cubic yards of secondary rock, and 13,100 cubic yards of core rock would be required for breakwater construction. The scour rock along the sheet-pile wall would require an additional 1,200 yd^3 of the secondary rock.

Dredged Material Disposal. Some of the dredged material would be disposed of in an intertidal area adjacent to the proposed harbor. The area would provide approximately 6 acres of uplands by filling in intertidal areas along the south side of the existing harbor and along the north side of the new basin area. Existing bottom conditions are sand, gravel, and cobbles. A total of 91,800 yd^3 of dredged material would be deposited in these disposal areas. Additional dredged material would be disposed of in water at the location previously used by the railroad, near the project site.

6.4 Aids to Navigation

A self-contained signal lantern has been installed at the head of the existing breakwaters as an aid to navigation. Alternatives 1, 3, and 4 would not require the altering of these lights. Alternative 2 would require the replacement of the existing navigation aids to define the new entrance channel. The existing navigation lights could be incorporated into the breakwaters at the new entrance to the harbor. Discussions with the U.S. Coast Guard have been conducted to assure that necessary marking of the new entrance channel would be considered.

6.5 Operation and Maintenance Plan

Operation of the completed moorage basin would be the responsibility of the city of Seward. The Federal Government would be responsible for the entrance channel, the breakwaters, and the Federal portions of the mooring basin. Representatives of the Corps' Alaska District would make site visits periodically to inspect the breakwaters and would conduct hydrographic surveys every 3 to 4 years for the dredging areas. The hydrographic surveys would be used to verify whether the prediction of minimal maintenance dredging is correct for the entrance channel and basin. Maintenance requirements for the breakwaters would be determined from the surveys and inspections. Local and Federal dredging requirements, if necessary, would probably be combined, so there would be only a single mobilization and demobilization cost.

The breakwaters are designed to be stable for the worst wave conditions. It is therefore anticipated that the structures would not sustain a significant loss of stone over the life of the project. Using a loss of 5 percent of the armor stone over 15 years, an estimated quantity of approximately 1,400 yd^3 of stone would need to be replaced every 15 years for alternative 1 and approximately 1,500 yd^3 of stone would need to be replaced every 15 years for alternative 2. Alternative 3 would require approximately 850 yd^3 of armor stone replacement every 15 years in addition to annual maintenance of the road surface along the crest of the new breakwater. Alternate 4 would require 500 yd^3 of armor rock replacement every 15 years. The sheet pile would probably require replacement of sacrificial anodes every 10 years.

6.6 Detailed Quantity and Cost Estimates

Detailed estimates of quantities for dredging and the breakwaters derived for all alternatives are presented in the cost estimate tables (tables 4-2 through 4-4, main report). Dredging quantities were estimated for general navigation features and for other features. The general navigation features include the entrance channel and the harbor basin.

6.7 Construction Schedule

Major construction items include the breakwaters, dredging, existing breakwater removal, and upland fill. For alternative 2, the core of the new east breakwater would be constructed first and armored on the seaward side using new stone or armor stone removed from the existing breakwater, leaving the existing breakwater's core berm intact. After the new breakwater is completed, work on dredging the new entrance channel and fairway would be started concurrently with the upland fill construction. The existing breakwater core berm material could be removed and used to contain the dredged material for uplands construction. Once the new entrance channel is completed, allowing access to the existing harbor, the existing entrance channel gap could be filled concurrently with the removal of the 415 feet of breakwater. The other alternatives would follow the same scenario, with construction of the new east breakwater first using the armor rock from the existing breakwater to be removed. Dredging of the new moorage basin would then be accomplished, using the material for upland fill construction or disposing of the material in the deep-water disposal area. The time needed to construct the project is estimated at ___ months. Construction scheduling would facilitate the continued use of the existing harbor by local fishermen and by fish processing and cargo vessels during construction. Project specifications would outline requirements for the contractor to conduct certain activities during specified time periods to allow continued harbor use and ensure environmental protection.

6.8 Effects of Harbor Improvements Construction

Construction of the Seward harbor improvements would not impact the relatively quiescent waters within Resurrection Bay. Construction would not affect the wave climate or sediment supply of adjacent shorelines to the south and east of the harbor. Improvements in the Federal project area (mooring area and entrance channel) would not adversely impact the adjacent inner harbor areas or tidelands outside the harbor. The entrance channel and mooring basin dredging would not increase shoaling at the harbor entrance or inside the harbor.

Water circulation near Seward is driven predominantly by tidal action. The proposed improvements would not impact this pattern significantly. Circulation would be unaffected by wave action during storm conditions. The breakwater would not affect the circulation patterns near Seward and would not significantly impact the overall tidal exchange or water quality in the existing harbor.

APPENDIX B
ECONOMIC ANALYSIS

HARBOR IMPROVEMENTS
INTERIM FEASIBILITY REPORT
SEWARD, ALASKA

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September 1, 1998

APPENDIX B
ECONOMIC ANALYSIS

HARBOR IMPROVEMENTS
INTERIM FEASIBILITY REPORT
SEWARD, ALASKA

1. COMMUNITY PROFILE

The purpose of this section is to provide general background information pertaining to the socioeconomic composition of the study area. This information is necessary to enable planners and report reviewers to understand the community infrastructure, the level of economic activity generated from this small community, and the potential of the area to support the project under consideration.

1.1 General

Situated at the head of Resurrection Bay on the Kenai Peninsula, Seward resembles both a port city and an alpine resort. Founded in 1903 as the ocean terminus of the Alaska Railroad, Seward boasts the State's only deep-water, ice-free harbor with rail, highway, and air links to interior Alaska. This strategically positions Seward for Pacific Rim maritime commerce. The importance of Seward as a commercial center relates to the ease of transportation from Seward to interior Alaska. The all-weather Seward Highway links Seward to Anchorage, Fairbanks, and the Alaska Highway. Driving time is about 2-1/2 hours between Seward and Anchorage. The Alaska Railroad provides freight and container transport connections from Seward to inland destinations, and a tourist-oriented passenger service runs from Anchorage in the summer.

Seward, located within the Kenai Peninsula Borough, is one of the oldest cities in Alaska. In 1792, Russian explorer Alexander Baranof arrived by boat in what is now known as Resurrection Bay. Seward was named in honor of William H. Seward, President Abraham Lincoln's Secretary of State, who was responsible for negotiating the purchase of Alaska from Russia in 1867. The 1964 "Good Friday" earthquake was centered 95 air miles northeast of Seward and measured 9.2 on the Richter Scale. The quake, several tsunami waves, and resulting fires severely damaged the town and the rail yards. Eventually both the town and the railroad were restored, but the rail business took many years to recover.

Until damaged by the 1964 earthquake, Seward was Alaska's major commercial port. Since 1964, the city has worked to regain its role as Alaska's prime port. Existing terminal facilities include the Alaska Railroad dock (two 600- to 650-foot berths and one 200-foot berth, all 35 feet deep at mean lower low water); the State ferry terminal (190 feet long and 30 feet deep); the University of Alaska wharf (140 feet long and 26 feet deep); and the Anderson dock (200 feet long). The Seward Small Boat Harbor has a total design capacity of 656 boats with fueling, repair, and supply services. Because of increased port activity at Seward, the U.S. Congress has authorized a dedicated customs agent for the Kenai Peninsula. Supply, repair, and servicing of the fishing industry are also important to the city's economy.

Tourism is also a major and expanding component of Seward's economy. The city's unique harbor, excellent inland connections, majestic setting, and abundance of nearby recreation activities promote cruises into Seward. Sport fishing, boating, sightseeing, charter tours to Prince William Sound and Kenai Fjords National Park, camping in Chugach National Forest, hiking visits to glaciers, and scenic views are the basis of local recreational activities. More than 25,000 visitors participate in day cruises to Kenai Fjords National Park from Seward each season.

Despite its location at latitude 60° north, Seward enjoys a temperate maritime climate with cool summers and relatively warm winters. The fair climate is due primarily to the moderating influence of the Japanese currents that flow through the nearby Gulf of Alaska. The average winter temperature is 25 °F, and the average snowfall is 81 inches.

The community possesses a full range of educational opportunities. With a new elementary school completed in 1990, the city has adequate school capacity to absorb substantial growth. The Alaska Vocational Technical Center (AVTEC) offers training in various skilled trades, including mechanical and maintenance occupations. The center offers employer-specific training support for larger Alaskan employers. It is also known for its state-of-the-art radar navigation and ship's pilot training programs. The school trains personnel for oil tanker certification worldwide.

The University of Alaska maintains its Institute of Marine Science in Seward. Through this institute, the university performs oceanographic research to support the State's maritime industry. The city of Seward is working to assist the development of a world-class marine mammal research station adjacent to the institute. The University operates the research vessel *Alpha Helix* from the Seward station.

City voters approved a plan in 1996 whereby Providence Hospital, in Anchorage, would take over administration of the Seward General Hospital and the city would sell bonds to finance construction of a new medical building. The present 33-bed hospital is scheduled for demolition after the new building is completed. Construction of the new building, which will be a trauma center and clinic, began in April 1996 and is scheduled for completion in 1998. Those with serious injuries and illness requiring specialized care are transported to Anchorage.

1.2 Population

The population history of Seward since 1930 is presented in table B-1. Over the past several years, the population of Seward has remained relatively flat, despite high overall growth for the Kenai Peninsula – particularly the larger communities of Soldotna, Kenai and Homer. Between 1990 and 1996, Seward grew 8.0 percent, while Kenai grew at 9.9 percent, Homer grew at 11.0 percent and Soldotna grew at 14.0 percent. The population grew in the late 1970's, due in part to Seward's important role in shipping supplies to the North Slope for trans-Alaska pipeline construction. Several new projects, including the State prison and development of the Seward Marine Industrial Center (SMIC), are driving the sharp current growth. Population figures in the table include only the area within the city limits. Neighboring residential areas served by Seward add another 1,400 to 1,500 people.

TABLE B-1.--*Population trends for Seward, Alaska*

Year	Population
1930	835
1940	949
1950	2,114
1960	1,891
1970	1,587
1980	1,843
1990	2,700
1996	2,914

1.3 Government

Seward is a home-rule city located within the Kenai Peninsula Borough, with a council-manager form of government. An elected seven-member council appoints the city manager.

The Kenai Peninsula Borough functions similarly to counties in other States. Incorporated in January 1964 as a second-class borough under the authority of the State of Alaska, the borough is responsible for areawide education, solid-waste management, planning and zoning, taxation, and assessment. Locally authorized service areas provide hospital, fire, emergency, and recreation services. An elected mayor serves as the chief administrator and works with a nine-member elected legislative assembly.

1.4 Services

1.4.1 Law Enforcement.

Law enforcement services include a city police department that also provides school drug awareness education programs, animal licensing and control, motor vehicle registrations, a 14-inmate jail, and 24-hour dispatch and radio communications with Alaska State Troopers. The troopers serve the outlying areas around the city.

1.4.2 Fire Services.

A department staffed by a full-time chief and deputy with 30 volunteers provides fire services within the city. Services include fire suppression, rescue, inspections, and plan reviews, as well as public training and education. The Bear Creek Fire Service Area, operating a rural fire department manned by 23 volunteers under the auspices of the Kenai Peninsula Borough, serves the outlying areas of the community.

1.4.3 Health Care.

Facilities include Providence Seward Medical Center with visiting medical specialists. Emergency medical services are provided by the Seward Volunteer Ambulance Corps, staffed by 24 trained EMT and ETT volunteers operating three ambulances. The Bear Creek Fire Service Area, staffed by 14 EMT volunteers and a dive rescue team, provides first-response medical service and search-and-rescue in the outlying community areas.

1.4.4 Education.

Seward public schools, operated by the Kenai Peninsula Borough, include one elementary and one junior high/high school. The University of Alaska's Institute of Marine Science provides marine laboratory research. Also located in Seward is the Alaska Vocational Technical Center (AVTEC), the State's largest such facility. AVTEC offers a wide variety of training, including office occupations, food services, oil technology, and nautical/fisheries technology.

1.4.5 Employment.

Because of the seasonality of local industries such as fishing and tourism, the Kenai Peninsula Borough's unemployment rate fluctuates from a high of 18.7 percent in the winter to a low of 7.6 percent in the summer. There is a moderate pool of skilled and semi-skilled workers available during most of the year. Future employment looks bright due to the development of the $47-million Alaska SeaLife Center and the growth rate of the tourism industry. Although Seward employment is projected to increase, unemployment is anticipated to remain above the statewide rate. Moreover, near-term employment growth will be composed of many higher-paying jobs in the construction industry as opposed to lower-paying service industry jobs. Employment in Seward has shown a slowly increasing trend in recent years, according to data from the Alaska Department of Labor (ADOL). The employment data from ADOL include most employment, but exclude self-employed persons such as commercial fishermen or bed-and-breakfast business operators. The large jump in 1989 was due to activities associated with cleanup of the *Exxon Valdez* oil spill. The peak employment in 1983 was due to an increase in employment from a processor operating in Seward that year.

Table B-2 lists the major employers in Seward for 1996, in order of jobs provided:

TABLE B-2.—*Major employers in Seward, 1996*

Employer	**No. of jobs**
Alaska Department of Corrections	205
Kenai Peninsula Borough/Seward schools	118
City of Seward	90
Alaska Department of Education (AVTEC)	74
Icicle Seafoods	73
Kenai Fjords Tours	57
Alaska Department of Labor	51
Trend/Breeze Inn Construction	46
Providence Hospital/Seward General	43
Seward Life Action	42
Eagle	30

Source: Alaska Department of Labor, unpublished data.

A "snapshot" of the Seward employment profile for 1996 is provided to gain an appreciation of the relative importance of the different job sectors. Table B-3 shows the employment by industry category. Government employment accounted for 652 jobs, or 37 percent of the total. The next highest job categories were in the service sector (338 jobs) and the trade sector (324 jobs). The 229 manufacturing jobs shown in Table B-3 relate to seasonal seafood processing.

TABLE B-3.—*Seward employment for 1996 by sector*

Job category	**No. of jobs**
Mining	1
Construction	60
Manufacturing	229
Transportation, commerce & utilities	149
Trade	324
Finance, insurance and real estate	22
Services	338
Agriculture, fisheries & forestry	2
Federal government	54
State government	367
Local government	231
TOTAL	**1,777**

Source: Alaska Department of Labor.

2. MARINE RESOURCE ASSESSMENT

2.1 General

Seward is the primary fish-processing center for Prince William Sound, due to the proximity of the Prince William Sound fishery and Seward's transportation links with Anchorage. The main species of fish within the bay are pink, chum, and chinook (king) salmon. Outside Resurrection Bay, the Seward fleet also fishes for cod, sablefish (blackcod), and halibut.

Most of the commercial boats in Seward are licensed to fish with long lines, targeting cod, sablefish, and halibut. This effort occurs in both State waters (within 3 miles of shore) and Federal waters (between 3 and 300 miles offshore), in the Gulf of Alaska outside Resurrection Bay. The International Pacific Halibut Commission manages halibut fishing. The halibut is managed under Individual Fishing Quotas (IFQ's). Individuals under IFQ management have been given the right to catch halibut based on previous landings. The season for halibut has increased from a few hectic days to 9 months, from March to November. Fishers can harvest the halibut at any time during the 9-month period.

2.2 Resurrection Bay

Chinook (king) salmon are present in Resurrection Bay due to a program managed by the Alaska Department of Fish & Game (ADF&G) to enhance sport fishing opportunities. Each year, 200,000 to 300,000 smolts are released into the bay. The adults return after 3 to 4 years at sea. The release sites for the chinook smolts are Lowell Creek and Seward Lagoon.

Coho (silver) salmon are the most popular species and the target of the frenzied activity associated with the Seward Silver Salmon Derby, which runs August 8-16. There are small wild populations of coho in various tributaries to Resurrection Bay. Due to unstable water flows, these streams are not extremely productive for coho. To augment the wild production, the ADF&G developed an enhancement program more than 30 years ago. A weir on Bear Creek assists capture of returning spawning salmon. Eggs stripped from the spawners are raised in the Trail Lake Hatchery operated by the Cook Inlet Aquaculture Association (on a contract basis for the Sport Fish Division of ADF&G). Fry raised in the program are stocked in Bear Lake. Another component of the program takes coho eggs from the Bear Creek weir and raises them in the Elmendorf hatchery. These fry are held until they reach the smolt stage and then released to Resurrection Bay streams.

The hatchery program for coho in Resurrection Bay serves to lengthen the fishing season. Wild salmon return from early July to mid-August. Returning coho from the enhancement program arrive in Resurrection Bay in early August through October.

Coho landed during the Silver Salmon Derby are approximately 50 percent hatchery fish and 50 percent wild production.

Pink salmon are also present in the small tributary streams of Resurrection Bay. These fish are on an even-year cycle, similar to those in Cook Inlet streams. The pink resource in Resurrection Bay is relatively modest in size.

There are very few wild sockeye (red) salmon in Resurrection Bay, but the Cook Inlet Aquaculture Association instituted a sockeye-stocking program in Bear Lake in 1990. The program has been successful enough to allow a commercial fishery on the returning sockeye. A seine fishery at the head of the bay targets the sockeye returns. Fishermen participating in the fishery are lower Cook Inlet salmon seine permit holders. The sockeye return in May and early June. The commercial fishery produces an annual harvest of 20,000 to 30,000.

Commercial fishermen have proposed an expansion of the sockeye program at the head of Resurrection Bay, to include smolt releases at Spring Creek. The Board of Fisheries will review this proposal in early 1999.

Chum salmon are widely distributed throughout the tributary streams emptying into Resurrection Bay. Chum salmon in Resurrection Bay return from early July to early August.

Halibut are a very important species in Resurrection Bay. At various times of the year, halibut are found in the outer areas of the bay. Most of the halibut fishing, both sport and commercial, occurs near areas of greater abundance outside Resurrection Bay. In recent years, large, fast charter boats have opened a wide area of the outer waters of Prince William Sound to halibut fishing. There is a limited amount of commercial halibut fishing in Resurrection Bay, primarily due to low abundance.

Shellfish harvesting is insignificant in the Resurrection Bay area. Tanner crab has been fished on occasion in Prince William Sound and other nearby waters, but this has traditionally been done by Kodiak boats, and has not occurred in the recent past. The only other shellfish fishery is pot shrimp, but this is a very small, low-key operation. No processors are buying pot shrimp, so the only market is for tourists. Since tourism occurs mainly in the summer, this is when the pot shrimp harvest occurs. No more than 10 to 15 boats participate in the fishery.

Lingcod are at low levels of abundance in Resurrection Bay. ADF&G has implemented a year-round closure of commercial harvest and a seasonal closure of sport harvests within the Bay. Conservative sport fish bag limits in the Central Gulf and a minimum size limit are intended to rebuild the resource.

There are numerous species of rockfish in Resurrection Bay and the nearby areas of Prince William Sound outside the bay. The rockfish population levels within

Resurrection Bay are depressed due to intense fishing pressure over the years. Recent sport fish bag limits are intended to maintain the level of the population.

A popular sport fishery has developed in the last several years for salmon sharks in Resurrection Bay and the surrounding waters. Commercial fishermen also harvest these fish as incidental and targeted species. ADF&G biologists have expressed concern that little is known of the shark resource. These sharks are slow-growing and long-lived (similar to many rockfish species), making them extremely vulnerable to overharvest. The Board of Fisheries implemented a sport fish shark season limit of two and a one-shark bag limit to reduce the risk of overharvest.

The only other frequently harvested fish in Resurrection Bay is anadromous dolly varden char. These fish return to spawn and are present from early July through early August.

2.3 Outside Resurrection Bay

Three processing companies currently operate in Seward: Seward Fisheries, Cook Inlet Processing, and Resurrection Bay Seafoods. Fishermen delivering to these plants fish primarily in the Gulf of Alaska outside Resurrection Bay. Salmon are occasionally tendered in from Prince William Sound.

Due to confidentiality restrictions, data providing specific landings of fishery products to Seward are not available. However, it is possible to get some idea of the magnitude of the fishing activities. Table B-4 shows the landings of halibut in Seward over the past 10 years. The amount landed has been relatively constant over time.

TABLE B-4.--*Halibut landings in Seward, 1988-97*

Year	Pounds harvested
1988	4,530,000
1989	4,454,000
1990	5,183,000
1991	3,283,000
1992	3,997,000
1993	2,936,000
1994	3,896,000
1995	3,303,000
1996	3,296,000
1997	4,732,861

Source: International Pacific Halibut Commission, annual reports; personal communication for 1997 data.

Table B-5 shows the amount of shared fish tax revenue Seward has received over the past 5 years. If we assume that all the fish was frozen (which means a raw fish tax rate of 2 percent) then the column to the right provides an estimate of the total ex-vessel value of fish landed in Seward. (The city gets half of 2 percent of the ex-vessel value.)

TABLE B-5.--*Shared fish tax revenue for Seward, 1993-97*

Year	Shared revenue	Estimate of value
1993	$187,378	$18,737,800
1994	$142,157	$14,215,700
1995	$125,329	$12,532,900
1996	$223,843	$22,384,300
1997	$174,277	$17,427,700

Source: Alaska Department of Revenue, Income & Excise Audit.

3. EXISTING CONDITIONS

3.1 Status of Existing Harbor

Seward Small Boat Harbor currently has 537 stalls for permanent moorage. There is also space available for approximately 119 transient vessels. The ratio of permanent moorage in the harbor is split approximately 45:55 between commercial (which includes commercial fishing and charter vessels) and recreational vessels. Most of the permanent moorage stalls are 42 feet long or less.

The harbor has two classes of moorage: reserved and transient. Reserved moorage is for vessels assigned to stalls. Transient vessels are those without assigned stalls. By the strict definition of the word "transient," many such vessels do not fit the term, in that they pay for long-term moorage and are year-round residents of the harbor.

In December 1987, Ernst and Whinney performed a market survey for the city of Seward which examined the demand for moorage space at Seward's harbor at various levels of cost and services. One important aspect of the report was price sensitivity. In July 1993, Seward increased moorage fees by 30 percent in an effort to increase revenues while decreasing congestion in the harbor. Seward's rates average $30.83 per ft/yr while other area harbors range from $16.00 to $22.00 per ft/yr, which places the facility in a noncompetitive situation. The success of the increased moorage is marginal. The reduced traffic primarily targeted boats 28 feet long or smaller, which were not a major concern relating to congestion anyway. The expansion currently under consideration could allow a reduction in moorage costs to the boat owner while retaining the revenues necessary for operations, maintenance, and improvements.

The 1992 implementation of the Individual Fishing Quota system for halibut and Pacific cod has changed the use of the harbor and demand for facilities. The halibut and cod fisheries now begin in mid-March and continue for a 9-month period. The IFQ system of distributing fishing permits has helped to reduce impact from the massive buildup of vessels waiting for a 24-hour opening; however, the increase in continual demand for offloading has increased dramatically. The IFQ program has impacted large shore-based processors by increasing the fixed costs for operating their facilities for the continual intake of small quantities of product. The small mobile operations are prospering and can compete directly with the large complex of Icicle Seafoods. Currently, processors required to offload in Seward include Columbia Ward (Ward Cove Packing), Inlet Salmon, Dragnet Fisheries, Cook Inlet Processing, Sahalee of Alaska, Alaska Custom Seafoods, Great Pacific Seafoods, Deep Creek Custom Packing, New West Fisheries, Pacific Eagle Seafoods, and Seward Fisheries. The harbor is unable to accommodate this demand.

A 250-ton travelift was installed in August 1991. While it is at the industrial complex on the east side of Resurrection Bay, it generates harbor traffic from the fishing fleet from as far away as Sitka. The attraction to the fleet is the savings in vessel repair and maintenance cost. This is the only facility with the capacity to dry-dock vessels to 250 tons and that will allow the vessel owners to work on their vessels in Alaska.

3.2 Damage to Harbor Facilities

In March 1995, the float system designated as 'X' had catastrophic piling failure due to overloading (rafting) and high winds. This float, installed in 1978, was the new float system in the harbor. To place the float back in operation with diminished capacity, the harbor spent $55,000 in emergency funds. The replacement float was constructed, using in-house labor to reduce the overall cost, at a cost of roughly $543,000. Had the entire job been contracted, ADOT&PF estimated the cost would have run between $850,000 and $900,000. Seward's harbormaster reports that on any given day when the harbor is overcrowded, the possibility that the inner-harbor facilities could fail is very real.

3.3 Rafting

When discussing rafting and hot-berthing, the discussion is limited to the assigned berths for vessels 22 feet long and larger, and vessels that are not easily trailerable. Smaller vessels (21 feet or less) enjoy alternatives for berthing that may be impractical or nonexistent for the larger boats. For example, when harbor overcrowding becomes extreme, smaller vessels can be trailered in and out daily to help alleviate the problem. This activity has a significant impact on harbor operations during short periods of the summer season. The option was further enhanced significantly by the addition of the four-lane launch ramp at the northeast corner of the basin in 1995.

Rafting occurs to varying degrees throughout the entire Individual Fishing Quota (IFQ) season. The highest degree of rafting occurs from Memorial Day through Labor Day, as increased pleasure boat activity and large numbers of salmon fishers generate more demand for limited moorage space. Vessels are occasionally rafted eight deep. The average raft is four deep.

Problems associated with rafting include:

a. Dissimilar vessels often tie together, such as large vessels to small ones, steel vessels to fiberglass, and fishing vessels to sailboats. All of these conditions can cause damage to either or both vessels. Excessive stress or point loading on the hull is generally associated with sailboats that do not have straight sides and power boats that flare at the gunwales.

b. Loss or lack of bumpers between vessels can create extensive damage to fiberglass and wooden vessels by the harmonic movement of the boats in the water. This is particularly noticeable between vessels of different sizes or design that have unequal pitch-and-roll cycles.

c. Delays and added costs are often associated with rafting. Harbor personnel are required to remove other vessels to the outside of a vessel wishing to depart. Most boat owners do not want the responsibility nor do they have the ability to remove obstructions by themselves to allow use of their boats. Occasionally, winter conditions will not allow safe towing or moving of rafted vessels, and the vessel owner is deprived the use of his/her boat.

d. Public safety is of paramount importance. The potential for catastrophic fire loss increases in proportion to the degree of rafting in the harbor. Access with gear to fight fires on a boat in a raft is difficult, and the probability of other vessels in the raft catching fire is much greater. These factors also increase the risk of injury to firefighters. Another safety issue is the increased risk of slips and falls. Crossing unfamiliar vessels, particularly during rainy or snowy conditions, leads to unexpected problems. For example, on one occasion a harbor worker was injured when he fell through a plastic daylight hatch that was covered with snow. On other occasions, harbor personnel have gone overboard while traversing a raft. The Seward harbormaster reports that during his 22 years working in the Seward harbor, he has seen people lose their lives by falling into the water from boats or docks.

3.4 Hot-Berthing

Hot-berthing may differ slightly from harbor to harbor. In Seward, it simply means placing a transient vessel in an assigned stall when the assigned vessel is out of the harbor. The moorage agreement for assigned stalls states that the only obligation of the harbor to an assigned vessel is to make the stall available when the vessel is in port. The assigned vessel is also required to notify the harbormaster's office when it is to be absent from the harbor. Hot-berthing helps minimize the many problems associated with overcrowding by allowing the harbor to use existing inner harbor facilities to the greatest extent possible.

Hot-berthing occurs year-round, and while it helps in maximizing existing facilities, it has its limitations and associated problems. For one, hot-berthing creates a never-ending burden on the harbormaster's staff. Notification of departures and arrivals is sporadic and often inaccurate, which forces harbor personnel to play a guessing game. When information regarding a vessel's arrival or departure is wrong, harbor personnel must tow the transient vessel out of the stall, resulting in a substantial bill for the towed vessel. On the occasion when an assigned vessel arrives in the middle of the night without proper notification, the vessel must be placed on a transient float until the next day, providing transient space is available. This system operates much more efficiently in places such as Kodiak. However, in Seward, most vessel owners live out of town and cannot respond quickly to move their boats. Hot-berthing also has a negative effect on public relations. More often than not, the transient and assigned vessel owners feel that they are not getting the full value of their moorage fee paid.

3.5 Current Fleet

The busy Seward harbor is used by a diverse group of vessels. The town is well situated for certain commercial fisheries, such as salmon and halibut, as well as being one of the most popular recreational harbors for railbelt residents. A growing number of charter tour boats that sail to nearby Kenai Fjords National Park operate out of Seward. The ship repair facility in Seward is well equipped and handles vessels ranging in length from less than 60 feet to more than 300 feet, drawing many vessels to Seward. While this activity is good for the local economy, it creates a problem with the harbor facilities, which were not designed for such a large number of vessels.

The majority of permanent moorage slips are 42 feet long or less. Commercial Fisheries Entry Commission (CFEC) data list 314 commercial vessels as either home-ported in Seward or with owners residing in Seward. Most Seward vessels hold more than one gear type. Licensed fisheries harvested by vessels operating out of Seward include salmon (pink, chum, and chinook), Pacific cod, sablefish, herring roe, and halibut.

Long-line gear is the most common license held by Seward vessels. This type of gear is used primarily for harvesting Pacific cod, sablefish, and halibut. Typically the same vessels fish for all three of these species.

Table B-6 lists the distribution of commercial fishing licenses for Seward vessels. The three most popular gear types are long-line, purse seine, and pots. The CFEC lists 193 vessels in Seward licensed to fish with long-line gear. Commercial salmon fishing is done primarily with purse seine gear. The CFEC lists 101 vessels in Seward that hold a purse seine license.

TABLE B-6. -- *Distribution of commercial fishing licenses for Seward vessels*

Rank	Gear type	No. of licenses
1	Long-line	193
2	Purse seine	101
3	Pots	95
4	Hand troll	36
5	Drift gill net	33
6	Mechanical jig	22
7	Diving or hand	21
8	Herring gill	16
9	Beam trawl	12
10	Beach seine	11
11	Otter trawl	10
12	Set gill net	5
13	Pair trawl	3
14	Double otter	2
15	Scallop dredge	2
16	Power troll	1
	Total number of licenses	**563**

The Prince William Sound salmon season generally runs from June 1 to September 30. The season is operated by emergency orders, which are 12-hour openings that occur throughout the season when deemed appropriate by the Alaska Department of Fish and Game (ADF&G). A total of 95 vessels hold licenses for pots, the third most common type of gear license in Seward. The pot gear used by these boats is essentially the same as that used for tanner crab fishing, with slight modification, and is also used for harvesting Pacific cod. The majority of pot gear vessels in Seward fall into the 27- to 36-foot and 37- to 45-foot ranges.

Seward is also the harbor of choice for many recreational vessel owners. Only a 2.5-hour drive from Anchorage, and in one of the State's most productive fishing areas, Seward affords recreational fishers a convenient location for their leisure activities. Pleasure boats in Seward generally range from 10 to 36 feet in length, and the vast majority are used only from late May through early September. Most pleasure boat owners dry-dock their vessels for the winter months, leaving the smaller-sized stalls empty for most of the year.

An area of rapid expansion is the increase of charter vessels. Growth is primarily due to the commercial passenger vessels used to accommodate the tourist industry. Demand is so prolific that the State has required the harbor to limit assignments to vessel owners to no more than three stalls each. This limit was designed to protect the general public's ability to obtain berths. The city requires that holders of multiple berths must generate one and one-half times the space required for public use if they wish to expand their operations. However, there is no room left for expansion in Seward's small boat harbor.

The active list of moorage tenants, maintained by the Seward harbormaster, contains the names of all vessels with permanent moorage as well as any transient boats that are expected to return to Seward within a few years. This list reports 3,571 individual vessels that have recently used the harbor and are expected to return within 3 years. Of these, 1,151 are commercial fishing, 906 are charter, and 1,514 are recreational.

4. MOORAGE DEMAND ANALYSIS

This section describes the current supply of moorage and the existing moorage demand for vessels in Seward. The number and sizes of slips at the Seward harbor and information on the existing wait list is presented.

4.1 Existing Moorage Capacity

The majority of the permanent moorage slips (472 of 537) in the Seward Small Boat Harbor are 42 feet long or less, while 62 slips are 50 to 75 feet. Permanent moorage is allocated by slip size, as shown in table B-7.

TABLE B-7.—*Moorage capacity at Seward*

Slip length (ft)	Vessel size (ft)	Number of slips
17	Up to 21	132
23	22-26	58
32	27-36	162
40	37-45	62
42	37-45	58
50	46-54	46
75	55-90	19
	Total assigned moorage	537
	Transient slips	119
	Total designed mooring capacity	**656**

4.2 Wait-Listed Vessels

A profile of the wait-listed fleet is presented for informational purposes and is used in estimating moorage demand. Currently, 339 vessels are on the waiting list for moorage in Seward. Table B-8 presents characteristics of vessels on Seward's waiting list as maintained by the harbormaster.

TABLE B-8.—*Wait-listed vessels at Seward*

Slip length (ft)	Vessel size (ft)	Wait-listed vessels
17	Up to 21	2
23	22-26	36
32	27-36	164
40	37-45	84
50	46-54	32
75	55-90	21
	Total wait-listed	**339**

The harbormaster began charging a $20 fee for holding a place on the moorage waiting list in early 1991. This reduced the number of names on the list from 1,598 to 784 as of January 1992. The fee eliminated from the waiting list people who were not serious about obtaining moorage and who did not own a vessel. Prior to the charge, the failure rate, defined by the harbormaster as the percentage of people who did not accept moorage when it was offered, was roughly 30 percent. With the new policy, this rate has been reduced to less than 5 percent. The average number of years for people on the wait list is 5.4. The waiting list is a conservative indicator of the real demand for moorage in Seward. The actual moorage demand probably exceeds the number on the list, since the combination of the waiting list fee and the length of the list discourage many boaters. Residual damages and rafting due to latent demand have been accounted for in calculations.

Harbor personnel track only the sizes of vessels for wait-list purposes, not whether they are currently mooring in transient space. Therefore, data does not exist to determine what percentage of the waiting list is comprised of vessels mooring at the transient dock. However, in this boat size it is reasonable to assume those willing to incur delays and damages associated with rafting, such as rafted transients do, would desire permanent slips. Typically, the larger vessels are commercial fishers or charters with established businesses operating out of Seward. The waiting list does not indicate whether a person owns a commercial or a recreational vessel. However, the split between commercial (which includes commercial fishing and charter vessels) and recreation vessels on the waiting list is assumed to be roughly the same as for vessels with permanent moorage in the harbor, which is approximately 60:40, commercial to recreational. The vast majority of recreational craft using Seward's Small Boat Harbor are in the 12- to 36-foot range.

The wait list indicates that at least 21 commercial vessels require 75-foot slips. For large fishing vessels (greater than 90 feet), there may be substantial latent demand for moorage that is unmet with current facilities but not reflected on the wait list. Because vessel owners are aware of the lack of moorage for larger vessels in Seward, they may not appear on the waiting list even if there is a geographical advantage to operating out of Seward. This latent demand is difficult to estimate, but harbor personnel consider it to be substantial.

4.3 Transient Vessels

Requests for transient moorage occur throughout the year, with the peak periods being between Memorial Day and Labor Day. The harbormaster does not prohibit entry of vessels into the harbor, primarily due to the liability to the city if they are turned away. Usually the vessel owner will determine whether attempts to moor in the basin will place the vessel in danger, or whether further congestion will allow the cost-effective discharge of fish products. Occasionally, large commercial vessels will ride on their anchor or on one of the buoys in the bay. However, for the vast majority of the vessels this is not an option.

Nearly 1,800 different vessels use Seward's small boat harbor on a transient basis each year. During the extremely busy summer months, up to 550 vessels may seek shelter in the harbor in a single day. With existing space for 119 transients, vessels are rafted an average of 4 deep during the extremely busy summer months of May through August in an attempt to accommodate as many boats as possible. The majority, slightly more than 60 percent, of vessels using Seward's transient space are commercial fishing and charter vessels. The remaining 40 percent are pleasure craft.

Crowded conditions result in vessels being rafted an average of four deep. By rafting, the existing harbor can accommodate approximately 476 (4 x 119) transient vessels. Subtracting the transient vessels that can currently moor in the harbor from the number that use the harbor on a transient basis each year yields 74 (550 - 476 = 74) vessels that require transient space in Seward on an annual basis.

Vessels unable to secure transient moorage in Seward may need to travel to alternate ports in search of protected areas. Seward's harbormaster does not keep records of who travels to alternative ports. Most skippers, after learning of Seward's crowded conditions, do not even bother showing up. This contributes to underestimating the total number of transients desiring space in Seward. Alternative ports in the area of Prince William Sound, such as Whittier, Kodiak, Homer, and Seldovia, also experience overcrowded conditions and require runs as long as 18 hours.

4.4 Commercial Fishing and Recreational Fleet Projections

No significant increases or decreases are expected in the Seward commercial fishing fleet. This is primarily due to healthy stocks, existing or proposed limitations on the number of vessels participating in significant fisheries, and the ability to fully exploit the resources with existing capital.

4.5 Summary of Moorage Demand

The demand for additional moorage at Seward is 413 vessels, including 339 seeking permanent stalls and 74 seeking transient space.

5. WITHOUT-PROJECT CONDITION

Inadequate moorage for vessels more than 22 feet in length causes increased maintenance and repair requirements for vessels and facilities, requires vessels to be shuffled about the mooring area, requires operators to take special precautions during storms, and causes operators to move their boats to distant harbors in an effort to secure protected moorage. These activities take time and labor and raise operating costs, causing operators to incur additional expenses, thereby reducing net income.

Damage to both vessels and facilities in Seward due to rafting is significant. When one boat needs to move, vessels to the outside have to be untied and then the raft reassembled. This requires the time and effort of several people. Because rafted boats extend into common maneuvering areas, congestion results in delays for other harbor users. All of these problems cause increased operating costs and loss of time for the vessels' crews.

The proposed eastward expansion of the existing boat harbor would be designated primarily for commercial fishing vessels more than 30 feet in length. These larger vessels put the most stress on the float system in the existing harbor. Most of the existing float system is 27 years old and not designed for the amount of rafting that occurs. An expanded harbor with a modern float system would be able to withstand greater loading. Expansion would also reduce the loading on the existing float system, extending its useful life.

Using available data, the number of commercial vessels using the Seward harbor is projected to remain at current levels over the 50-year period of analysis. Although there will be minor increases and decreases as marginal operators move in and out of the industry, the overall trend is for no significant increase or decrease.

6. REGIONAL BENEFITS

The evaluation of regional benefits is intended for the use and information of Seward residents, their local government, and the State government as a tool to understand the impacts of the proposed project. Under Corps of Engineers guidelines, projects are evaluated for their Federal interest. Federal interest is based on a specific approach to estimating benefits and costs under the national economic development (NED) guidelines. This is an appropriate stance for the Corps of Engineers, since they are interested in overall benefits to the Nation. However, communities such as Seward have their own concerns for developments such as the proposed small boat harbor expansion. Seward residents want to know the type of employment and incomes (both direct and indirect) that are likely to result from the project.

6.1 General Overview of the Economy

Seward is located at the head of Resurrection Bay on the Kenai Peninsula. Seward is the southern terminus for the Alaska Railroad, and its past has been historically linked with transportation of freight and passengers to Alaska's rail and road system. Different types of economic development activities have been introduced to Seward in recent years, including a lumber mill, coal loading dock, correctional facility, and a vessel haul-out and repair facility, among others. Most recently, growth in the recreation/tourism industry has added a great deal to economic activity in the community.

Several businesses operate excursion tours out of Seward, primarily for sightseeing within Resurrection Bay and the Kenai Fjords National Park. These companies include Kenai Fjords Tours (recently purchased by Cook Inlet Region, Inc., a Native corporation), Major Marine Tours, Renown Charters & Tours, and Aurora Charters.

Many users of Seward's harbor, both private and those using commercial charter and excursion boat services, are engaged in general viewing, fishing, or a combination of both. There was a large influx of guide businesses from the Kenai River to Seward in 1997. Many of these new operators will probably extend their operations to Seward permanently if the harbor can accommodate them.

Some of the larger charter boat operations have greatly expanded the scope of fishing out of Seward with their trips far into Prince William Sound waters in search of halibut, groundfish, salmon, and salmon sharks.

Since the early 1990's, the growth in visitation to Seward has been dramatic, increasing from 69,764 visitors in 1990 to 312,008 visitors in 1997. This trend can be expected to continue, given the strong growth in visitors to Alaska. A new factor influencing the numbers of visitors is the Alaska SeaLife Center, which recently opened for business. The SeaLife Center will be a major destination attraction pulling visitors to Seward.

6.2 Municipal Finances

The City of Seward is a home rule city. It provides services to its residents through a number of taxes, including a 3-percent sales tax and a 4-percent bed tax. There is also a property tax of 3.0 mills. In 1997, Seward received $1,567,909 from sales tax and $84,666 from bed tax (Alaska Taxable 1997). They also received $423,664 from property tax revenues in 1997. Seward has one of the highest levels of general obligation bonded indebtedness in Alaska, at $5,887 per capita. Only the North Slope Borough and the communities of St. George and St. Paul have higher per-capita bonded indebtedness.

The level of taxable sales in Seward has steadily increased in recent years. In 1988, the total taxable sales were $30.2 million. In 1996, they were $56.9 million (Kenai Peninsula Borough, 1998). More than 70 percent of total taxable sales were during the second and third quarters, which contain most of the harbor-related activity season. The most important sectors for sales tax revenues are retail sales, services, and transportation.

6.3 Without-Project Conditions

Without expansion of the small boat harbor, economic growth in Seward will proceed modestly, but it will be constrained by lack of infrastructure to support tourism-related businesses, commercial fishing activities, and larger numbers of visitors that contribute substantially to municipal tax revenues.

As the municipal finance review indicated, Seward is dependent upon sales tax revenues to fund its services. If lack of moorage in the harbor provides a constraint for growth of visitors to Seward, there will be a direct effect on overall sales tax receipts.

6.4 With-Project Benefit Categories

6.4.1 Direct Employment From Moorage Rental.

The expansion of the Seward small boat harbor would create direct employment in the community for additional staff for the harbormaster's office. These positions would likely include the following:

Two administrative personnel – approximately $25,000 per position.
Two "Harbor 2" assistants – approximately $35,000 per person.
One "Harbor 1" assistant – approximately $16,000.

The annual dollar total for direct additional employment by the Port of Seward is estimated at $136,000 annually, not including employee benefits.

6.4.2 Indirect Employment.

Secondary jobs would also be created from operation of charter boat businesses. Without a detailed analysis of the Seward economy, it is difficult to estimate the number of secondary jobs created, but the number would be substantial.

The review of municipal revenues emphasizes the importance of harbor-related activities during the summer months. One-third of the assessed value for the property tax is from personal property – largely from boats moored in the harbor or stored in the community. Sales tax revenues during the port activity season provide the majority of sales tax revenues to the community.

Local businesses that would benefit from increased harbor activity and increases to the recreation/tourism industry include the following:

Shoreside Petroleum – fuel
Seward Ships Drydock, Inc. – repairs, welding, supplies, storage
Quality Marine of Alaska – repairs, welding, storage
J & T Diesel & Gas Repair – repairs
Midnight Engines – repairs
Storm Chasers, Inc. – diving
Seward Heavy Industrial Power – supplies, repairs
Chugach Refrigeration & Heating Co. – repairs
Communications North – radar, electronics
Four Seasons Boat Services – supplies, storage, repairs
City Express – freight
Anderson Tug & Barge – tug service
The Fish House – supplies
Bardarson Marine Surveys - marine surveys
Ron Long - marine surveys
Service Electric - electric repairs
AC Electric - electric repairs
Carlile Enterprises - Inc. – freight

This listing does not include the lodging, food services, and transportation providers operating in Seward.

6.4.3 Moorage Revenues to Community.

The proposed small boat harbor expansion would provide an additional 11.7 acres of mooring basin. Based on a preliminary estimate by the Alaska Department of Transportation and Public Facilities (Harvey Smith, personal communication), a preliminary configuration of 346 moorage stalls was selected.

Total annual revenue from this additional moorage would be approximately $488,424, as shown in table B-9.

TABLE B-9.--*Estimate of potential annual moorage revenues, Seward Small Boat Harbor expansion*

Vessel size (ft)	Estimated no. of slips	Annual moorage fees
22-36	272	$331,160
37-54	64	127,744
More than 55	10	29,520
Total	346	$488,424

Note: Calculated by ResourEcon, 1998.

6.5 Summary of Regional Benefits

The overall economy of Seward has been lagging behind the other Kenai Peninsula communities in recent years. The community has depended on government jobs for a large proportion of overall employment. The community has tried to develop several resource-based activities over the years (*i.e.*, lumber mill, large vessel haul-out and repair) but has not succeeded in diversifying its economy.

Commercial fishing activities will continue to be a strong part of the economic activity associated with the Seward Small Boat Harbor. The major area of commercial development anticipated is in tourism-related fishing and sightseeing charters.

Direct employment in the harbormaster's office is estimated to be $136,000 per year (plus employee benefits). Data are not available to estimate the secondary employment associated with providing goods and services to the users of the expanded harbor, but it would be a major economic boost to the community. From review of the municipal finances for Seward, it can be seen that harbor-related sales taxes during the summer provide a major component of total income to the community. It is anticipated that increased activities associated with support of the expanded boat harbor would have a similar impact.

The community of Seward receives a substantial fiscal boost from sales tax revenues for goods and services associated with harbor activities. Municipal funding will have to be shifted to other sources if growth does not continue in the visitor/tourism and other harbor-related activity.

7. BENEFIT ANALYSIS

7.1 General

This section provides the analysis of the total potential economic benefits that could be realized with expanded moorage facilities at Seward. Only those categories of benefits that can be assigned tangible monetary values directly resulting from harbor development are included. Vessel operating costs are calculated for various sizes of craft, opportunity costs of time are defined, congestion-related problems within the existing harbor are discussed, and travel to alternative ports by vessels unable to secure moorage at Seward is examined.

Benefits of harbor expansion would include savings in operating costs and opportunity costs of time, and reductions in damages to both vessels and harbor facilities. Overcrowding is a major problem in the existing harbor, causing inefficient operations for both users and managers. Damage reductions would be expected for harbor facilities and fishing and recreation vessels.

Justification for a proposed action is determined by comparing average annual equivalent costs – including project first costs, interest during construction, and operating and maintenance expenses – with an estimate of the average annual benefits to be derived from the project. Benefits and costs are made comparable to an equivalent time value of money by application of appropriate interest. The interest rate used in this analysis is 7-1/8 percent, and a 50-year project life is assumed. Estimated costs and benefits reflect April 1998 price levels.

7.2 Delay Analysis

Some aspects of the Seward feasibility study provide information for the planning process, drawing from a large and diverse set of models, data sets, and estimated values. In contrast, lack of economic data and constraints of time and budget necessitate reliance on expert judgment in some aspects of the economic evaluation. In the Seward study, as with most other harbor studies, reliance on judgment is unavoidable. This study used an interview approach designed to verify expert opinion in support of analysis of harbor delay problems. The search for expert opinion was designed to:

- Improve judgment-based estimates, both of most likely values and of uncertainty about the delay problem.

- Provide documentation of assumptions, data, and other information that go into the delay estimate.

Due to lack of harbor records on vessel delay and lack of any modeling information from prior studies, a great deal of uncertainty is present in analysis of the delay problem. A single-point estimate cannot reasonably represent the uncertain range of possible outcomes. Ignoring the range by using a single-point estimate does not make the decision easier, since the stakeholders would be left wondering whether a different decision would have been made if a different single-point estimate had been used. However, limitation to making decisions based on single-point estimates of the decision criteria is not the case. The judgments and uncertainties about a large number of variables influencing the decision criteria can be combined and communicated to the decisionmakers in a simple manner using probability distributions. The probability distributions for delay in this study represent judgments and reveal uncertainty in the analysis.

The judgment and uncertainty represented in this process is that of specific individuals defined to be the experts. Thus the probabilities in this contest are called *subjective probabilities*. This study relies on judgment of regular users of the harbor having capital investment or income at stake for our expert opinion.

Therefore, the "right" distribution to represent in the decision process is the one that best represents the expert's state of information. Subjective probabilities are not necessarily less "scientifically valid" than probabilities viewed from the more familiar vantages of classical statistics, they are just used in different situations. In simple situations, probabilities can be defined by *observation of frequency* (*e.g.*, 20 percent of the vessels waited at least 400 times in the past year) or *mechanism* (*e.g.*, rolling a six-sided die leads to one out of six equally likely outcomes). However, in most policy analyses, the observed data substitute for what is really needed. In this case, the interpretation and use of the *frequency* observation (*i.e.*, results of statistical analysis) are still open to subjective human judgment.

The challenge for subjective probability assessment is to base probability distributions on thorough and objective thinking, and to document this thinking and the assumptions in a manner than can be readily reviewed. The process of defining the distributions explicitly and documenting key assumptions helps to focus review on tangible issues. The judgment and uncertainty represented in this process is that of specific individuals defined to be the experts. Thus the probabilities are, in this context, called *subjective probabilities*.

7.2.1 Expert Interview Approach.

The expert interview approach was developed to accommodate circumstances specific to the Seward study. However, it followed widely recognized principles and in a broad way incorporated a standard protocol, the "Stanford/SRI" protocol, for conducting a formal elicitation meeting with the expert. The Stanford/SRI protocol emphasizes bias reduction, careful consideration of information, and sound principles for encoding probabilities.

The approach includes four steps, culminating in the one-time in-person elicitation interview.

Step 1 - Selection of Experts. The Corps interviewer selected the "expert group" for the study. These experts have similar degrees of qualification in estimating the parameters of interest so that opinions are considered equally valid. This is important because different experts may define different distributions (i.e., have different opinions) and those distributions must be combined to form a single distribution in the end. Another option to combining distributions from individual experts was to define a team of experts, with a single designated leader, which would go through the elicitation process together, combining opinions and rationale, to produce a single consensus distribution for each study. The first option was selected as being more cost-effective and convenient from the interviewer's perspective. The nature of the fishing industry with its many overlapping seasons is such that it would be difficult to gather a team and keep them together.

Step 2 - Review of Background Material on Probability Assessment. Verification of familiarity with issues is one of the important principles of expert elicitation. An initial objective was to establish initial rapport with the interviewer and introduce concepts of probability assessment into the discussion. At this time the interview searched for motivation biases, which are conscious or unconscious adjustments in estimates based on self-interest or conflict of interest.

Step 3 - Interviewer's Familiarization with Expert's Knowledge. The experts were asked to provide background or descriptions accounting for their knowledge of similar studies. They were also asked to verify characteristics of delay as a variable that will be assigned uncertainty distributions. They were also asked to explain or describe what they felt was the value of the uncertain variables.

Step 4 – Interview. The interviews were held on an individual basis at the project location or via telephone, with most being completed in less than 30 minutes.

In addition to gathering information about delays, the interviewer made an effort to identify the expert's assumptions and repeat them as a way of verifying them. A feedback technique was used to reveal or develop an unambiguous definition of the delay quantity being assessed, including any "conditioning factors" that might have been assumed. The objective was to make sure that the expert considered all relevant information about the delay quantity.

7.2.2 Feedback.

At the conclusion of the interview, a freehand sketch of the implied probability judgment was shown or described to arrive at verification of the expert opinion. The objective was to determine if the interviewer's understanding actually represented the expert's beliefs. No significant discrepancies were found. Individual distributions were similar to a skewed distribution. It was not necessary to combine them or adjust the data for statistical analysis. Subjective analysis was used to conclude the data set held the properties of a skewed distribution with an average delay of 30 minutes. The experts alluded that on average, the half-hour delay is more realistically an hour for half the fleet during a period of major congestion. During off-hours when the charter fleet is neither coming nor going, there is little traffic, and delays are minimal.

7.2.3 Summary Results.

The entire interview process identified more than 100 individuals as prospective experts fitting a predescribed profile. Experts had to be adults, regular users of the project, admitted stakeholders, accessible, and willing to cooperate. Of the group identified, 23 were interviewed. Notes were taken on every occasion, but an interview form or questionnaire was not used.

Vessels likely to experience the most delays were those tied into rafts. The second most likely were boats needing to use the launch area. The least likely were vessels leasing slips near the fairway of the channel, although they might be delayed by vessels already using the entrance channel forcing them to wait at their slip or near it until able to safely join moving traffic.

The extreme delay of rafters was described as including events several times during the night when the entire raft might be disrupted for a vessel needing to depart. The make-break operation did not account for delay in the channel, but it was repeatedly described as often accounting for several man-hours aboard every rafted vessel over the period of a single day. In all delay cases where rafted vessels were involved, the delay would be prevented by project expansion. Extreme delays impact more than 400 rafted vessels on a peak day and up to 1,600 man-hours. This is an average of 4 man-hours per rafted vessel, not including delay on arrival and departure, which adds more than an hour for each of the vessels on the inside of the raft.

The extreme delay for launched vessels due to vessel traffic congestion in the vicinity of the launch area is in excess of 2½ hours. The scenario is typically for a late arrival on a peak use day. If a skipper is trying to haul out, he will need to jockey the boat in a crowded area until he can gain access to the launch area. The experience is dangerous, and damages are frequent. The delay time can be double the estimated 2½ hours if there are disabled vessels in the launch area, inexperienced haul-out crews involved, broken equipment present, or if land-side traffic delays the arrival of trailers for the boats being taken out. Before and after the haul-out, a driver must negotiate a landward traffic jam with a boat trailer in tow. The estimated delay of 2½ hours does not include delay experienced entering and exiting the channel.

The extreme delay for vessels with permanent moorage occurred daily during peak arrival and department of the charter fleet. The charter fleet contributes to the congestion problem because it must accommodate customers on a schedule basis. Charter customers travel from great distances and have complicated travel arrangements that cannot be compromised by charter operators. With passenger and vessel safety the main concern, the exodus requires that vessels wait for the proper opportunity to merge into the traffic. This can have several boats holding in their moorage row near their slip, waiting for the right time. Delays at the moorage tie-up exceed 30 minutes, and delays at the moorage row also exceed 30 minutes, though the two delays do not necessarily accompany one another. Delays on returning also exceed 30 minutes. The extreme cases of delay bring in effects of adverse weather, breakdowns, traffic congestion, and peak use period. The non-typical extreme is 2 hours.

The first vessels to depart are not delayed at all if they move quickly into the channel. After the parade has begun, every vessel is delayed, and the closer one is to the end of the line, the longer the wait. Less disciplined non-charter skippers, who are not duty-bound to strict rules of the road, compound the total wait time by crowding to lessen their own delay. When a flow of dozens of recreational craft are added, waiting time during peak use days becomes excessively long.

7.2.4 Subjective Probabilities.

Part of the interview process was designed to gather information regarding the probability that delay would take place. All subjects were asked the nature of the probability distribution, and were asked to verify the interviewer's understanding of their expression of the subjective probabilities embodied in their opinion.

The interviewer concluded the distribution most likely to represent the opinions gathered was skewed, with a mean delay value of 30 minutes. The distribution demonstrated extremes of 0 minutes and 3 hours. When non-project-related delay factors were removed (weather, accidents, breakdowns, etc.) the non-typical extreme delay became 2 hours but happened only to an estimated 20 percent of users less than 15 times per year, an expected probability of about 3 percent. The typical extreme delay was judged to be 1 hour, and impacted 50 percent of the users less than 20 times per year, an expected probability of about 11 percent. Delay of one-half hour was used as representative of a fleet average. If all traffic problems were eliminated, the average delay time that could be saved is estimated at 30 minutes per vessel per day. Residual delay would remain in the form of 1.5 hours for 20 percent of the users and 0.5 hour for 50 percent of the users. Delay problems related to use of the launch facility would not be alleviated by any of the proposed alternatives. Results of the interviews are summarized in figure B-1.

Thirty minutes was judged to be appropriate for use in estimating average fleet delay, as it was the most common expectation amount for all classes of users, except those involved in rafting situations. Rafted vessels had higher delay expectation. Another factor in favor of using 30 minutes as the representative average is that up to 30 minutes is the most frequent expected delay among charter vessels. This is an important consideration, since charter vessels targeting salmon make two trips per day. In effect, this increases peak vessel traffic in excess of one trip per day. So on days when the harbor may still have 20 percent of the vessels at their moorage, the total number of arrivals and departures may be as if each boat in the harbor had made at least one trip.

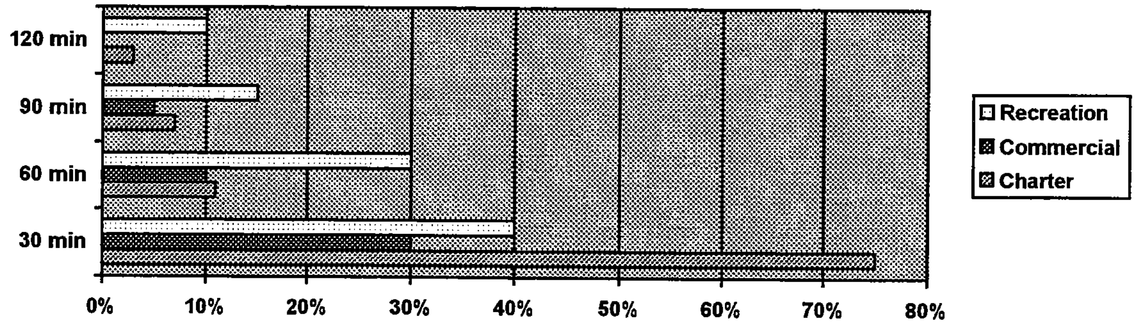

FIGURE B-1.—Estimated average delay for each non-rafted vessel, Seward Harbor.

7.2.5 Delay-Related Diversions.

Under a predicted waiting time of 3 hours, a vessel 3 hours distant from Seward will be ambivalent about heading for an alternative port. The choice is based on traveling 3 hours to Seward plus a wait of 3 hours or steaming steadily for 6 hours to a port with no waiting anticipated. On an annual basis, the situation is presented to about 3 percent of the commercial fleet. Saving in travel time to alternative ports is not included in the delay benefits in this report. It would, however, add benefits based on savings in opportunity cost of time plus specific vessel direct operating cost.

7.3 Vessel Operating Costs

The majority of commercial fishing and charter vessels using the Seward area are seiner-type craft between 27 and 55 feet. The average operating costs for this type of boat are shown in table B-10. Data were obtained from conversations with fishers and statistics from the Alaska Department of Fish and Game, Division of Commercial Fisheries Management and Development. This profile summarizes activities for Seward area fishers throughout the year.

The commercial fleet in Seward (including commercial and charter fishers) spends an average 195 days participating in a number of fisheries in the Price William Sound region. Crews work an average of 12 hours per day. In calculating operating costs, individual items were classified into fixed, variable, and direct operating costs. Fixed costs are those that would be incurred by the vessel owner whether or not the boat was put to any productive use. These annual cost items include fixed depreciation and return on investment. Fixed costs were not considered when calculating annual operating costs. Direct operating costs are those incurred in running the vessel engine and include only the cost of fuel and lubricating oil (including hydraulic oil and similar consumables). Lube oil expenses were estimated as 7 percent of fuel costs. Variable costs, for this exercise, are those that occur while the vessel is in operation, including vessel repair and replacement, maintenance, food, and miscellaneous. Average daily costs were found by spreading the total costs over the total number of operating days. Dividing daily operating costs by 12 hours, average time spent actually working, identified hourly costs. Information was obtained from Seward fishers and from the State of Alaska's Division of Commercial Fisheries.

7.3.1 Vessels 37 to 54 Feet.

The majority, 51 percent (156 of 307), of charter and commercial fishers in the Seward area operate vessels in the 37- to 54-foot range. The operating cost profile for an average seiner-type craft in the Seward area is shown in table B-10. The typical seiner incurs direct and variable (less insurance and moorage expenses, which remain constant) operating costs of $47 per hour.

TABLE B-10.–*Daily and hourly vessel operating costs for Seward seiners, 37 to 54 feet*

Variable		Direct operating	
Item	**Cost**	**Item**	**Cost**
Gear repair	$15,867	Fuel	$61,582
Maintenance	12,213	Lube oil	4,309
Stores	11,560		
Miscellaneous	4,707		
TOTAL	**$44,347**		**$65,891**
Daily costs	**$227**		**$338**
Hourly costs	**$19**		**$28**

7.3.2 Vessels 55 to 120 Feet.

There are 19 of the larger purse-seine type vessels (55-120 feet) using Seward's harbor. These vessels are used for both commercial fishing and charter purposes. The average operating cost for this type of craft is greater than for the smaller seiner. Hourly operating costs were calculated using the same method as for the smaller craft. These costs are presented in table B-11.

TABLE B-11. – *Daily and hourly vessel operating costs for vessels 55 to 120 feet*

Category	Cost	Daily cost	Hourly cost
Variable	$144,631	$742	$31
Direct	84,937	436	18
TOTAL	**$229,568**	**$1,178**	**$98**

7.3.3 Smaller Vessels.

There are 132 commercial vessels between 22 and 35 feet. The operating cost for this size craft was calculated as for the previous size boats and is shown in table B-12.

TABLE B-12. – *Daily and hourly vessel operating costs for vessels 22 to 36 feet*

Category	Cost	Daily cost	Hourly cost
Variable	$37,695	$193	$8
Direct	56,007	287	12
TOTAL	$93,702	$480	$20

7.4 Opportunity Cost of Time

Travel of any kind imposes costs on the fleet. These costs include additional operating expenses for the vessel as well as the crew's opportunity costs. Crewmembers incur an opportunity cost of time (OCT) associated with down time. OCT is the value of work or leisure activities forgone because of having to spend hours traveling to alternate ports or incurring delays when the Seward harbor is overcrowded. The opportunity cost premise is based on the concept that the more time a vessel's crew is required to spend away from town searching for moorage space, the more valuable space at Seward becomes. Operating costs measure the direct out-of-pocket expenses associated with searching for harbor space, while the opportunity cost measures the time forgone by a vessel's crew.

For OCT calculations, a value of next best use of time has been assigned. For this report, the OCT has been given a minimum, or leisure time, value. According to Engineering Regulation (ER) 1105-2-100, in lieu of a project-specific estimate of the opportunity cost of leisure time, a value equal to one-third the wage rate is used.

7.4.1 Commercial Fishers.

Based on a 1997 survey performed by Northern Economics in association with ResourcEcon entitled, "Opportunity Cost of Time for Fishers," one-third the hourly wage rate for Alaska commercial fishers is $14.67, say $15.00. This figure is used in opportunity cost of time calculations.

7.4.2 Charter.

The OCT for Seward charter industry workers is calculated at one-third the pre-tax income. The average annual hourly wage for charter fishing crew is $16.39, based on the city of Seward's tax records. One-third of this figure is $5.00.

7.5 Benefit Categories

7.5.1 Overcrowding-Related Expenses.

Vessel Damage. Chafed lines, broken cleats, and damaged paint are a few of the common problems caused by crowded conditions in the existing harbor. Rafting and hot-berthing are used to accommodate the overflow of vessels. Rafted boats are the most likely to experience damages. When rafted vessels rub, bump, and collide, damage results to rails, guards and planking, and fiberglass. Annual repair estimates were derived from interviews with Seward fishers, harbor personnel, and marine repair shops in the area. One marine repair shop related that to replace a guardrail on a 37- to 54-foot seiner-type craft costs about $10,000. This cost does not include repairing damages incurred when the boat is n the center of a raft, resulting in the vessel being hit from either side or up against the piling. Other damages include separation of deck from hull laminate, damage to sides of cabins, and damage to hulls. Hidden damages are often created in the fiberglass laminate, as well. The only thing that bonds fiberglass together is the adhesions between the layers, which become stronger the more layers are put together. Continual rafting tends to separate the layers within the laminate. The hull looks fine from the outside and the inside, but within the laminate the bond has been broken and created a delamination, which absorbs moisture. This eventually leads to significant damage. A telephone survey of randomly selected Seward fishers operating various sizes of vessels revealed that damage caused by rafting of vessels averages $1,200 per year. According to Seward fishers and harbor personnel, an average of 350 vessels sustain damage from rafting each year. This results in $420,000 ($1,200 x 350) in rafting-related damages to vessels annually. This is a conservative figure, in that many lesser damages go unreported and/or unrepaired.

Dock and Piling Damage. Currently, an average of $375,000 is spent each year to maintain, repair, and/or replace damaged docks and pilings. Constant rafting decreases the useful life of docks and pilings. The difference in the annual capital cost between the with-project and without-project conditions represents the benefit. Of the total amount spent annually on repair and/or replacement, harbor personnel estimate roughly 35 percent, or $131,000, can be attributed to the additional strain caused by continual and significant rafting practices. This amount would be eliminated with the expansion of the existing harbor.

7.5.2 Opportunity Cost of Time and Operating Cost.

Benefits of harbor expansion are expected to include savings in operating costs and opportunity costs of time. Problems related to overcrowding and congestion in the existing harbor cause inefficient operations for both users and harbor personnel. Based on conversations with Seward's harbormaster and a variety of area fishers, the average delay for those with permanent moorage is one-half hour each day and 1½ hours for transients. Delays occur approximately 90 days each year during the peak use months of May through August. Crew size for commercial craft varies depending on vessel size. For the smaller boats, 22–36 feet, average crew on board is two; vessels 37–54 feet normally require three; the larger vessels, those in excess of 55 feet, employ an average of 3.5. In this case, crew size includes the skipper.

Permanent Moorage Vessels. Although there are 537 slips for permanent moorage, 132 of those are sized for vessels less than 21 feet, which can be trailered out of the water daily and are not considered a problem. Congestion and subsequent rafting and delay problems lie with the larger vessels. This leaves 405 boats that experience delays during the 90 peak-use days each season. Roughly 307 of these are commercial or charter fishers, while 98 are recreational. The ratio of commercial fishing vessels to charter vessels is about 50/50.

Commercial Fishers – Permanent Moorage.

Vessels 22–36 feet

66 vsls x 0.5 h x $40/h op cost x 90 days	=	$119,000
66 vsls x 0.5 h x $15.00/h OCT x 2 crew x 90 days	=	89,000

Vessels 37–55 feet

78 vsls x 0.5 h x $47/h op cost x 90 days	=	$165,000
78 vsls x 0.5 h x $15/h OCT x 3 crew x 90 days	=	158,000

Vessels over 55 feet

10 vsls x 0.5 h x $98/h op cost x 90 days	=	$44,000
10 vsls x 0.5 h x $15/h OCT x 3.5 crew x 90 days	=	24,000
	Total	**$599,000**

Commercial Fishers – Transient Moorage.

The Seward Small Boat Harbor has transient space for 119 vessels. Usage of this mooring space is split about 60:40, commercial to recreational. The division between commercial and charter fishers is nearly 50/50, or 35.5 of each, say 35. Assuming the transient vessel sizes follow the ratio of those with permanent moorage, existing-condition expenses are as follows.

Vessels 22–36 feet

15 vsls x 1.5 h x $40/h op cost x 90 days	=	$81,000
15 vsls x 1.5 h x $15/h OCT x 2 crew x 90 days	=	61,000

Vessels 37–55 feet

18 vsls x 1.5 h x $47/h op cost x 90 days	=	$114,000
18 vsls x 1.5 h x $15/h OCT x 3 crew x 90 days	=	109,000

Vessels over 55 feet

2 vsls x 1.5 h x $98/h op cost x 90 days	=	$26,000
2 vsls x 1.5 h x $15/h OCT x 30.5 crew x 90 days	=	14,000
	Total	**$405,000**

Total Commercial Fishers		**$1,004,000**

Commercial Charter – Permanent Moorage.

Vessels 22–36 feet

66 vsls x 0.5 h x $40/h op cost x 90 days	=	$119,000
66 vsls x 0.5 h x $5/h OCT x 2 crew x 90 days	=	30,000

Vessels 37–55 feet

78 vsls x 0.5 h x $47/h op cost x 90 days	=	$165,000
78 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	53,000

Vessels over 55 feet

9 vsls x 0.5 h x $98/h op cost x 90 days	=	$40,000
9 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	6,000
	Total	**$413,000**

Commercial Charter – Transient Moorage.

Vessels 22–36 feet

14 vsls x 1.5 h x $40/h op cost x 90 days	=	$76,000
14 vsls x 1.5 h x $5 OCT x 2 crew x 90 days	=	19,000

Vessels 37–55 feet

16 vsls x 1.5 h x $47/h op cost x 90 days	=	$102,000
16 vsls x 1.5 h x $5/h OCT x 3 crew x 90 days	=	32,000

Vessels over 55 feet

2 vsls x 1.5 h x $98/h op cost x 90 days	=	$26,000
2 vsls x 1.5 h x $5/h OCT x 3 crew x 90 days	=	4,000
	Total	**$259,000**
	Total Charter	**$672,000**

Harbor Personnel. As mentioned earlier, Seward harbor personnel spend a significant amount of time each year to move boats in a raft when the owners cannot be located, and in hot-berthing situations. Harbor personnel relate that a minimum of three employees spend an average 2.5 hours each per day, 90 days per year, moving vessels from rafts and for hot-berthing purposes. Seward's harbor crew makes an average hourly wage of $17.81, say $18.00. Annual benefits would therefore be:

3 crew x 2.5 h/day x 90 days x $18/h = $12,000

7.5.3 Coast Guard Vessel Problems.

The Coast Guard Cutter *Mustang*, stationed in the harbor at Seward, is used for law enforcement and rescue operations from Seward east to Kayak Island (the far side of Prince William Sound), west to Kodiak Island, and into Cook Inlet. The cutter is adversely affected by crowding when trying to dock or cast off. The ship is designed for high speed at sea, which makes docking difficult in optimal conditions. When the harbor is crowded, a small boat must pull the stern of the cutter out from the dock to give the vessel room to maneuver around rafted boats. When the cutter docks, the small boat must be used to push the stern in. Although difficulty in maneuvering around rafted boats has not yet caused a delay in responding to an emergency, this possibility is quite real. If the cutter were blocked by other boats from exiting the harbor fast enough in an emergency, a decision would need to be made whether to risk damaging boats in the harbor to reach the rescue scene. The cost of this extra care and the risk of damaging other vessels in the harbor warrant further consideration.

7.5.4 Existing Conditions Cost Summary.

Table B-13 summarizes the without-project costs associated with existing conditions at Seward.

TABLE B-13. – *Existing conditions cost summary*

Cost category	Amount
Vessel damage	$420,000
Dock and piling damage	131,000
OCT* and operating costs – comm. fishers	1,004,000
OCT* and operating costs - charter	672,000
OCT* – harbor personnel	12,000
TOTAL	**$2,239,000**

*Opportunity cost of time.

8. WITH-PROJECT CONDITIONS

Three alternatives were investigated in detail, and a variation on one of them was formulated. With-project conditions for all of the alternatives are discussed in this section.

8.1 Alternative 1

Alternative 1 would provide 288 stalls for permanent moorage. The moorage distribution would include 216 slips for vessels up to 36 feet, enough to accommodate all vessels of this size currently on the wait-list for permanent space; 64 slips for vessels up to 54 feet; and 8 slips for vessels in excess of 55 feet. No additional space would be created for transient vessels. Expenses that would accrue with alternative 1 are discussed in the following paragraphs.

8.1.1 Vessel Damage Reduction.

Because demand would continue to exceed capacity to some extent, some problems associated with congestion and rafting would remain. There is currently a demand at Seward for at least 465 vessels, including 339 seeking permanent moorage and 126 desiring transient space. Alternative 1 would provide 288 additional slips, alleviating approximately 60 percent of the problem. Currently, $420,000 in vessel damage due to rafting is incurred each year. Reducing this amount by 60 percent would lower the annual expense to $168,000.

8.1.2 Dock & Piling Damage.

Without a project, $131,000 in annual repair costs is attributed to significant rafting practices. Applying a 60-percent decrease to this would lower the annual cost to $52,000.

8.1.3 Commercial Fishers.

Commercial Fishers – Permanent Moorage.

Vessels 22–36 Feet. Alternative 1 would provide enough slips sized for vessels up to 36 feet to accommodate all on the existing waiting list.

Vessels 37–55 Feet. Sixty-four additional permanent stalls sized for vessels up to 55 feet would be created with this alternative. Approximately one-half, or 32, of the new slips would be assigned to commercial fishers. Currently, 78 commercial fishing vessels in this size category are using the harbor and experiencing delays. With-project conditions would reduce the number of vessels to 42. Annual costs for these craft are shown below.

46 vsls x 0.5 h x $47/h op cost x 90 days	=	$97,000
46 vsls x 0.5 h x $15/h OCT x 3 crew x 90 days	=	93,000

Vessels Over 55 Feet. Eight stalls would be created for vessels more than 55 feet long. Half, or 4 slips, would be assigned to commercial fishers desiring permanent moorage. This would leave 6 vessels to experience delays.

6 vsls x 0.5 h x $98/h op cost x 90 days	=	$26,000
6 vsls x 0.5 h x $15/h OCT x 3.5 crew x 90 days	=	14,000

Commercial Fishers – Transient Moorage.

This alternative would provide moorage for 16 transients in the 37- to 55-foot range. Assuming one-half of the space is used by commercial fishers, as is occurring under existing conditions, the number of commercial fishing transients experiencing delays would be reduced to 10 (18 – 8 = 10).

10 vsls x 1.5 h x $47/h op cost x 90 days	=	$63,000
10 vsls x 1.5 h x $15/h OCT x 3 crew x 90 days		61,000
Total Commercial Fishers' Expenses		**$354,000**

8.1.4 Charter Fishers.

Charter Fishers – Permanent Moorage.

Vessels 22–36 Feet. All charter vessels in this size category would be provided permanent slips. Costs associated with delays would be eliminated.

Vessels 37–55 Feet. Thirty-two charter vessels in the 37- to 54-foot range would be assigned permanent space, reducing the number of boats that would continue to experience delays to 46.

46 vsls x 0.5 h x $47/h op cost x 90 days	=	$97,000
46 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	31,000

Vessels Over 55 Feet. Four permanent stalls would be created for charter vessels in excess of 55 feet, reducing the number continuing to experience delays to 5.

5 vsls x 0.5 h x $98/h op cost x 90 days	=	$22,000
5 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	3,000

Charter Fishers – Transient Moorage.

Additional space for 8 charter vessels in the 37- to 55-foot range would be created with this alternative, reducing the number experiencing delays to 10.

10 vsls x 1.5 h x $47/h op cost x 90 days	=	$63,000
10 vsls x 1.5 h x $5/h OCT x 3 crew x 90 days	=	20,000
Total Charter Expenses		**$236,000**

8.1.5 Harbor Personnel Time.

As calculated above, alternative 1 would reduce overall crowding by approximately 60 percent. Applying this percentage to the current annual expense of $12,000 would reduce harbor employee time spent moving vessels in rafts and hot-berthing to $5,000 annually.

8.1.6 Alternative 1 Summary.

Total expenses with alternative 1 are $815,000. Annual expenses under existing conditions are $2,239,000, resulting in annual benefits of $1,424,000 for the plan.

8.2 Alternative 2

Alternative 2 would provide 346 permanent slips and space for 20 transients in the 37- to 55-foot range. Moorage would be designated as follows: 272 stalls for vessels up to 36 feet; 64 stalls for boats in the 37–55-foot range; and 10 slips for craft more than 55 feet.

8.2.1 Vessel Damage Reduction.

As with alternative 1, demand would continue to exceed capacity to some extent, and some congestion-related problems would likely continue. Alternative 2 would reduce congestion by approximately 74 percent (364/465). Applying this percentage to the current amount incurred for vessel damage due to rafting would lower the annual expense from $420,000 to $109,000.

8.2.2 Dock and Piling Damage.

Under without-project conditions, $131,000 is spent annually on the repair/ replacement of docks and pilings. Applying a 74-percent decrease in congestion would lower the yearly maintenance cost to $34,000.

8.2.3 Commercial Fishers.

Commercial Fishers – Permanent Moorage.

Vessels 22–36 Feet. Alternative 2 would create 272 permanent slips for vessels up to 36 feet. This would accommodate all on the waiting list for this size stall and eliminate the opportunity cost of time and operating costs associated with delays.

Vessels 37–55 Feet. This alternative would provide 64 additional slips for vessels in the 37- to 55-foot category. Half, or 32, of these would likely be assigned to commercial fishing vessels, reducing the number to 46 that would continue to experience delays.

46 vsls x 0.5 h x $47/h op cost x 90 days	=	$97,000
46 vsls x 0.5 h x $15/h OCT x 3 crew x 90 days	=	93,000

Vessels Over 55 Feet. Moorage for 10 vessels over 55 feet would be added with this alternative. About one-half of these stalls, or 5 slips, would be assigned to commercial fishers, leaving 5 vessels to experience delays.

5 vsls x 0.5 h x $98/h op cost x 90 days	=	$22,000
5 vsls x 0.5 h x $15/h OCT x 3.5 crew x 90 days	=	12,000

Commercial Fishers – Transient Moorage. Alternative 2 would also provide space for 20 transients in the 37- to 55-foot range. Assuming half are used by commercial fishers, as is occurring under existing conditions, the number of commercial fishing transients experiencing delays would be reduced to 5.

8 vsls x 1.5 h x $47/h op cost x 90 days	=	$51,000
8 vsls x 1.5 h x $15/h OCT x 3 crew x 90 days	=	49,000
	Total Commercial Fishers' Expenses	**$324,000**

8.2.4 Commercial Charter.

Commercial Charter – Permanent Moorage.

Vessels 22–36 Feet. Alternative 2 would provide enough moorage to accommodate the number of vessels of this size currently on the wait list.

Vessels 37–55 Feet. Sixty-four permanent stalls would be added for vessels in the 37- to 55-foot range. Approximately one-half of these would be assigned to charter fishers, reducing the number experiencing delays to 46.

46 vsls x 0.5 h x $47/h op cost x 90 days	=	$97,000
46 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	31,000

Vessels Over 55 Feet. Alternative 2 would create 10 slips for vessels over 55 feet. About 5 of these would be assigned to charter fishers, leaving 4 that would continue to experience delays.

4 vsls x 0.5 h x $98/h op cost x 90 days	=	$18,000
4 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	3,000

Commercial Charter - Transient Moorage.

Alternative 2 would create moorage for approximately 20 transients in the 37- to 55-foot range. Assuming charter vessels use one-half of the space, the number experiencing delays would be cut to 8.

8 vsls x 1.5 h x $47/h op cost x 90 days	=	$51,000
8 vsls x 1.5 h x $5/h OCT x 3 crew x 90 days	=	16,000
	Total Charter	**$216,000**

8.2.5 *Harbor Personnel Time.*

Alternative 2 would alleviate roughly 74 percent of the congestion, reducing the cost for harbor personnel from $12,000 to $3,000 annually.

8.2.6 *Alternative 2 Summary.*

Total expenses with alternative 2 total $686,000. Annual benefits would accrue at $1,553,000 ($2,239,000 - $686,000 = $1,553,000).

8.3 Alternative 2a

Alternative 2a is a variation of alternative 2, differing only in the location of the disposal area for dredged material. The harbor size, dimensions, and slip configuration are the same as alternative 2; thus the with-project condition and the annual benefits would be the same.

The total with-project expenses for this alternative are estimated at $686,000, and the annual benefits would be $1,553,000.

8.4 Alternative 3

This design would create 302 permanent stalls: 230 for vessels 22 to 36 feet, 64 for boats 37 to 55 feet, and 8 for craft over 55 feet. Additional transient space would provide moorage for 20 vessels in the 37- to 55-foot range.

8.4.1 *Vessel Damage Reduction.*

Alternative 3 would reduce congestion with the harbor by approximately 65 percent. This would lower annual expenses for this category from $420,000 to $147,000.

8.4.2 *Dock & Piling Damage.*

Under existing conditions, an average of $131,000 is spent annually on dock and piling repair/replacement attributable to excessive rafting practices. This figure would be reduced to roughly $46,000 with the construction of alternative 3.

8.4.3 Commercial Fishers.

Commercial Fishers – Permanent Moorage.

Vessels 22–36 Feet. Adequate additional moorage to cover all those currently on the waiting list would be available for vessels in this size category.

Vessels 37–55 Feet. Sixty-four additional stalls for permanent moorage of crafts 37 to 55 feet long would be built with this alternative. Approximately one-half would likely be assigned to charter vessels, allowing 32 for the commercial fishing fleet. This would reduce the number of commercial fishing vessels experiencing delays from 78 to 46.

46 vsls x 0.5 h x $40/h op cost x 90 days	=	$83,000
46 vsls x 0.5 h x $15/h OCT x 3 crew x 90 days	=	93,000

Vessels Over 55 Feet. Assuming four slips for vessels over 55 feet are allotted to commercial fishers, expenses for this category would be as follows:

6 vsls x 0.5 h x $98/h op cost x 90 days	=	$26,000
6 vsls x 0.5 h x $15/h OCT x 3.5 crew x 90 days	=	14,000

Commercial Fishers – Transient Moorage.

Additional moorage for 20 transients in the 37- to 55-foot range would be created with alternative 3. Assuming commercial fishers would use half the space, as occurs now, 10 more transient vessels could moor safely. This would reduce the number experiencing delays to 8.

8 vsls x 1.5 h x $47/h op cost x 90 days	=	$51,000
8 vsls x 1.5 h x $15/h OCT x 3 crew x 90 days	=	49,000
Total Commercial Fishers' Expenses		**$316,000**

8.4.4 Commercial Charter.

Commercial Charter – Permanent Moorage.

Vessels 22–36 Feet. Adequate moorage would be created for vessels of this size to accommodate all those currently on the waiting list.

Vessels 37-55 Feet. Roughly 32 permanent slips would be added for commercial charter vessels 22 to 36 feet in length. Forty-six would continue to experience delays.

46 vsls x 0.5 h x $47/h op cost x 90 days	=	$97,000
46 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	31,000

Vessels Over 55 Feet. Alternative 3 would add 8 stalls for vessels over 55 feet. Assuming the same ratio between commercial fishers and charter vessels continues, charter fishers would use 4 of the new slips.

5 vsls x 0.5 h x $98/h op cost x 90 days	=	$22,000
5 vsls x 0.5 h x $5/h OCT x 3 crew x 90 days	=	3,000

Commercial Charter – Transient Moorage.

Ten additional transient vessels in the 37- to 55-foot range would be able to moor with alternative 3. This would reduce the number currently experiencing delays to 8.

8 vsls x 1.5 h x $47/h op cost x 90 days	=	$51,000
8 vsls x 1.5 h x $5/h OCT x 3 crew x 90 days	=	16,000
	Total Charter	**$220,000**

8.4.5 Harbor Personnel Time.

Currently, $12,000 is spent annually by harbor personnel to move boats in rafts or in hot-berthing situations. Alternative 3 would eliminate about 65 percent of the congestion problem, reducing the yearly expense to $4,000.

8.4.6 Alternative 3 Summary.

Total annual expenses with alternative 3 total $733,000. Annual benefits would accrue at $1,506,000 ($2,239,000 - $733,000 = $1,506,000).

8.5 Benefit Summary

Table B-14 summarizes the National Economic Development benefits attributable to the proposed harbor improvements at Seward.

TABLE B-14.–*Benefit summary*

Benefit category	Without project	Alt. 1	Alts. 2 and 2a	Alt. 3
Vessel damage	$420,000	$168,000	$109,000	$147,000
Dock/pilings	131,000	52,000	34,000	46,000
Commercial fishers	1,004,000	354,000	324,000	316,000
Charter fishers	672,000	236,000	216,000	220,000
Harbor personnel	12,000	5,000	3,000	4,000
TOTAL	**$2,239,000**	**$815,000**	**$686,000**	**$733,000**
NED benefits		**$1,424,000**	**$1,553,000**	**$1,506,000**

9. SENSITIVITY ANALYSIS

The intent of this analysis is to test the sensitivity of project justification and scoping to changes in the major variables used in computing project benefits. By examining likely ranges of values of these variables, the sensitivity analysis demonstrates the supportability of the economic justification of the recommended plan.

Under Existing Conditions, the delay for commercial transient vessels is 1.5 hours per vessel, per day. If delay times were reduced by half, to 0.75 hours per vessel, per day, annual without-project costs would fall from $2,239,000 to $1,907,000. NED benefits for alternative 2 would accrue at $1,221,000 annually. Annual costs are $837,000, so annual net benefits would be $384,000 and the benefit-to-cost ratio would still be positive at 1.46.

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Report to

The Department of the Army
U.S. Army Engineer District, Alaska

for

GEOTECHNICAL INVESTIGATION PROPOSED SMALL BOAT HARBOR EXPANSION SEWARD, ALASKA

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1. INTRODUCTION

The following report summarizes the results of the geotechnical investigation conducted by Golder Associates to assist the study of several alternatives for improving the Small Boat Harbor at Seward, Alaska. The project location is shown in Figure 1. One of these alternatives consists of eastward expansion of the existing facility. Under this plan, the inner 1300 ft of the existing east breakwater would be removed and replaced with a new 2,200 ft breakwater parallel and adjacent to the west side of the existing coal loading trestle shown in Figure 2. This project was conducted for the Alaska District - Corps of Engineers under Contract No. DACA85-96-D-0002, Delivery Order No. 007. Survey support was provided by Terra Surveys of Palmer, Alaska. Drilling services were provided by Discovery Drilling Inc. Field work was carried out during October, 1997.

1.1 Purpose

The purpose of the investigation was to determine the soil conditions in the vicinity of the proposed expansion area and address the geotechnical considerations and appropriate recommendations relative to the expansion of the harbor.

1.2 Scope

The scope of work included the review of existing data relevant to the site, drilling and sampling of six boreholes to supplement existing data, survey of the horizontal and vertical locations of the boreholes, providing samples for chemical testing to a Corps chemist, conducting laboratory testing for geotechnical parameters, and preparing a report summarizing the investigation results. The report was to address:

- Dredgability of the soils,
- Suitability of the soils for support of the proposed breakwater,
- Recommendations for dredged slopes,
- Potential effects of the proposed new breakwater on the existing coal trestle, and
- Mitigation of impacts to the existing coal trestle.

2. BACKGROUND

The existing Seward Small Boat Harbor was constructed at the head of Resurrection Bay, adjacent to the Seward-Anchorage highway, in 1965, following destruction of the previous harbor in the Alaska earthquake of March 27, 1964. The new boat harbor was established north of the destroyed harbor because of the unstable slopes identified at the old site. The existing harbor includes 4.7 acres of berthing area dredged to a depth of -15 ft mean low low water (MLLW). The harbor is protected by two rubble-mound breakwaters.

In 1966, the Alaska Railroad (ARRC) completed construction of a railroad dock about 800 ft east of the harbor and dredged a berthing area to a depth of -35 ft MLLW. Slopes were dredged at 3:1. Dredged fill was deposited in the intertidal area between the Small Boat Harbor and the dock, as shown in Figure 3.

In 1984, a pile-supported coal trestle was constructed adjacent to the ARRC dredged basin and the basin was dredged to a depth of -55 ft, as shown in Figure 2. A sewer outfall was subsequently constructed adjacent to and west of the trestle.

3. METHODOLOGY

3.1 Data Review

Prior to drilling, a review of existing and available data and aerial photographs was made to assess the site conditions and make a preliminary evaluation of potential effects of the new breakwater on the trestle. This included discussions with Foster Singleton, longtime Seward Harbormaster, review of geotechnical reports relative to the construction of coastal facilities at the head of Resurrection Bay, U.S. Geological Survey reports and maps, nautical charts, and drawings and photomaps provided by the Corps. Based on this review, locations for the six boreholes were selected and submitted to the Corps for approval.

3.2 Drilling and Sampling

The field investigation consisted of utility locates and the drilling and sampling of seven test borings between the existing breakwater and the coal trestle at the locations shown in Figure 4. One test boring, GAI-1, was drilled on shore near the parking area on October 15, 1997. Three of the test borings, GAI-2 through GAI-4, were drilled in the intertidal zone during the evening low tide between October 15 and October 17, 1997. Three of the test borings, GAI-5 through GAI-7, were drilled off the west side of the coal trestle between October 21 and October 23, 1997.

The boreholes were drilled by a CME-75 drill rig supported on a Nodwell for the on-shore and intertidal boreholes and mounted to decking for boreholes drilled off the coal trestle. Auxiliary equipment for drilling off the coal trestle included a John Bean Division 425-9-B water pump and top mount grout swivel.

The boreholes were drilled using a 3.25-in. inside diameter (I.D.) hollow-stem auger with a bullet-tooth bit. The on-shore and intertidal borings used drill rod inside the auger during drilling. The borings off the coal trestle were performed by initially aligning and setting the augers with a drill rod, which was removed, and then drilling the remainder of the hole by pumping water through the augers.

Heaving sand conditions were generally observed during drilling and were controlled by raising and shaking the augers during sampling and/or by maintaining a water head inside the augers. Heaving sands encountered while drilling off the coal trestle were removed from inside the augers with a tri-cone bit or by washing water through a split-spoon sampler.

The boreholes were located using a Trimble 4000SSi GPS receiver on October 17, 1997. The on-shore and intertidal boreholes were marked with survey lathe and located during or after drilling operations. Intertidal boreholes were also marked with a milk-jug float tied to a cement block. The location of the coal trestle boreholes were identified by triangulating off two located markings on either side of the proposed borehole locations. The elevation of the coal trestle boreholes was identified by measuring the drill rod length from the trestle decking to the mudline and relating that distance to the located markings.

The drilling and sampling of the boreholes was supervised by a GAI geotechnical engineer who visually classified the soils, prepared samples for laboratory testing, and maintained a log of each borehole. The soil samples were visually classified in the field in accordance with ASTM D-2488.

Soil samples were obtained at every five foot interval down to 20 ft and then at 10 ft intervals thereafter. Samples were taken with a 3-in. outside diameter split-spoon sampler driven with a 340-lb hammer from a 30-in. drop height. Samples were visually classified, logged, and placed in moisture proof containers.

3.3 Laboratory Testing

Laboratory tests were performed on recovered samples to confirm visual field classification and to determine characteristics of the various geologic units encountered. The laboratory testing and methods included:

- ❑ Moisture content (ASTM D-2216)
- ❑ Particle-size analysis (ASTM D-422)
- ❑ Atterberg limits (ASTM D-4318)
- ❑ Consolidated-drained (CD) triaxial testing (ASTM D-4767)

A summary of the laboratory test results are presented in Table 1. The laboratory reports are provided in Appendix B.

4. RESULTS

4.1 General Site Description

The proposed expansion area for the Seward Small Boat Harbor is located at the head of Resurrection Bay about one mile north of the city center at 60°7'N and 149°25' W. Resurrection Bay is a deep fjord about 25 miles long, 3 to 5 miles wide, and is ice-free all year. The region has steep mountainous terrain with peaks rising above the site to elevations of about 5,000 ft. The site lies between the existing harbor and a coal trestle that extends offshore about 1800 ft . The area has moderately large tides with a diurnal range of up to 19 ft. The land slopes slightly to the south. Gravelly deposits are exposed at low tide over most of the site with water depths ranging from 0 to 5 ft at MLLW. Photographs of the site are presented in Figures 5 and 6.

4.2 Geologic Setting

Seward lies on the axis of the Chugach Mountains geosyncline. The region is underlain by sedimentary rocks of the Valdez Group, principally of Jurrassic and the late-Cretaceous age. These rocks have undergone low-grade metamorphism and consist mainly of graywacke, phyllite, argillite and slate.

The region was intensely glaciated during the late Pleistocene and numerous valley and piedmont glaciers occupy the higher elevations within a few miles of Seward. Unconsolidated glacially-derived sediments fill the broad U-shaped valley floors and overlie the bedrock on low-angle slopes.

The area is one of the most seismically active in the world. Seward is located about 100 miles from the epicenter of the Alaska Earthquake of March 27, 1964. This earthquake, with a Richter magnitude of 9.2, destroyed most of the Seward coastal facilities by subsea landslides and slide-generated waves. Tectonic subsidence of about 3.5 ft resulted in low areas being inundated at high tide.

4.3 Site Conditions

4.3.1 Site Geology

The proposed expansion area is situated at the edge of the Resurrection River floodplain. The floodplain is wide, braided with a low-banked stream, and occupies a deep U-shaped valley with steep valley walls. The continuation of this deep bedrock valley is manifested as a trough on the bay floor offshore of Seward. The floodplain has been subject to recent alternate accretion and erosion with the channel migrating laterally across the floodplain. At the southern end of the floodplain, these unconsolidated deposits slope steeply into Resurrection Bay. Marine geophysical surveying in the vicinity has identified landslide features in the submarine slopes south of the proposed site (Sylwester, 1997).

Based on aerial photographs taken prior to the earthquake, the intertidal materials in the vicinity of expansion area appear to have been dredged, presumably as a material site (Lemke, 1967). Subsequent to the earthquake, the northern portion of the site was covered with materials dredged from the berthing basin of the adjacent ARRC dock. The surface of these materials have since been modified by wave action. Miscellaneous debris may be incorporated into the beach and intertidal deposits according to the Seward harbormaster (Singleton, 1997), but none was encountered in the boreholes.

4.3.2 Soils

Seven boreholes were drilled at the locations shown in Figure 4. The logs are presented in Appendix A. Laboratory test results of the soil samples are presented in Table 1 and in Appendix B. Based on these boreholes and those of previous investigators (HLA, [1977] and S&W, [1964]), the subsurface is characterized by pro-grading glacial-fluvial sand and gravel which overlies marine deposits consisting mainly of silt with silty sand interbeds. The top of a lower unit of sand and gravel underlies the marine sediments at depths ranging from 75 to 100 ft. This unit contains interbeds of dense glacial till (S&W, 1964). The distribution of the near-surface sediments is shown in the cross-sections in Figures 7, 8, and 9. Locations of the cross sections are shown on Figure 4. The depth to bedrock is unknown, but assumed to be hundreds of feet based on the configuration of the valley and geophysical surveying by Shannon and Wilson (1964).

The following is a description of each of the major soil units encountered:

Fill

Approximately 13 ft of fill was encountered at the surface of the only onshore borehole (AP-186). The fill, apparently composed of dredged materials from the adjacent ARRC dock, consisted of compact, moist sand with silt and gravel (SP-SM). Maximum particle size diameter was about 1 in.

Sand and Gravel (Floodplain Deposits)

The near-surface sand and gravel deposits were originally deposited as glacially-derived outwash and alluvium. These materials are gray to black, range from loose to dense, are poorly sorted, and are subangular to subround. Boulders were not encountered or detected in this unit and have not been reported in the preceding investigations.

Silt and Silty Sand (Marine Deposits)

The marine deposits consist mainly of black, non-plastic silt with silty fine sand interbeds. Traces of gravel and organic material is typically present including shells. These materials are likely interfingered with the alluvium.

4.3.3 Groundwater

Previous investigators reported artesian conditions in onshore boreholes below a depth of about 20 ft in the vicinity of the harbor expansion area (S&W, 1964). Heaving conditions were encountered while drilling in our investigation and by S&W (1964). The groundwater level is tidally affected.

5. Engineering Analysis

5.1 Breakwater Foundation

The breakwater will be founded on floodplain deposits consisting of sand and gravel. Bearing capacity will be controlled by these materials. Settlement of the breakwater will be controlled partially by elastic compression of these same materials, but predominantly by consolidation of the underlying marine silts.

5.1.1 Bearing Capacity

Bearing capacity analyses were conducted for the following breakwater geometry:

Crest Elevation	18 ft
Crest Width	30 ft
Side Slopes	1.5H:1V
Toe Elevation	-5 ft

Because of the high friction angle of the foundation materials, a significant factor of safety exists against bearing capacity failure. The width of the crest does not have a significant effect on the factor of safety against bearing capacity failure.

5.1.2 Settlement

Settlement of the breakwater will occur as a result of elastic compression of the surficial, coarse-grained floodplain deposits and as a result of consolidation of the underlying, fine-grained marine silts. Elastic compression of the floodplain deposits is estimated to be approximately 0.5 feet. This will occur immediately, during construction, so its impacts on the crest elevation of the breakwater will be negligible.

Consolidation of the silts under the breakwater was estimated for the breakwater geometry shown above. Consolidation properties for the silts were obtained from empirical correlations with Atterberg limits reported in the literature, and from testing conducted by Shannon & Wilson (1964). Consolidation settlements of 1 to 1.5 feet were determined from our analysis. Consolidation settlements are time dependent, and may occur over the course of several months to a few years. It may be prudent to make allowances for future settlement by adding to the height of the breakwater during construction.

Consolidation settlements are directly related to the width and height of the structure. The settlement estimates discussed above are specific to the geometry shown above. For planning purposes, settlements for different breakwater widths (same height) can be assumed to be roughly proportional to the width of the structure, measured from toe to toe.

5.2 Dredging and Dredge Slopes

Stability analyses were performed to determine appropriate dredge slope geometries for the harbor expansion. The performance of the slopes under seismic loading was of particular concern.

5.2.1 Seismic Hazard

Seward is in a high seismic hazard area, as evidenced by the virtual destruction of the port during the 1964 earthquake. The recurrence interval of an earthquake of similar magnitude is estimated to be on the order of 700 years (Combellick, 1992). Smaller magnitude earthquakes will have a more frequent recurrence interval.

No site specific seismic risk assessment has been performed for the Seward area, to our knowledge. In lieu of site specific information, probabilistic values for earthquake acceleration as a function of recurrence interval have been obtained from maps by Algermissen, et. al. (1990). These maps indicate that a horizontal acceleration of 0.60g has a 10 percent probability of being exceeded in 50 years. This value was used in our stability analyses to help understand the likelihood of damage to the harbor expansion within its design life.

5.2.2 Material Properties

Based on our borings and the geologic history of the area, the surficial soils in the harbor area are sand and gravel floodplain materials deposited by the Resurrection River. The particles are subround to subangular and the material is generally compact. These materials are underlain by marine silt and sandy silt. However, because of the thickness of the floodplain deposits, the stability of the existing and future dredge slopes is controlled only by the properties of the floodplain deposits. The finer grained marine deposits occur below the base of the failure planes identified in our stability analyses.

The soil properties shown below were used in all stability analyses. These properties are based on the laboratory testing presented in Appendix B and are considered appropriate for both the natural floodplain deposits and the rock fill used to construct the breakwater.

Moist Unit Weight:	128 pcf
Saturated Unit Weight:	137 pcf
Friction Angle:	42 degrees
Cohesion:	0 psf

5.2.3 Static Stability

Stability analyses for the harbor expansion dredge slopes were performed using the computer program XSTABL. The critical failure surface was identified from a search of 500 to 1000 potential failure surfaces. Circular failure surfaces were analyzed using Bishop's method of slices. Non-circular failure surfaces were also analyzed using the modified Janbu method.

Existing dredge slopes in the small boat harbor are approximately 2.7H:1V. Dredge slopes of 2H:1V and 3H:1V were evaluated in our stability analyses. The side slopes of the existing breakwater are approximately 2H:1V. We understand that side slopes of 1.5H:1V are planned for the new breakwater, so our analyses used this value. The results of our analyses are summarized below and shown on Figure 10.

Dredge Slope	Factor of Safety	Yield Acceleration
2H:1V	1.5	0.15g
3H:1V	1.8	0.22g

The static factor of safety is acceptable (1.5 or greater) for both the 2H:1V and 3H:1V dredge slopes. Pseudo-static analyses were also performed to determine the yield acceleration. This is the horizontal acceleration which results in a factor of safety of one for the slope. The yield accelerations determined from this analysis are shown above and on Figure 10.

5.2.4 Dynamic Stability

The dredge slopes, whether constructed at 2H:1V or 3H:1V, are expected to fail under the design earthquake, since the yield accelerations are less than the design acceleration of 0.6g. The critical failure surfaces identified in these analyses (see Figure 10) are quite shallow, as is typical for granular materials. However, during a long earthquake, a series of shallow failures can occur, resulting in significant regression of the crest of the slope. The slope failures which occurred in Seward during the 1964 earthquake followed this pattern, as described by Lemke (1967): "Slice after slice of ground along the shore slid progressively as shaking continued, until a strip of harbor area 50-500 feet wide [i.e., a 50-500 foot regression of the crest of the slope] had disappeared into the bay."

Estimating the magnitude of seismically induced downslope movements for submarine slopes is a complex procedure which is beyond the scope of this work. A simplified formula for estimating movements on dry slopes was developed by Newmark (1965):

$$\delta = \frac{V^2}{2gN}\left(1 - \frac{N}{A}\right)\frac{A}{N}$$

where	δ	=	expected deflection
	V	=	maximum ground velocity during earthquake
	N	=	maximum ground acceleration during earthquake (design acceleration)
	A	=	yield acceleration (acceleration which results in a factor of safety of one for the slope in question)
	g	=	acceleration of gravity

This relationship does not take pore pressure or liquefaction effects into consideration, and thus will tend to underestimate movements for submarine slopes. In particular, it does not effectively predict large scale displacements such as those which occurred during the 1964 earthquake. Consequently, displacements predicted by this method should be considered a lower bound for the possible displacements which might occur as a result of an earthquake.

Figure 11 shows a plot of estimated displacement vs. maximum ground acceleration for the proposed dredge slopes, using Newmark's method. For a maximum ground acceleration of 0.60g, downslope displacements of one to two feet are predicted, depending on the dredge slope. Actual movements during such an event are likely to be larger than predicted by this method, and would likely cause settlement of and/or damage to the breakwater.

It should be noted that the maximum bedrock accelerations which caused the catastrophic slope failures during the 1964 earthquake were probably less than 0.8g. According to Figure 11, less than 6 feet of downslope movement would be predicted for this acceleration. This illustrates the inability of Newmark's method to predict large scale movements on submarine slopes.

Based on our analyses and past experience in Seward, movements ranging from barely perceptible to catastrophic are possible, depending on the magnitude of the seismic event. In our opinion, there is a greater than 10 percent probability of suffering seismically induced movements sufficient to cause damage to or destruction of the breakwater within a 50 year time period.

5.3 Dredging

Dredging for the Seward harbor expansion will require equipment capable of handling dense, coarse grained materials. We recommend the use of mechanical excavation equipment such as backhoes and clamshell excavators. Suction dredges and other types of hydraulic equipment may also be capable of moving the coarser materials, but may need to be equipped with cutter heads. Boulders were not encountered in our investigations, nor have they been reported in previous investigations. However, given the depositional environment of the floodplain deposits, some cobble and boulder sized material may be encountered.

5.4 Effects on Existing Facilities

The breakwater will be constructed adjacent to an existing coal trestle which is supported on pile foundations. Analyses were conducted to determine the potential effects of the breakwater construction on the coal trestle, and to establish a setback from the trestle that would minimize these effects.

There are two primary concerns with construction of the breakwater adjacent to the coal trestle:

- ❑ The weight of the breakwater could induce static or dynamic instability in the dredge slopes to the east of the trestle, resulting in damage to or destruction of the coal trestle.
- ❑ Settlement caused by the breakwater could induce downdrag loads on the trestle piles, resulting in settlement of the structure.

5.4.1 Stability of Existing Slopes

The existing dredge slopes adjacent to the coal trestle range from 1.6H:1V to 2H:1V. The slopes extend underneath the trestle, with the crest of the dredge slope coinciding approximately with the west edge of the trestle over the southern half of the structure. The current condition of the coal trestle dredge slopes was evaluated using an infinite slope analysis. The results of the analysis are as follows:

Slope Angle	Static FOS	Yield Acceleration
1.6H:1V	1.44	0.10g
2H:1V	1.80	0.15g

Under the design seismic acceleration of 0.6g, the existing slopes would be expected to fail. Estimated displacements, as shown on Figure 11, would be significant, although the failure mechanism modeled by an infinite slope failure is a thin "skin" slide. The major concern with this type of failure, as discussed previously, is that a series of multiple failures would progress back into the slope during the prolonged shaking associated with a major earthquake. If this were to occur, significant damage to the coal trestle could occur, even without the breakwater in place. This is consistent with observations of the effects of the 1964 earthquake, during which significant submarine slope failures occurred on slopes which were generally flatter than these dredge slopes.

Additional stability analyses were performed using the computer program XSTABL to assess the impacts of the breakwater construction. The setback from the crest of the coal trestle dredge slope to the eastern toe of the breakwater was varied to find the location at which no adverse impacts occurred. Figure 12 shows the results of these analyses. With a setback of 25 ft, the addition of the breakwater resulted in no decrease in the static factor of safety or yield acceleration. This indicates that the coal trestle is no worse for the presence of the breakwater if this setback is observed. However, as indicated above, the coal trestle could suffer damage during a significant earthquake even if the breakwater is not present.

5.4.2 Downdrag

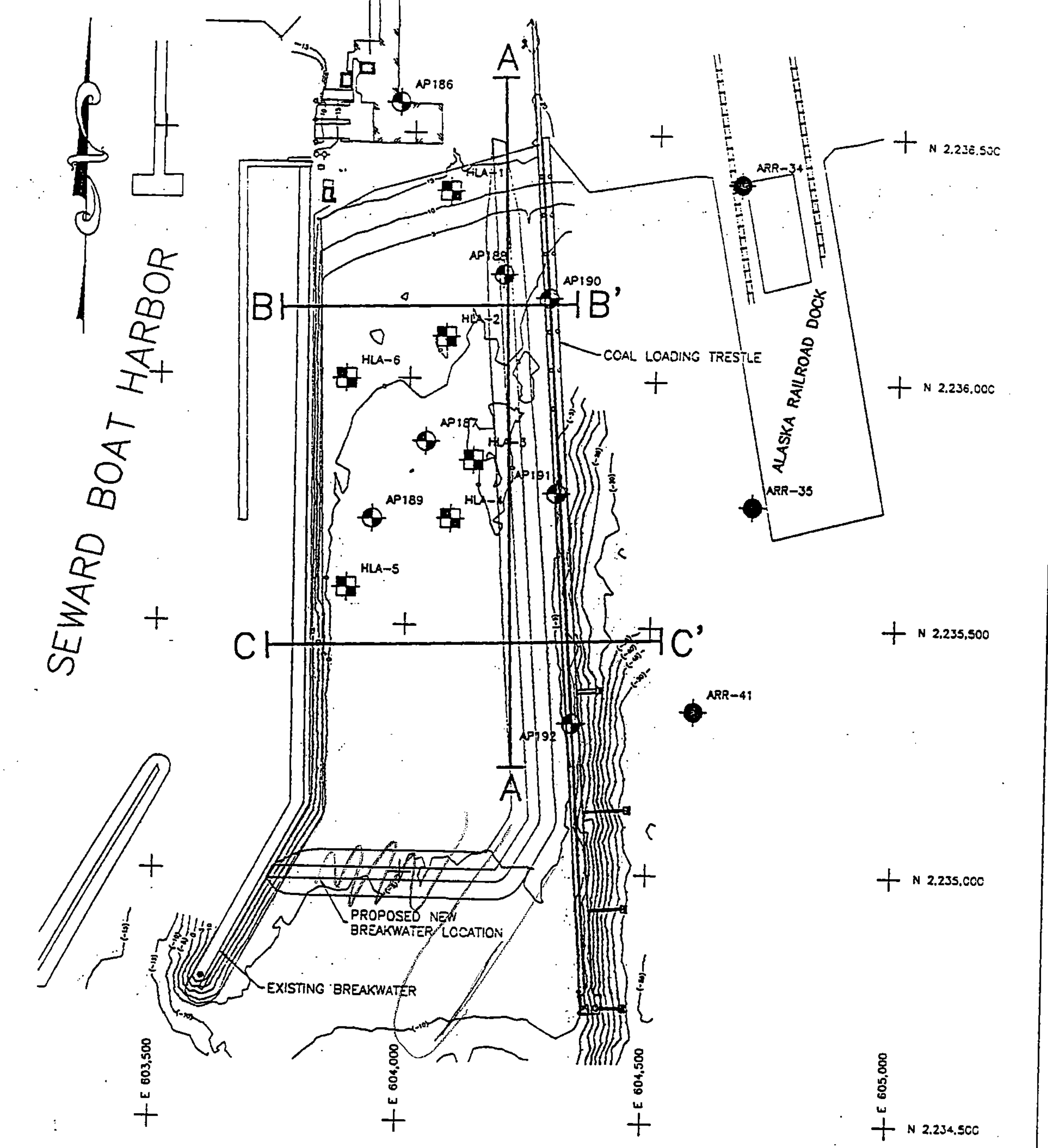
Consolidation of the fine grained materials will occur in response to the added weight of the breakwater. If the breakwater is located too close to the coal trestle, downdrag loads will be imposed on the pile foundations, with the potential to cause settlement of the piles.

A minimum setback of 30 feet between the toe of the breakwater and the nearest trestle pile is recommended to minimize downdrag effects.

TABLE 1
SUMMARY OF LABORATORY TEST RESULTS

TESTHOLE NUMBER	SAMPLE NUMBER	APPROX. DEPTH (ft)	MOISTURE CONTENT (%)	SIEVE ANALYSIS +#4 (%)	SIEVE ANALYSIS #4-#200 (%)	SIEVE ANALYSIS -#200 (%)	ATTERBERG LIMITS PI	ATTERBERG LIMITS LL	ASTM CLASSIFICATION	USCS CLASS.
AP186	1	4.5	-	-	-	-	-	-		
	2	9.5	-	38	51	11	-	-	-	-
	3[a]	14.5	-	-	-	-	-	-	Poorly graded SAND with silt and gravel	SP-SM
	4	19.5	37	-	-	-	21	49	-	-
	5	29.5	18	-	-	-	-	-	Lean CLAY	CL
	6[b]	39.5	-	-	-	-	-	-	-	-
AP187	1[a]	4.5	-	-	-	-	-	-	-	-
	2	9.5	-	46	52	2	-	-	-	-
	3	14.5	-	-	-	-	-	-	Poorly graded SAND with gravel	SP
	4[c]	19.5	-	-	-	-	-	-	-	-
	5	24.5	22	-	-	-	-	-	-	-
AP188	1[d]	4.5	-	-	-	-	-	-	-	-
	2[d]	9.5	-	-	-	-	-	-	-	-
	3	14.5	-	24	73	3	-	-	-	-
	4	19.5	-	-	-	-	-	-	Poorly graded SAND with gravel	SP
AP189	1[a]	4.5	-	-	-	-	-	-	-	-
	2	9.5	-	-	-	-	-	-	-	-
	3	14.5	-	18	80	2	-	-	-	-
	4	19.5	-	-	-	-	-	-	Poorly graded SAND with gravel	SP
AP190	1[e]	3.9	-	-	-	-	-	-	-	-
	2[d]	8.9	-	-	-	-	-	-	-	-
	3	13.9	-	41	52	7	-	-	-	-
	4	19.2	27	-	-	-	NP	NP	Poorly graded SAND with silt and gravel	SP-SM
	5[c]	28.9	-	-	-	-	-	-	-	-
	6	38.9	16	-	-	-	-	-	-	-
	7	49.0	39	-	-	-	7	35	-	-
AP191	1[d]	4.8	-	-	-	-	-	-	-	-
	2	9.9	-	-	-	-	-	-	-	-
	3	15.1	32	-	-	-	-	-	-	-
	4	19.8	14	-	-	-	-	-	-	-
	5	30.1	24	10	70	20	-	-	Silty SAND	SM
	6	39.9	35	-	-	-	-	-	-	-
	7[e]	49.8	-	-	-	-	-	-	-	-
	8	60.1	29	-	-	-	-	-	-	-
	9	70.0	32	-	-	-	NP	NP	-	-
AP192	1[d]	8.1	-	-	-	-	-	-	-	-
	2[d]	13.2	-	-	-	-	-	-	-	-
	3[d]	18.1	-	-	-	-	-	-	-	-
	4[e]	23.1	-	-	-	-	-	-	-	-
	5[c]	27.4	-	-	-	-	-	-	-	-
	6	38.3	-	8	83	9	-	-	Poorly graded SAND with silt	SP-SM
	7[c]	47.9	-	-	-	-	-	-	-	-
	8[c]	60.1	-	-	-	-	-	-	-	-
	9[e]	70.0	-	-	-	-	-	-	-	-

NOTES: USCS = Unified Soil Classification System
a = Sample collected by COE representative for environmental testing.
b = Sample discarded as being unrepresentative heave materials.
c = Sample used in "sand" composite sample for consolidated-drained triaxial testing.
d = Sample used in "gravel" composite sample for consolidated-drained triaxial testing.
e = No sample recovered.



0 300 600

SCALE, FEET

BOREHOLE LEGEND:

- AP186 — GOLDER ASSOC., OCTOBER, 1997 THIS INVESTIGATION
- HLA-5 — HARDING-LAWSON ASSOC., JULY – AUGUST, 1976 DRESSER INDUSTRIES DOCK FACILITIES
- ARR-41 — ALASKA RAILROAD, JULY, 1964 RESTORATION OF ALASKA RAILROAD FACILITIES

NOTES: 1. DRAWING ADAPTED FROM ALASKA CORPS OF ENGINEERS AND TERRA SURVEYS LLC, 1997.

Figure 4

SITE MAP WITH BOREHOLE LOCATIONS

USACOE / SEWARD HARBOR EXPANSION / AK

PROJECT NO 973-5287007 AutoCAD FILE BORINGS DATE 1/98 DRAWN SLA

Golder Associates

Unified Soil Classification System

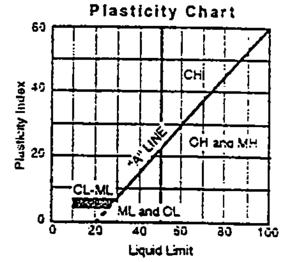
CRITERIA FOR ASSIGNING GROUP SYMBOLS AND NAMES				SOIL CLASSIFICATION AND GENERALIZED GROUP DESCRIPTIONS
COARSE - GRAINED SOILS More than 50% retained on No. 200 Sieve	GRAVELS More than 50% of coarse fraction retained on No. 4 Sieve	CLEAN GRAVELS Less than 5% fines	GW	Well-graded Gravels
			GP	Poorly-graded Gravels
		GRAVELS WITH FINES More than 12% fines	GM	Gravel and Silt Mixtures
			GC	Gravel and Clay Mixtures
	SANDS 50% or more of coarse fraction passes No. 4 Sieve	CLEAN SANDS Less than 5% fines	SW	Well-graded Sands
			SP	Poorly-graded Sands
		SANDS WITH FINES More than 12% fines	SM	Sand and Silt Mixtures
			SC	Sand and Clay Mixtures
FINE-GRAINED SOILS 50% or more passes the No. 200 Sieve	SILT AND CLAYS Liquid limit less than 50	INORGANIC	CL	Low-plasticity Clays
			ML	Non-plastic and Low-Plasticity Silts
		ORGANIC	OL	Non-plastic and Low-Plasticity Organic Clays Non-plastic and Low-Plasticity Organic Silts
	SILTS AND CLAYS Liquid limit greater than 50	INORGANIC	CH	High-plasticity Clays
			MH	High-plasticity Silts
		ORGANIC	OH	High-plasticity Organic Clays High-plasticity Organic Silts
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat

Laboratory Tests

Test	Designation
Moisture	(1)
Density	D
Grain Size	G
Hydrometer	H
Atterberg Limits	(1)
Consolidation	C
Unconfined	U
UU Triax	UU
CU Triax	CU
CD Triax	CD
Permeability	P

(1) Moisture and Atterberg Limits plotted on boring log

Plasticity Chart



Relative Density or Consistency Utilizing Standard Penetration Test Values

Cohesionless Soils [a]			Cohesive Soils [b]		
Density[c]	N_1 blows/ft.[c]	Relative Density (%)	Consistency	N_1 blows/ft.[c]	Undrained[d] Shear Strength (Psf)
Very loose	0 to 4	0 - 15	Very soft	0 to 2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Compact	10 to 30	35 - 65	Firm	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	over 50	>85	Very Stiff	15 to 30	2000 - 4000
			Hard	over 30	>4000

(a) Soils consisting of gravel, sand, and silt, either separately or in combination, possessing no characteristics of plasticity, and exhibiting drained behavior.

(b) Soils possessing the characteristics of plasticity, and exhibiting undrained behavior.

(c) Refer to text of ASTM D 1586-84 for a definition of N, in normally consolidated cohesionless soils Relative Density terms are based on N values corrected for overburden pressures (N1). N values may be affected by a number of factors including material size, depth, drilling method, and borehole disturbance. N values are only an approximate guide to the consistency of cohesive soils.

(d) Undrained shear strength = 1/2 unconfined compression strength.

Silt and Clay Descriptions

Description	Typical Unified Designation
Silt	ML (non-plastic)
Clayey Silt	CL-ML (low-plasticity)
Silty Clay	CL
Clay	CH
Plastic Silt	MH
Organic Soils	OL, OH, PT

Descriptive Terminology Denoting Component Proportions

Descriptive Terms	Range of Proportion
Trace	0 - 5%
Little	5 - 12%
Some or Adjective[a]	12 - 30%
And	30 - 50%

a) Use Gravelly, Sandy or Silty as appropriate.

Samples

SS	SPT Sampler (2 in. O.D.)
SSO	Oversize SPT (2.5 in. O.D.)
HD	Heavy Duty Spoon (3.0 in. O.D.)
SH	Shelby Tube
P	Pitcher Sampler
B	Bulk
C	Cored
RC	Air Rotary Cuttings
AC	Auger Core

1. SS drive samples advanced with 140 lb hammer with a 30 in. drop.
2. HD drive samples are advanced with 300 lb. hammer with a 30 in. drop.
3. SSO drive samples advanced with 140 lb. hammer with a 30 in. drop.

Component Definitions by Gradation

Component	Size Range
Boulders	Above 12 in.
Cobbles	3 in. to 12 in.
Gravel	3 in. to No. 4 (4.76mm)
Coarse gravel	3 in to 3/4 in.
Fine gravel	3/4 in. to No. 4 (4.76mm)
Sand	No. 4 (4.76mm) to No 200 (0.074mm)
Coarse sand	No. 4 (4.76mm) to No 10 (2.0mm)
Medium sand	No. 10 (2.0mm) to No 40 (0.42mm)
Fine sand	No. 40 (0.42mm) to No 200 (0.074mm)
Silt and Clay	Smaller than No. 200 (0.074mm)

Golder Associates

Figure A-1

SOIL CLASSIFICATION/LEGEND

PROJECT: COE / Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP186

BORING DATE: October 15, 1997
BORING LOCATION: N 2236560.18, E 603969.02

SHEET: 1 OF 2
DATUM: MLLW

BORING METHOD: 3.25-in. I.D. Hollow Stem Auger

SOIL PROFILE

DEPTH SCALE FEET	DESCRIPTION	ELEV / DEPTH
0	Compact, moist, dark gray, poorly graded SAND with silt and gravel, 25-40% fine to coarse subrounded gravel up to 1-in., 45-55% fine to coarse sand, 10-15% non-plastic silt (SP-SM) (FILL)	17.3 / 0.0
4.5	Sample 1 (4.5 ft - 5.7 ft) FIELD CLASSIFICATION: Compact, moist, dark gray, silty SAND with gravel, 15-20% fine to coarse subrounded gravel up to 1 in., 50-55% medium to coarse sand, 15-20% non-plastic silt (SM)	
9.5	Sample 2 (9.5 ft - 10.7 ft) LAB CLASSIFICATION: Poorly graded SAND with silt and gravel, 38% fine to coarse gravel up to 1 in., 51% fine to coarse sand, 11% fines (SP-SM)	
13	Compact, wet, dark gray to black, poorly graded SAND with silt, 10-15% fine angular gravel up to 3/8 in., 45-55% fine to coarse sand, 5-10% non-plastic silt (SP-SM) COE representative took Sample 3 for environmental testing	4.3 / 13.0
18	Very soft, wet, gray, lean CLAY (CL)	-0.7 / 18.0
26	Intermittant 4-in. to 3-ft thick layers of very loose to loose, wet, dark gray to black, poorly graded SAND with silt, 5-10% fine subrounded to angular gravel up to 1/2 in., 65-75% fine to coarse sand, 5-10% non-plastic silt, and gray, non-plastic SILT (SP-SM and ML)	-8.7 / 26.0
32	CONTINUED ON NEXT PAGE	-14.7 / 32.0

SAMPLES

NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT
1	HD	7/5/5	10	14/18
2	HD	4/10/8	18	14/18
3	HD	2/4/6/5	10	12/24
4	HD	1/1/1	2	9/18
5	HD	1/4/1	5	14/18

PENETRATION RESISTANCE BLOWS/FT ■ 20 40 60 80
WATER CONTENT, PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80

PIEZOMETER OR STANDPIPE INSTALLATION: 13 ft ▽ 10/15/97

DRILL RIG: CME-75 on Nodwell
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A-1

Golder Associates

LOGGED: Steve L Anderson
CHECKED: RGD
DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP186

BORING DATE: October 15, 1997
BORING LOCATION: N 2236560.18, E 603969.02

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ (20 40 60 80); WATER CONTENT, PERCENT Wp —O^W— Wl (20 40 60 80)	PIEZOMETER OR STANDPIPE INSTALLATION
32	3.25-in. I.D. Hollow Stem Auger	CONTINUED FROM PREVIOUS PAGE										
32–39		Intermittent layers 4-in. to 4-ft thick of very loose to loose, wet, dark gray to black, poorly graded SAND with silt, 5-10% fine subrounded to angular gravel up to 1/2 in., 65-75% fine to coarse sand, 5-10% non-plastic silt, and gray, non-plastic SILT (SP-SM and ML)										
39		About 2 ft of heave in auger when sampling at 39.5 ft										
40–42		Sample 6 FIELD DESCRIPTION: Soils recovered appeared to be unrepresentative heave materials that were discarded. Blow counts are not representative of the true relative density.				6	HD	8/8/18		18/18		
43		About 15 ft of heave in auger when attaching auger flight to drill deeper.			-26.7							
44		Bottom of hole at about 44 ft			44.0							

NOTES:

1. Groundwater encountered at about 13 ft.
2. Samples collected with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.
3. Major soil description same as sample field classification when field classification is not noted.
4. Hole terminated at 44 ft due to excessive heave inside augers.

DRILL RIG: CME-75 on Nodwell
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A-1

Golder Associates

LOGGED: Steve L. Anderson
CHECKED: RGD
DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK

PROJECT LOCATION: Seward, Alaska

PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP187

BORING DATE: October 15, 1997

BORING LOCATION: N 2235872.63, E 604035.24

SHEET: 1 OF 1

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ (20 40 60 80); WATER CONTENT, PERCENT Wp —○W— Wl (20 40 60 80)	PIEZOMETER OR STANDPIPE INSTALLATION
0	3.25-in. I.D. Hollow Stem Auger	Soft intertidal zone with mussel shells.			-0.2 / 0.0							
0–4		Compact, wet, gray-black, poorly graded SAND with silt and sand, 45-50% fine to coarse subrounded, flat gravel up to 1 in., 45-55% fine to coarse sand, 5-10% non-plastic silt (SP-SM)										
5–6		Sample 1 (4.5 ft - 5.2 ft) FIELD CLASSIFICATION: Compact, wet, gray-black, poorly graded GRAVEL with silt and sand, 45-50% fine to coarse subrounded, flat gravel up to 1.25 in., 25-30% medium to coarse sand, 10-15% non-plastc silt (GP-GM) (COE representative took sample for environmenmtal testing)				1	HD	10/6/10/10	16	20/24	■	
10		Sample 2 (9.5 ft - 10.3 ft) LAB CLASSIFICATION: Poorly graded SAND with gravel, 46% fine to coarse gravel up to 1 in., 52% fine to coarse sand, 2% fines (SP)				2	HD	6/8/10	18	10/18	■	
14		About 5 ft of heave in auger when sampling at 14.5 ft										
15–17		Sample 3 (14.5 ft - 15.3 ft) FIELD CLASSIFICATION: Compact, wet, black-gray, poorly graded GRAVEL with silt and sand, 45-50% fine to coarse subrounded gravel up to 1 in., 30-35% fine to coarse sand, 10-15% non-plastic silt (GP-GM) (QUESTIONABLE REPRESENTATION)				3	HD	3/6/10	16	10/18	■	
18					-18.2 / 18.0							
18–21		Compact, wet, black-gray, poorly graded SAND with silt and gravel, 15-20% fine subangular gravel up to 3/8 in., 55-65% fine to coarse sand, 10-15% non-plastic silt, occasional lenses of non-plastic SILT up to 3-in. thick (SP-SM)				4	HD	4/7/7	14	18/18	■	
22					-22.2 / 22.0							
22–25		Compact, wet, black, poorly graded SAND with silt, 90-95% fine sand, 5-10% non-plastic silt (SP-SM)				5	HD	9/8/8	16	12/18	■ ○	
26		Bottom of hole at about 26 ft			-26.2 / 26.0							

NOTES:

1. Samples taken with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.
2. Major soil description same as sample field classification when field classification is not noted.
3. Hole terminated at 26 ft due to nearness of incoming tide.

DRILL RIG: CME-75 on Nodwell

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A2

Golder Associates

LOGGED: Steve L Anderson

CHECKED: RCO

DATE: 12/23/97

RECORD OF BOREHOLE AP188

PROJECT: COE / Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

BORING DATE: October 16, 1997
BORING LOCATION: N 2236213.35, E 604186.92

SHEET: 1 OF 1
DATUM: MLLW

Boring method: 3.25-in. I.D. Hollow Stem Auger

Depth (ft)	Description	Elev / Depth
0	Flat gravelly surface in intertidal zone	1.9 / 0.0
0–13.0	Compact, wet, dark gray to black, poorly graded GRAVEL with silt and sand, 45-55% fine to coarse, subrounded to subangular gravel up to 1.25 in., 45-50% medium to coarse sand, 5-10% non-plastic silt (GP-GM) Sample 1 (4.5 ft - 5.5 ft) FIELD CLASSIFICATION: Compact, wet, dark gray, poorly graded GRAVEL with silt and sand, 45-55% fine to coarse, subrounded to subangular gravel up to 1.25 in., 30-35% medium to coarse sand, 5-10% non-plastic silt (GP-GM) Sample 2 (9.5 ft - 10.4 ft) FIELD CLASSIFICATION: Compact, wet, dark gray to black, poorly graded GRAVEL with silt and sand, 45-55% fine subrounded to subangular gravel up to 3/4 in., 30-35% medium to coarse sand, 5-10% non-plastic silt (GP-GM)	-11.1 / 13.0
13.0–29.5	Compact, wet, black to dark gray, poorly graded SAND with silt and gravel, 25-30% fine subrounded gravel up to 1/2 in., 55-60% medium to coarse sand, 0-10% non-plastic silt, occasional lenses of non-plastic SILT at least 3-in. thick, drilling indicates occasional lenses about 2 ft thick with higher gravel content (SP-SM) Sample 3 (14.5 ft - 15.3 ft) LAB CLASSIFICATION: Poorly graded SAND with gravel, 24% fine gravel, up to 3/4 in., 73% fine to coarse sand, 3% fines (SP) About 3 ft of heave in auger when sampling at 19.5 ft Sample 4 (19.5 ft - 20.3 ft) FIELD CLASSIFICATION: Compact, wet, black to dark gray, poorly graded SAND with silt and gravel, 25-30% fine subrounded gravel up to 1/2 in., 55-60% medium to coarse sand, 5-10% non-plastic silt, lense of non-plastic SILT at least 3-in. thick (SP-SM) About 8 ft of heave in auger when sampling at 29.5 ft	-27.6 / 29.5
29.5	Bottom of hole at about 29.5 ft	

Samples

Number	Type	Blows / 6 in	N	Rec/Att
1	HD	14/12/17	29	12/18
2	HD	18/13/14	27	11/18
3	HD	20/12/9	21	15/18
4	HD	6/10/8	18	8/18

NOTES:

1. Samples taken with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.
2. Hole terminated at 29.5 ft due to excessive heave in auger and nearness of incoming tide.

DRILL RIG: CME-75 on Nodwell
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A3

Golder Associates

LOGGED: Steve L. Anderson
CHECKED: RGD
DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK

RECORD OF BOREHOLE AP189

SHEET: 1 OF 1

PROJECT LOCATION: Seward, Alaska

BORING DATE: October 17, 1997

DATUM: MLLW

PROJECT NUMBER: 973-5287x007

BORING LOCATION: N 2235713.98, E 603928.68

BORING METHOD: 3.25-in. I.D. Hollow Stem Auger

DEPTH SCALE FEET	SOIL PROFILE – DESCRIPTION	ELEV / DEPTH	SAMPLE NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT
	Soft intertidal zone with mussel shells	-0.5 / 0.0					
0–4	Compact, wet, dark gray to black, poorly graded GRAVEL with silt and sand, 45-65% fine to coarse, subrounded to subangular gravel up to 1 in., 30-45% medium to coarse sand, 0-10% non-plastic silt (GP-GM)						
4.5–7	Sample 1 (4.5 ft - 5.4 ft) FIELD CLASSIFICATION: Compact, wet, dark gray to black, poorly graded GRAVEL with silt and sand, 45-55% fine to coarse, subrounded to subangular gravel up to 1 in., 30-35% medium to coarse sand, 5-10% non-plastic silt (GP-GM) (COE representative took sample for environmental testing)		1	HD	5/6/11	17	11/18
9	About 2 ft of heave in auger when sampling at 9.5 ft						
9.5–12	Sample 2 (9.5 ft - 10.0 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded GRAVEL with sand, 55-65% fine, subrounded to subangular gravel up to 3/4 in., 35-40% fine to coarse sand, 0-5% non-plastic silt (GP)		2	HD	6/7/6	13	6/18
13		-13.5 / 13.0					
13–16	Loose to dense, wet, black to gray, poorly graded SAND with gravel, 10-20% fine subangular gravel up to 3/8 in., 80-95% fine to medium angular sand, 0-5% non-plastic silt, occasional lense of gray, non-plastic SILT at least 2-in. thick (SP)		3	HD	10/5/3	8	14/18
16–18	Sample 3 (14.5 ft - 15.7 ft) LAB CLASSIFICATION: poorly graded SAND with gravel, 18% fine gravel up to 3/8 in., 80% fine to coarse sand, 2% fines (SP)						
19	About 3 ft of heave in auger when sampling at 19.5 ft						
19.5–22	Sample 4 (19.5 ft - 20.2 ft) FIELD CLASSIFICATION: Compact to dense, wet, gray-black, poorly graded SAND with silt, 85-95% fine to medium angular sand, 5-10% non-plastic silt (SP-SM) (QUESTIONABLE SAMPLE AND BLOW COUNT REPRESENTATION)		4	HD	22/28/20	48	8/18
28	About 6 ft of heave in auger when sampling at 29.5 ft	-30.0 / 29.5					
29.5	Bottom of hole at about 29.5 ft						

PENETRATION RESISTANCE BLOWS/FT ■ (20, 40, 60, 80)

WATER CONTENT, PERCENT Wp —○W— Wl (20, 40, 60, 80)

PIEZOMETER OR STANDPIPE INSTALLATION

NOTES:

1. Samples taken with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.
2. Boring terminated at 29.5 ft due to excessive heave in auger and nearness of incoming tide.

DRILL RIG: CME-75 on Nodwell

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A4

Golder Associates

LOGGED: Steve L Anderson

CHECKED: RGD

DATE: 12/22/97

PROJECT: COE/ Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP190

BORING DATE: October 23, 1997
BORING LOCATION: N 2235771.30, E 604309.70

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV / DEPTH	NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ / WATER CONTENT, PERCENT Wp —O^W— Wl	PIEZOMETER OR STANDPIPE INSTALLATION
0	3.25-in. I.D. Hollow Stem Auger	Compact to dense, wet, black-dark gray, poorly graded SAND with silt and gravel, 40-50% fine to coarse, subrounded to subangular gravel up to 1 in., 45-55% fine to coarse sand, 5-10% non-plastic silt (SP-SM)	-4.1 / 0.0							
4		Sample 1 (No recovery)								
5				1	HD	9/12/13/16	25	0/24	■	
9		Sample 2 (8.9 ft - 9.9 ft) FIELD DESCRIPTION: Compact, wet, black, poorly graded GRAVEL with sand, 45-55% fine subrounded to subangular gravel up to 1/2 in., 35-45% medium to coarse sand, 0-5% non-plastic silt (GP)								
10				2	HD	14/17/13/14	30	12/24	■	
14		Sample 3 (13.9 ft - 15.2 ft) LAB DESCRIPTION: Poorly graded SAND with silt and gravel, 41% fine to coarse gravel up to 1 in., 52% fine to coarse sand, 7% fines (SP-SM)								
15				3	HD	10/19/14/12	33	16/24	■	
18		Loose, wet, dark gray to black, SILT with sand, 5-10% fine subrounded gravel up to 5/8 in., 25-45% fine to medium sand, 65-75% non-plastic silt, 0-5% organics (shells, etc.), strong odor, occasional silty SAND seams about 2-in. thick (ML)	-22.1 / 18.0							
21				4	HD	3/3/2/4	5	24/24	■ O	
22		Sample 4 (19.2 ft - 21.2 ft) ATTERBERG LIMITS: PL = non-plastic LL = non-plastic (ML)								
25		Dense, wet, black to dark gray, poorly graded SAND with gravel, 15-20% fine subangular gravel up to 1/4 in., 75-85% medium to coarse sand, 0-5% non-plastic silt, occasional dark gray non-plastic SILT lenses at least 3-in. thick (SP)	-29.1 / 25.0							
30				5	HD	10/22/15/20	37	14/24	■	
32		CONTINUED ON NEXT PAGE	-36.1 / 32.0							

DRILL RIG: CME-75 mounted on trestle
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A5

Golder Associates

LOGGED: Steve L. Anderson
CHECKED: RCD
DATE: 12/22/97

PROJECT: COE/ Seward Small Boat Harbor / AK

RECORD OF BOREHOLE AP190

PROJECT LOCATION: Seward, Alaska

BORING DATE: October 23, 1997

DATUM: MLLW

PROJECT NUMBER: 973-5287x007

BORING LOCATION: N 2235771.30, E 604309.70

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE – DESCRIPTION	ELEV / DEPTH	SAMPLES – NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ / WATER CONTENT, PERCENT (Wp, W ○, Wl)	PIEZOMETER OR STANDPIPE INSTALLATION
32–34	3.25-in. I.D. Hollow Stem Auger	CONTINUED FROM PREVIOUS PAGE	-38.1 / 34.0							
34–45		Dense, wet, dark gray-black, silty SAND with gravel, 15-20% fine, subrounded to subangular gravel up to 3/4 in., 45-55% fine to medium sand, 15-25% non-plastic silt (SM)	-49.1 / 45.0	6	HD	17/24/17/23	41	17/24		
45–51		Loose, wet, dark gray, SILT with sand, 5-10% fine to coarse subrounded gravel up to 1 in., 25-35% fine to medium sand, 65-85% slightly plastic silt, 0-5% organics (shells, roots, etc.) (ML)	-55.1 / 51.0	7	HD	3/3/5/4	8	24/24		
51		Bottom of hole at about 51 ft								

NOTES:

1. Samples taken with 2.5-in. I.D. split-spoon sampler driven with 340-lb hammer.
2. Major soil description same as sample field classification when field classification is not noted.

DRILL RIG: CME-75 mounted on trestle

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A5

Golder Associates

LOGGED: Steve L. Anderson

CHECKED: RCW

DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP191

BORING DATE: Oct. 22-23, 1997
BORING LOCATION: N 2235771.30, E 604309.70

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ / WATER CONTENT, PERCENT (Wp, W, Wl)
0	3.25-in. I.D. Hollow Stem Auger	Compact, wet, black, poorly graded GRAVEL with silt and sand, 40-55% fine to coarse, subrounded to subangular gravel up to 2 in., 35-45% medium to coarse sand, 0-10% non-plastic silt (GP-GM)	-4.1 / 0.0						
5–6		Sample 1 (4.8 ft - 5.8 ft) FIELD DESCRIPTION: Compact, wet, black, poorly graded GRAVEL with silt and sand, 40-50% fine to coarse, subrounded to subangular gravel up to 1.5 in., 35-45% medium to coarse sand, 5-10% non-plastic silt (GP-GM)		1	HD	8/13/13/14	26	12/24	■
10–11		Sample 2 (9.9 ft - 10.2 ft) FIELD DESCRIPTION: Compact, wet, black, poorly graded GRAVEL with sand, 45-55% fine to coarse, subrounded to subangular gravel up to 2 in., 35-40% medium to coarse sand, 0-5% non-plastic silt (GP) (QUESTIONABLE REPRESENTATION)		2	HD	7/7/8/9	15	3/24	■
13		Compact to loose, wet, black, silty SAND with gravel, 0-25% fine subrounded to subangular gravel up to 1/2 in., 50-80% fine to coarse sand, 15-35% non-plastic silt, 0-5% organics (small roots, shells), strong smell, occasional lenses of dark gray non-plastic SILT about 1/4-in. thick (SM)	-17.1 / 13.0						
15–16		Sample 3 (15.1 ft - 16.3 ft) FIELD DESCRIPTION: Compact, wet, black, silty SAND, 65-80% fine sand, 20-35% non-plastic silt, occasional dark gray non-plastic SILT lenses about 1/4-in. thick (SM)		3	HD	4/5/6/7	11	14/24	■ O
20–21		Sample 4 (19.8 ft - 21.0 ft) FIELD DESCRIPTION: Compact, wet, black, silty SAND with gravel, 15-25% fine, subrounded to subangular gravel up to 1/2 in., 50-60% medium to coarse sand, 15-20% non-plastic silt (SM)		4	HD	9/12/10/9	22	14/24	O ■
30–31		Sample 5 (30.1 ft - 32.1 ft) LAB DESCRIPTION: Silty SAND, 10% fine gravel up to 3/4 in., 70% fine to medium sand, 20% fines (SM)		5	HD	4/7/13/11	20	24/24	■O
32		CONTINUED ON NEXT PAGE	-36.1 / 32.0						

DRILL RIG: CME-75 mounted to trestle
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A6

Golder Associates

LOGGED: Steve L. Anderson
CHECKED: RGD
DATE: 12/10/97

PROJECT: COE / Seward Small Boat Harbor / AK

PROJECT LOCATION: Seward, Alaska

PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP191

BORING DATE: Oct. 22-23, 1997

BORING LOCATION: N 2235771.30, E 604309.70

SHEET: 2 OF 3

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV / DEPTH	SAMPLE NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ / WATER CONTENT, PERCENT	PIEZOMETER OR STANDPIPE INSTALLATION
32	3.25-in. I.D. Hollow Stem Auger	CONTINUED FROM PREVIOUS PAGE								
32–55		Compact, wet, black, silty SAND with gravel, 0-25% fine subrounded to subangular gravel up to 1/2 in., 50-80% fine to coarse sand, 15-35% non-plastic silt, 0-5% organics (small roots, shells, etc.), strong smell, occasional dark gray non-plastic SILT lense about 1/4-in. thick (SM)								
40–41.2		Sample 6 (39.9 ft- 41.2 ft) FIELD DESCRIPTION: Loose, wet, black, silty SAND, 0-5% fine subangular gravel up to 1/4 in., 65-75% fine sand, 20-25% non-plastic silt, 0-5% organics (small roots), strong odor (SM)		6	HD	2/3/6/14	9	16/24	■ ○	
50–52		Sample 7 (No recovery)		7	HD	4/9/10/10	19	0/24	■	
55			-59.1 / 55.0							
55–64		Loose to very loose, wet, black, SILT with sand, 0-5% fine subrounded gravel up to 3/8 in., 20-35% fine sand, 70-85% non-plastic silt, occasional lenses at least 4-in. thick of poorly graded SAND with silt, 0-10% fine subangular gravel up to 1/4 in., 75-85% medium to coarse sand, 10-15% non-plastic silt (ML)								
60–62		Sample 8 (60.1 ft - 62.1 ft) FIELD DESCRIPTION: Loose, wet, black, SILT with sand, 20-30% fine sand, 70-80% non-plastic silt, 4-in. lense of poorly graded SAND with silt, 0-10% fine subangular gravel up to 1/4 in., 75-85% medium to coarse sand, 10-15% non-plastic silt (ML and SP-SM)		8	HD	3/3/6/10	9	24/24	■ ○	
64		CONTINUED ON NEXT PAGE	-68.1 / 64.0							

DRILL RIG: CME-75 mounted to trestle

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A6

Golder Associates

LOGGED: Steve L. Anderson

CHECKED: RGD

DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK

PROJECT LOCATION: Seward, Alaska

PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP191

BORING DATE: Oct. 22-23, 1997

BORING LOCATION: N 2235771.30, E 604309.70

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ (20 40 60 80) / WATER CONTENT, PERCENT Wp —O W— Wl (20 40 60 80)	PIEZOMETER OR STANDPIPE INSTALLATION
64	3.25-in. I.D. Hollow Stem Auger	CONTINUED FROM PREVIOUS PAGE										
64–70		Loose to very loose, wet, black, SILT with sand, 0-5% fine subrounded gravel up to 3/8 in., 20-35% fine sand, 70-85% non-plastic silt, occasional lense at least 4-in. thick of poorly graded SAND with silt, 0-10% medium to coarse subangular gravel up to 1/4 in., 75-85% medium to coarse sand, 10-15% non-plastic silt (ML)										
70–72		Sample 9 (70.0 ft - 72.0 ft) ATTERBERG LIMITS: PL = non-plastic LL = non-plastic (ML)			-76.1 / 72.0	9	HD	1/2/2/3	4	24/24	■ O	
72		Bottom of hole at about 72 ft										

NOTES:

1. Samples taken with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.

DRILL RIG: CME-75 mounted to trestle

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A6

Golder Associates

LOGGED: Steve L. Anderson

CHECKED: RGD

DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK

PROJECT LOCATION: Seward, Alaska

PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP192

BORING DATE: Oct. 21-22, 1997

BORING LOCATION: N 2235304.40, E 604343.70

SHEET: 1 OF 3

DATUM: MLLW

BORING METHOD: 3.25-in. I.D. Hollow Stem Auger

DEPTH SCALE FEET	SOIL PROFILE – DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES – NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT (20, 40, 60, 80) / WATER CONTENT, PERCENT (Wp, W, Wl; 20, 40, 60, 80)	PIEZOMETER OR STANDPIPE INSTALLATION
0	Compact, wet, black, poorly graded GRAVEL with sand, 45-55% fine to coarse, subrounded to subangular gravel up to 1 in., 35-55% medium to coarse sand, 0-5% non-plastic silt (GP)			-5.7 / 0.0							
8	Sample 1 (8.1 ft - 8.9 ft) FIELD DESCRIPTION: Compact, wet, black, poorly graded GRAVEL with sand, 45-50% fine subrounded to subangular gravel up to 1 in., 35-45% medium to coarse sand, 0-5% non-plastic silt (GP)				1	HD	6/8/8/14	16	9/24		
13	Sample 2 (13.2 ft - 14.0 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded GRAVEL with sand, 45-55% fine to coarse, subrounded to subangular gravel up to 1 in., 35-45% medium to coarse sand, 0-5% non-plastic silt (GP)				2	HD	5/11/14	25	10/18		
18	Sample 3 (18.1 ft - 19.0 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded GRAVEL with sand or poorly graded SAND with gravel, 45-55% fine to coarse, subrounded to subangular gravel up to 1 in., 45-55% medium to coarse sand, 0-5% non-plastic silt (GP or SP)				3	HD	5/11/9/10	20	11/24		
22	Loose to compact, wet, black-gray, poorly graded SAND, 5-20% fine to coarse subrounded to subangular gravel up to 1 in., 75-95% fine to coarse sand, 0-10% non-plastic silt (SP)			-27.7 / 22.0							
24	Sample 4 (No recovery)				4	HD	3/3/3/3	6	0/24		
27	Sample 5 (27.4 ft - 28.3 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded SAND with gravel, 15-25% fine subangular to angular gravel up to 3/8 in., 75-85% fine to coarse sand, 0-5% non-plastic silt (SP) (QUESTIONABLE RELATIVE DENSITY)				5	HD	?/10/11/12	21	11/24		
32	CONTINUED ON NEXT PAGE			-37.7 / 32.0							

DRILL RIG: CME-75 mounted on trestle

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A7

Golder Associates

LOGGED: Steve L. Anderson

CHECKED: RGD

DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK
PROJECT LOCATION: Seward, Alaska
PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP192

BORING DATE: Oct. 21-22, 1997
BORING LOCATION: N 2235304.40, E 604343.70

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ (20, 40, 60, 80); WATER CONTENT, PERCENT Wp —O^W— Wl (20, 40, 60, 80)	PIEZOMETER OR STANDPIPE INSTALLATION
32		CONTINUED FROM PREVIOUS PAGE										
33–37	3.25-in. I.D. Hollow Stem Auger	Loose to compact, wet, black-gray, poorly graded SAND to poorly graded SAND with silt to poorly graded SAND with gravel, 5-20% fine to coarse subrounded to subangular gravel up to 1 in., 75-95% fine to coarse sand, 0-5% non-plastic silt (SP to SP-SM)										
38–40		Sample 6 (38.3 ft - 39.5 ft) LAB DESCRIPTION: poorly graded SAND with silt, 8% fine to coarse gravel up to 1 in., 83% fine to coarse sand, 9% fines (SP-SM)				6	HD	7/9/11/11	20	14/24	■	
48–50		Sample 7 (47.9 ft - 48.7 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded SAND, 5-10% fine subrounded gravel up to 1/2 in., 90-95% fine to medium sand, 0-5% non-plastic silt (SP)				7	HD	6/10/10/8	20	10/24	■	
58–60		Sample 8 (58.2 ft - 59.0 ft) FIELD CLASSIFICATION: Compact, wet, black, poorly graded SAND with gravel, 15-20% fine subrounded to subangular gravel up to 3/8 in., 75-85% medium to coarse sand, 0-5% non-plastic silt (SP)				8	HD	7/14/16/20	30	9/24	■	
64		CONTINUED ON NEXT PAGE			-69.7 / 64.0							

DRILL RIG: CME-75 mounted on trestle
DRILLING CONTRACTOR: Discovery Drilling
DRILLER: Scott Clinkerbeard

Figure A7

Golder Associates

LOGGED: Steve L Anderson
CHECKED: RGD
DATE: 12/22/97

PROJECT: COE / Seward Small Boat Harbor / AK

PROJECT LOCATION: Seward, Alaska

PROJECT NUMBER: 973-5287x007

RECORD OF BOREHOLE AP192

BORING DATE: Oct. 21-22, 1997

BORING LOCATION: N 2235304.40, E 604343.70

DATUM: MLLW

DEPTH SCALE FEET	BORING METHOD	SOIL PROFILE: DESCRIPTION	ICE BOND	GRAPHIC LOG	ELEV / DEPTH	SAMPLES: NUMBER	TYPE	BLOWS / 6 in	N	REC/ATT	PENETRATION RESISTANCE BLOWS/FT ■ (20 40 60 80); WATER CONTENT, PERCENT Wp —O^W— Wl (20 40 60 80)	PIEZOMETER OR STANDPIPE INSTALLATION
64	3.25-In. I.D. Hollow Stem Auger	CONTINUED FROM PREVIOUS PAGE			-69.7 / 64.0							
65–67		Loose to compact, wet, black-gray, poorly graded SAND to poorly graded SAND with silt to poorly graded SAND with gravel, 5-20% fine to coarse subrounded to subangular gravel up to 1 in., 75-95% fine to coarse sand, 0-5% non-plastic silt (SP to SP-SM)										
68		Sample 9 (No recovery)										
69						9	HD	5/6/8/7	14	0/24	■	
70		Bottom of hole at about 70.2 ft			-75.9 / 70.2							
71		NOTES:										
72		1. Samples taken with 2.5-in. I.D. split-spoon sampler (HD) driven with 340-lb hammer.										
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DRILL RIG: CME-75 mounted on trestle

DRILLING CONTRACTOR: Discovery Drilling

DRILLER: Scott Clinkerbeard

Figure A7

Golder Associates

LOGGED: Steve L. Anderson

CHECKED: RGD

DATE: 12/22/97

EXCERPT FROM

The Great Alaska Earthquake of 1964

COMMITTEE ON THE ALASKA EARTHQUAKE
OF THE
DIVISION OF EARTH SCIENCES
NATIONAL RESEARCH COUNCIL

HUMAN ECOLOGY

NATIONAL ACADEMY OF SCIENCES
WASHINGTON, D.C.
1970

The following report summarizes the work of the scientific and engineering task force that was assigned to evaluate land in the cities damaged by the 1964 Alaska earthquake and to define those areas where reconstruction was inadvisable because of land stability problems. Those parts of the report that pertain to Seward are reproduced here, along with the introductory material.

The task force concluded that the Seward waterfront site (site of the north city waterfront harbor plan) was likely to be unstable in future earthquakes and that no economically feasible means of stabilizing it was known. The 1964 earthquake caused landslides which completely destroyed an extensive dock structure and harbor breakwaters at this site. The task force recommended no repair, rehabilitation, or new construction there using Federal funds, except for grading and light fill. The present use of the waterfront area is generally in keeping with these recommendations.

THE WORK OF THE SCIENTIFIC AND ENGINEERING TASK FORCE

EDWIN B. ECKEL*
U.S. GEOLOGICAL SURVEY

WILLIAM E. SCHAEM
U.S. ARMY CORPS OF ENGINEERS

ABSTRACT: The Scientific and Engineering Task Force, made up of structural engineers, engineering geologists, and seismologists, was an arm of the Federal Reconstruction and Development Planning Commission for Alaska. Its duties were to gather engineering and earth-science information from all available sources, to interpret it, and to define those parts of the earthquake-damaged cities where reconstruction was inadvisable because of land-stability problems. In practice, the Task Force recommendations became binding on all federal agencies involved in reconstruction or in supplying funds for it.

*Now with The Geological Society of America.

For Anchorage, the Task Force produced a series of maps that divided the metropolitan area into various categories of earthquake risk; the reconstruction effort was governed to a large extent by these maps. Similar maps were made for Seward. The recommendations for Homer were considered to be more temporary than those for other towns because it was expected that natural shore processes might, in time, reduce the risks of flooding. For Valdez and Kodiak, the Task Force merely endorsed decisions that had already been made by town and federal officials.

Initial response of federal and local agencies and of the public to recommendations of the Task Force was very largely favorable. These recommendations led, directly or indirectly, to retardation of reconstruction efforts until sound knowledge of land stability could be gained, to relocation of many facilities and of one entire town, to permanent changes in land use by means of extensive urban-renewal projects, and to stabilization of several valuable tracts of land.

The Reconstruction Commission and the Scientific and Engineering Task Force were dissolved 6 months after the earthquake. This action left dangling a series of firm recommendations, with no very clear plans for enforcement and no procedures for adjusting or relaxing restrictions after ground-stablilization measures were effected. In the ensuing period from October 1964 to early 1968, there was a trend toward reducing restraints on land use, particularly in Anchorage, but federal lending agencies at least required that property buyers must be informed as to whether or not their land was considered to be unstable in the event of another severe earthquake.

INTRODUCTION

The prompt and direct application by the federal government of the knowledge of earth scientists and engineers to the problems of reconstruction that resulted from the Alaska earthquake of March 27, 1964, was unique in the history of disasters.

The Scientific and Engineering Task Force, an arm of the Federal Reconstruction and Development Planning Commission for Alaska, was the vehicle for gathering engineering and earth-science information from all available sources, for interpreting it, and for making recommendations to federal agencies on matters that involved the stability of buildings or their foundations. This group became known in Alaska and in Washington as Task Force 9 and is referred to in this paper as the Task Force.

HISTORY AND OBJECTIVES

On April 25, 1964, the Commission's chairman, Senator Clinton B. Anderson, established the Scientific and Engineering Task Force (Task Force 9). The Task Force's recommendations played a significant part in guiding reconstruction decisions in Anchorage, Seward, Homer, Valdez, and Kodiak. Its basic charter was to advise the Commission immediately on the physical parameters in Alaska that should be considered in connection with reconstruction, on the basis of information then available, and to participate in the conduct of a scientific study of the earthquake.

The urgencies of the situation were such that the Task Force had to devote nearly all its energies to the first objective. It did, however, make definite recommendations to the Commission on the need for long-range scientific studies (Federal Reconstruction and Development Planning Commission for Alaska, 1964, p. 54–58), and many of the ideas of its members have borne fruit in the plans for further scientific studies by public and private agencies.

On April 30, 1964, the Task Force established a Field Team to develop and coordinate the execution of specific plans for field studies pertinent to reconstruction and to recommend to the Task Force (and through it to the Commission) those areas suitable for reconstruction. The team was also to establish interim zoning and design criteria to guide construction in this earthquake-prone region.

Both Task Force and Field Team were made up of structural engineers, engineering geologists, and seismologists, drawn from the Corps of Engineers, the U.S. Coast and Geodetic Survey, and the U.S. Geological Survey (Hansen and others, 1966). The Task Force was authorized to use the talents of federal agencies and their consultants as required to augment memberships in both Task Force and Field Team. In compliance with Executive Order 11150, the presidential directive that had established the Commission, the Field Team was also required to work very closely with state, local, and federal representatives in the field.

The Task Force was dissolved on October 6, 1964, at the same time as its parent Commission. The Field Team had already ceased to function as a unit at the conclusion of its final reports of September 8, 1964, on Anchorage and Homer. Individual members of both Task Force and Field Team continued to work intermittently for a few months, responding to queries from various citizens and agencies on the application of the Task Force recommendations.

RESPONSIBILITIES AND METHODS

The principal responsibility that evolved for the Task Force and its Field Team was to make firm recommendations to the Commission and its constituent agencies on where federal funds should or should not be spent for ground stabilization, for repair of damage, or for complete reconstruction or relocation of structures and facilities. Despite this necessary preoccupation with financial matters, members of the Task Force and Field Team kept in mind that the public safety was to be their primary responsibility. For this reason, their recommendations were undoubtedly more conservative than they otherwise might have been.

By the time the Task Force was organized, the Alaska District, Corps of Engineers, had already been designated by the Office of Emergency Planning as the responsible agency for developing most of the basic information that was essential for final recommendations. The closest possible cooperation was necessary between the gatherers and users of basic data—that is, between the Task Force and Field Team on the one hand and the Corps of Engineers and its consultants and contractors on the other. Much of the credit for the friendly cooperation that ensued belongs to Colonel Kenneth T. Sawyer, Alaska District Engineer, and to Warren George, chief, Engineering Division, Alaska District.

The Field Team participated in thorough discussions of the soils-exploration program of the Corps of Engineers when it was being formulated and scheduled with the contractor firm of Shannon and Wilson, Inc. All suggestions and requests made by the Field Team were accepted by the District Engineer, and the contractor was given the responsibility for carrying them out.

In its series of recommendations on parts of Anchorage, the Field Team adhered to a rigid schedule that paralleled the Corps of Engineers' schedule of reports on soils investigations compiled by Shannon and Wilson, Inc. (1964a). By

U.S. Army Corps of Engineers

FIGURE 1 Opening cage after emerging from calyx hole. Many such test holes were drilled in the Anchorage area to study subsurface soil conditions.

joint decision of the Commission, the Alaska District Engineer, and the contractor, the results of the soil program were reported in segments and on specified dates (Plate 1).

After each initial presentation, the Field Team usually met with Corps of Engineers personnel, and generally with one or more of the Corps consultants, to discuss the matter more fully and to translate the findings of the soil-exploration program, first into a set of official engineering decisions by the District Engineer and finally into a map that divided the area under study into various categories of earthquake risk; the reconstruction effort was to be governed to a large extent by this map. At this point the Field Team drew on the specialized knowledge of its own members or on the knowledge of their colleagues who were engaged in field studies sponsored by the parent organizations. The Field Team also used extensively the facts accumulated earlier by the Engineering Geology Evaluation Group (1964), under the leadership of Dr. Lidia Selkregg, a geologist with the Alaska State Housing Authority. This group, organized by the Housing Authority and the City of Anchorage on Sunday, March 29, 1964, to outline the immediate course of action, consisted of all available geologists, engineering geologists, and soil scientists. They had mapped the entire earthquake area and obtained aerial photographs of the damage. They had also measured all observable vertical and horizontal displacements and had indicated them, together with other pertinent information, on maps. Their preliminary report was issued on April 14, 1964, and the final version appeared on May 8, 1964.

For each segment of the investigation, the final recommendations and risk maps thus represented the combined judgment of a large group of scientists and engineers, each of whom was a specialist in one or more facets of the immediate problem. The Task Force, which presented the recommendations to the Commission for approval, and the Field Team, which reported the final decisions to city officials and to the public, necessarily assumed primary responsibility for their validity.

In conference with the Alaska District Engineer, his staff, and consultants to the Corps of Engineers, the Field Team drafted the proposed press notices, which were then cleared by the Task Force in Washington, which in turn obtained the approval of the Federal Reconstruction Commission. This approval constituted a firm policy decision by the federal government that applied to all agencies involved in financing the reconstruction efforts.

When Commission approval of a set of recommendations reached Anchorage, the Alaska District Engineer, his staff, and the Field Team met with the mayor and other city and state officials; representatives of all local news media were invited. The District Engineer explained the recent findings of the soil-exploration program (Figure 1), and the chairman of the Field Team explained the Task Force recommendations that had been adopted by the Commission. Copies of the press notices and maps, issued jointly by the Task Force and the Corps of Engineers, were then distributed. The conferences provided ample opportunity for questions, discussion, explanation of details, and expressions of opinion. As a general rule, the Anchorage City Council met shortly after the close of the press conference to make its own decisions concerning the impact of the Task Force recommendations on the city's activities.

Structural engineers recognized very early after the earthquake that, except in the areas of ground failure, those structures designed and constructed in accordance with sound criteria for seismic areas generally withstood the temblor without major damage. The Task Force, therefore, tended to ignore seismic damage to specific structures and to concentrate on problems of land stability—on determining which parts of the several cities were unstable or might be made so by another great earthquake. The Task Force believed that decisions to rebuild or to raze specific damaged structures—so long as they stood on stable ground—were the responsibility of city officials and of private engineers and architects. The responsibilities of the Task Force were more general and were in part discharged by their continual stress on the recommendation that the construction of all new buildings or the reconstruction of earthquake-damaged structures must be in strict conformity with the requirements (Figure 2) of the latest edition of the Uniform Building Code for Seismic Zone 3 (International Conference of Building Officials, 1964).

BOUNDARIES OF ACTIVITIES

The Task Force was concerned almost exclusively with the land-stability and reconstruction problems of Anchorage, Seward, Valdez, Homer, and, to a lesser degree, of Kodiak. Many other towns and cities had also been severely damaged, but the damage was not of a nature that called for the special skills or knowledge of Task Force members in assessing it or in planning reconstruction. Damage by waves or fire was due to transitory causes; for this type of damage the Task Force could only encourage long-range studies aimed at better prediction of earthquakes and of their effects, including tsunamis. Cordova, which had been affected by tectonic uplift and consequent withdrawal of the sea, sustained great losses. So did towns like Kodiak, where tectonic downdrop and sea waves drowned port facilities and much of the town. Because of our present inability to predict earthquakes and their tectonic effects, such changes in land and sea level can only be considered as permanent or semipermanent in terms of human time. Reconstruction had to be planned and conducted on this basis with little or no interpretation of local geologic or seismic conditions.

The Task Force also played only a small part in reconstruction plans for airports, railroads, and highways. These facilities were separately funded, largely by the federal government, so there was little need for recommendations from the Task Force. Only at Seward and Anchorage,

U.S. Army Corps of Engineers

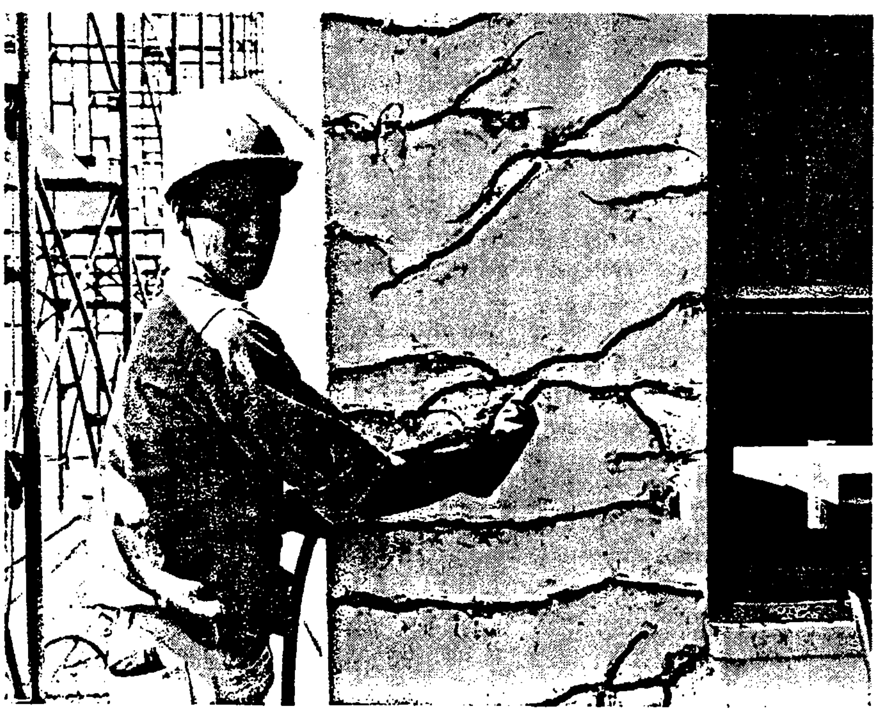


FIGURE 2 In some instances, cracks in buildings were filled with pressurized injections of epoxy resin, which literally glued the building back together.

where The Alaska Railroad's reconstruction problems were linked inextricably with those of the cities, did the Task Force and the Field Team act as advisors to railroad officials.

TASK FORCE RECOMMENDATIONS

SEWARD

The Task Force made two sets of recommendations on Seward to the Commission; these recommendations were based on visits to the town by Field Team members, on informal detailed geologic reports to the Field Team by Richard W. Lemke of the U.S. Geological Survey (Lemke, 1967), and on a soils report to the Corps of Engineers by Shannon and Wilson, Inc. (1964b).

The first report, released on July 17, 1964, dealt with the suburban subdivisions of Clearview and Forest Acres and the Eads site at Lowell Point. The Corps of Engineers was not involved in exploration in these areas. The recommendations were made by the Field Team and the Task Force, with only informal consultation with the Corps of Engineers officials.

The Clearview and Forest Acres subdivisions were classified in two categories: *nominal risk*, in which the hazards from another earthquake were considered no greater than are normally expected in the construction industry, and *limited risk*. This latter classification included the land that had been strongly fractured by the earthquake. Within such areas, it was recommended that all new foundations be of reinforced concrete and that all concrete or masonry work be reinforced and interconnected. On the basis of Lemke's findings that Lowell Point had incurred damage from waves only, and not from ground fractures or submarine slides, that area, where the building of a marine way was planned, was placed in the nominal-risk category.

Recommendations on Seward proper were made in a joint Corps of Engineers and Task Force report, released to the mayor of Seward on July 24, 1964.

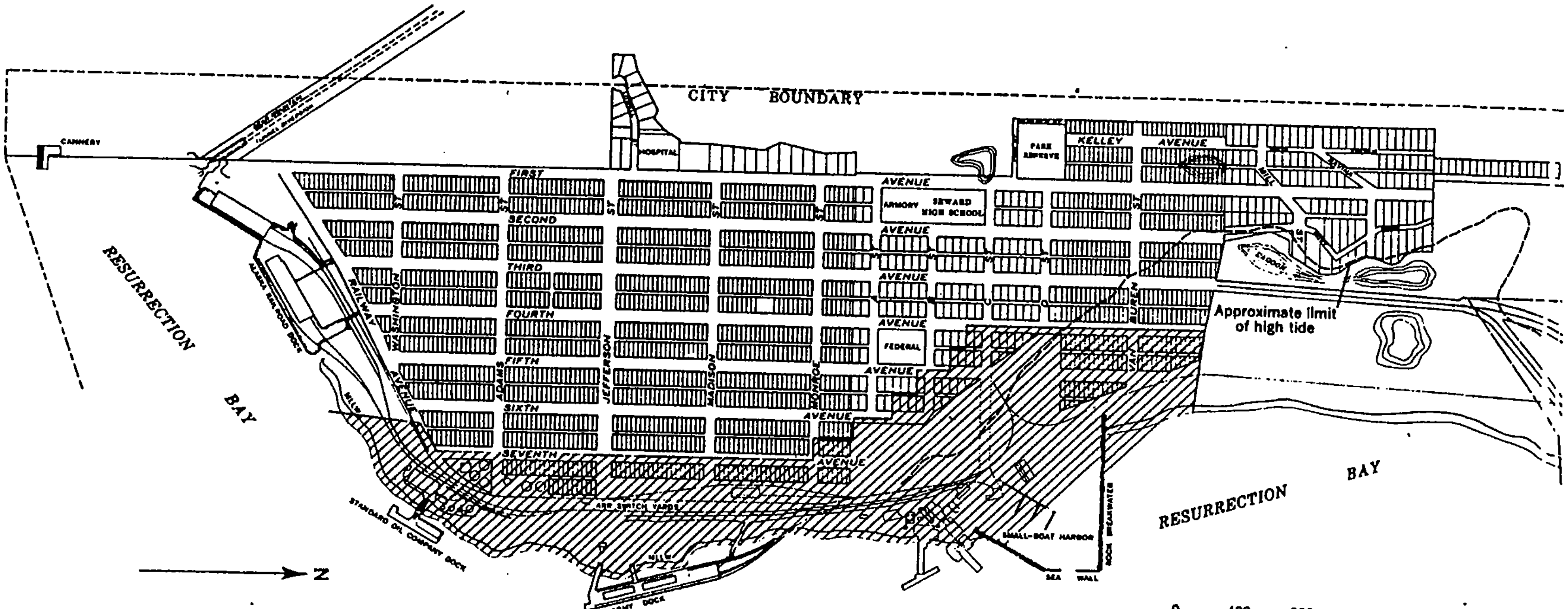
The greater part of Seward was classified as nominal risk, with consequent eligibility for federal aid, provided that the current Uniform Building Code for Seismic Zone 3 was followed in all design and construction work. The waterfront area, carefully defined in detail on the map (Figure 5), was classed as high risk, and the firm recommendation was made that it be reserved for parks or other uses that do not involve large congregations of people. The waterfront land within the high-risk line was fractured and weakened as a result of the submarine landslides that destroyed the Seward dock facilities, and the Field Team and Corps of Engineers believed that another severe earthquake might cause further submarine sliding within the high-risk area. The high-risk line was based partly on the distribution of visible earth fractures, but more on the differences in the type and structure of the underlying geologic materials.

AFTERMATH

The abrupt early termination of the Reconstruction Commission and its task forces served to relax or remove the pressures of federal dictation and control as soon as practicable, freeing the people of Alaska to shoulder most of their own burdens in their own way. On the other hand, it left dangling a series of firm Task Force 9 recommendations with no very clear plans for enforcement. No procedures had been set up for adjusting the recommendations or of relaxing restrictions after ground-stabilization measures are effected. The status of the various recommendations and stabilization measures, as known early in 1968, is reviewed in the following paragraphs. (Much of this information was supplied by public officials to Miss Janet Archibald of the Anchorage *Daily News*, who kindly compiled it for the writers.)

SEWARD

All the waterfront area of Seward that was classified as high risk by Task Force 9 became the site of an urban renewal project. The letter and spirit of the original classification was closely followed in the urban renewal development plan, and the need to consider reexamination or reclassification of any of the Seward lands did not arise.



EXPLANATION

Nominal-risk area

Little likelihood of landslides except for small slumps, largely in artificial fill. In all other respects risks are no greater than is normally expected in the construction industry. Current Uniform Building Code for Seismic Zone 3 applies both to new buildings and to plans for rehabilitation of earthquake-damaged structures

High-risk area

Land considered unstable, particularly in event of future earthquakes; no economically feasible means of stabilization known. No repair, rehabilitation, or new construction involving use of Federal funds is recommended, except for grading and light fill

MLLW — **Mean lower low water line**

U.S. Geological Survey

FIGURE 5 Map showing nominal-risk and high-risk areas of a part of Seward; released to Seward city officials on July 25, 1964, by the Scientific and Engineering Task Force.

CONCLUSION

By the fourth anniversary of the earthquake, the Task Force recommendations as to risk classification had met with a wide range of acceptance and treatment. There were differences even among federal agencies but in general these agencies had tended to adhere to the letter and spirit of the recommendations at least until changed conditions or new information on local situations made it desirable to lift or tighten restrictions. Local governments and private citizens, on the other hand, showed a natural tendency to fight, avoid, or ignore the restraints that had been imposed by the Task Force.

These differences in reaction to restraints are understandable and expectable. It is normal human behavior not only to try to forget a disaster once reconstruction has taken place but to disbelieve that similar disasters can recur. These human traits place the added burden of responsibility on public officials of protecting people against themselves.

The high-risk lines and accompanying restrictions recommended by the Task Force, in recognition of this responsibility, were aimed not at the 1964 earthquake but at future earthquakes that may strike Alaskan towns.

The primary purpose of the federal government was to help Alaska repair the damage caused on March 27, 1964. In following the Task Force recommendations the federal government also committed itself to providing a very considerable measure of protection for life and property against future disasters. The trend in early 1968 appeared to be toward reducing this protection to provide no more than warnings to property buyers.

In retrospect, it seems that the government's responsibilities might have been better reinforced had some official machinery been provided for maintaining some high-risk restrictions indefinitely and for removing or relaxing others as and when land-stabilization measures were taken or new information became available.

The form that such machinery might have taken is open to debate but perhaps the Office of Emergency Planning, which inherited all responsibilities of the Reconstruction and Development Planning Commission for Alaska, might have been given the specific duty of monitoring and altering risk classifications. A continuing advisory committee, perhaps including geologists, engineering seismologists, soils and structural engineers, and economists, might have been organized to make firm recommendations to the OEP, based on the Committee's own knowledge or on the work of its consultants. Whatever the exact form of machinery that may be adopted for this facet of government participation in future disaster relief, it cannot be too strongly urged that the federal government provide for continuous surveillance, at least until all problems of land use have been resolved.

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THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE FEASIBILITY STUDY, DATED: 1998

PROJECT: HARBOR IMPROVEMENTS - Alt#2 - South Uplands
LOCATION: SEWARD, ALASKA

DISTRICT: ALASKA
P.O.C.: FRANK ANTOLIN, CHIEF, CE

ACCOUNT NUMBER	FEATURE DESCRIPTION		CURRENT MCACES ESTIMATE PREPARED: 29 Jun 98 EFFECTIVE PRICING LEVEL: 01 Jan 98 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: FY2001 EFFECT. PRICING LEVEL: 1 Oct 2000 COST ($K)	CNTG ($K)	TOTAL ($K)	FULLY FUNDED ESTIMATE FEATURE COST ($K)	MID PT: Oct 2001 CNTG ($K)	FULL ($K)
C-10-01	MOB DEMOB & PREWORK		$466	$70	15%	$536	$500	$75	$575	$513	$77	$590
C-10-06	BREAKWATERS & SEAWALLS		$2,507	$501	20%	$3,008	$2,688	$538	$3,226	$2,758	$552	$3,310
C-12-02	NAVIGATION, PORTS & HARBORS		$5,738	$1,148	20%	$6,886	$6,153	$1,230	$7,383	$6,313	$1,262	$7,575
	TOTAL CONSTRUCTION COSTS =====>		$8,711	$1,719	20%	$10,430	$9,341	$1,843	$11,184	$9,584	$1,891	$11,475
P-01---	LANDS AND DAMAGES		$45	$5	11%	$50	$48	$5	$53	$49	$5	$54
P-30-02	PLANNING, ENGINEERING, DESIGN	6.7%	$586	$29	5%	$615	$629	$31	$660	$645	$31	$676
P-31-02	CONSTRUCTION MANAGEMENT	8.9%	$776	$39	5%	$815	$832	$42	$874	$853	$43	$896
	TOTAL OWNER COSTS==========>		$1,407	$73	5%	$1,480	$1,509	$78	$1,587	$1,547	$79	$1,626
	TOTAL PROJECT COSTS =========>		**$10,118**	**$1,792**	**18%**	**$11,910**	**$10,850**	**$1,921**	**$12,771**	**$11,131**	**$1,970**	**$13,101**

THIS TPCS REFLECTS A PROJECT COST CHANGE OF $ ~~~~~ ~~~~~~~~~

THE MAXIMUM PROJECT COST IS =======> $ ~~~~~ ~~~~~~~~~

TOTAL FEDERAL SHARED COSTS === 41% $5,309

TOTAL NON-FEDERAL COSTS ======= 59% $7,792

DISTRICT APPROVED:

[signature] CHIEF, COST ENGINEERING

[signature] CHIEF, REAL ESTATE

[signature] CHIEF, PLANNING

[signature] CHIEF, ENGINEERING

For [signature] CHIEF, CON-OPS

[signature] PROJECT MANAGER

[signature] DDE (PM)

DIVISION APPROVED:

____________ CHIEF, COST ENGINEERING

____________ DIRECTOR, REAL ESTATE

____________ CHIEF, PROGRAMS MANAGEMENT

____________ DIRECTOR OF PPMD

APPROVED DATE: ____________

CONTRACT A - FEDERAL SHARED

**** TOTAL CONTRACT COST SUMMARY ****

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE PLAN & SPECS, DATED: Mar 98, Revised Jun 98

PROJECT: HARBOR IMPROVEMENTS - Alt#2 - South Uplands
LOCATION: SEWARD, ALASKA

DISTRICT: ALASKA
P.O.C.: FRANK ANTOLIN, CHIEF, CE

ACCOUNT NUMBER	FEATURE DESCRIPTION	CURRENT MCACES ESTIMATE PREPARED: 29 Jun 98, EFFECTIVE PRICING LEVEL: 01 Jan 98 COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	AUTHORIZ./BUDGET YEAR: FY2001, EFFECT. PRICING LEVEL: 1 Oct 2000 OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	........FULLY FUNDED ESTIMATE........ CWCCIS - 27 Mar 98 EATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
C-10-01	MOB DEMOB & PREWORK	$466.	$70	15%	$536	7.2%	$500	$75	$575	Oct 2001	2.6%	$513	$77	$590
C-10-06	BREAKWATERS & SEAWALLS	$2,507	$501	20%	$3,008	7.2%	$2,688	$538	$3,226	Oct 2001	2.6%	$2,758	$552	$3,310
C-12-01	ENTRANCE CHANNEL	$374	$75	20%	$449	7.2%	$401	$80	$481	Oct 2001	2.6%	$411	$82	$493
	TOTAL CONSTRUCTION COSTS =====>	$3,347	$646	19%	$3,993		$3,589	$693	$4,282			$3,682	$711	$4,393
P-01--- 0.9%	LANDS AND DAMAGES	$30	$3	10%	$33	7.2%	$32	$3	$35	Oct 2001	2.6%	$33	$3	$36
P-30-02	PLANNING, ENGINEERING, DESIGN 8.5%	$286	$14	5%	$300	7.2%	$307	$15	$322	Oct 2001	2.6%	$315	$15	$330
P-31-02	CONSTRUCTION MANAGEMENT 14.2%	$476	$24	5%	$500	7.2%	$510	$26	$536	Oct 2001	2.6%	$523	$27	$550
	TOTAL COSTS ==================>	$4,139	$687	17%	$4,826		$4,438	$737	$5,175			$4,553	$756	$5,309

CONTRACT B - NON-FEDERAL **** TOTAL CONTRACT COST SUMMARY ****

THIS ESTIMATE IS BASED ON THE SCOPE CONTAINED IN THE PLAN & SPECS, DATED: Mar 98, Revised Jun 98

PROJECT: HARBOR IMPROVEMENTS - Alt#2 - South Uplands
LOCATION: SEWARD, ALASKA

DISTRICT: ALASKA
P.O.C.: FRANK ANTOLIN, CHIEF, CE

		CURRENT MCACES ESTIMATE PREPARED: 29 Jun 98 EFFECTIVE PRICING LEVEL: 01 Jan 98				AUTHORIZ./BUDGET YEAR: FY20 EFFECT. PRICING LEVEL: 1 Oct 2000				........FULLY FUNDED ESTIMATE........ CWCCIS - 27 Mar 98				
ACCOUNT NUMBER	FEATURE DESCRIPTION	COST ($K)	CNTG ($K)	CNTG (%)	TOTAL ($K)	OMB (%)	COST ($K)	CNTG ($K)	TOTAL ($K)	EATURE MID PT	OMB (%)	COST ($K)	CNTG ($K)	FULL ($K)
C-12	MOB DEMOB & PREWORK	$0	$0	15%	$0	7.2%	0	0	0	Oct 2001	2.6%	0	0	0
C-12-02	ADJACENT UPLANDS	$370	$74	20%	$444	7.2%	$397	$79	$476	Oct 2001	2.6%	$407	$81	$488
C-12-05	MOORING BASIN	$819	$164	20%	$983	7.2%	$878	$176	$1,054	Oct 2001	2.6%	$901	$181	$1,082
C-12-08	INNER HARBOR	$3,839	$768	20%	$4,607	7.2%	$4,117	$823	$4,940	Oct 2001	2.6%	$4,224	$844	$5,068
C-12-09	POWER, LIGHT & WATER	$317	$63	20%	$380	7.2%	$340	$68	$408	Oct 2001	2.6%	$349	$70	$419
C-12-04	HYDROGRAPHIC SURVEY	$19	$4	20%	$23	7.2%	$20	$4	$24	Oct 2001	2.6%	$21	$4	$25
	TOTAL CONSTRUCTION COSTS =====>	$5,364	$1,073	0%	$6,437		$5,752	$1,150	$6,902			$5,902	$1,180	$7,082
P-01---	LANDS AND DAMAGES	$15	$2	13%	$17	7.2%	$16	$2	$18	Oct 2001	2.6%	$16	$2	$18
P-30-01	PLANNING, ENGINEERING, DESIGN 5.6%	$300	$15	5%	$315	7.2%	$322	$16	$338	Oct 2001	2.6%	$330	$16	$346
P-31-01	CONSTRUCTION MANAGEMENT 5.6%	$300	$15	5%	$315	7.2%	$322	$16	$338	Oct 2001	2.6%	$330	$16	$346
	TOTAL COSTS =================>	$5,979	$1,105	18%	$7,084		$6,412	$1,184	$7,596			$6,578	$1,214	$7,792

Seward SBH, South Upland
Seward, Alaska Alt#2

Y:/CIV/SBH/SEW013/FEASIBIL/
REVISED/ALT-2R

Designed By: CENPA-EN-CW-HH
Estimated By: CENPOA

Prepared By: Al Arruda

Preparation Date: 06/22/98
Effective Date of Pricing: 10/01/97
Est Construction Time: 180 Days

Sales Tax: 0.00%

M C A C E S f o r W i n d o w s

Release 1.2

41 04

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
10 Breakwaters and Seawalls								
10_ 1 Mob, Demob & Preparatory Work		370,660	37,251	20,396	32,765	4,455	465,527	
TOTAL Mob, Demob & Preparatory Work		370,660	37,251	20,396	32,765	4,455	465,527	
10_ 2 Breakwater Removal								
10_ 2. 1 Armor Rock Removal	10700 BCY	22,127	2,224	1,218	1,956	266	27,790	2.60
10_ 2. 2 Core Rock Removal	30000 BCY	62,038	6,235	3,414	5,484	746	77,916	2.60
TOTAL Breakwater Removal	1575.00 LF	84,165	8,459	4,631	7,440	1,012	105,706	67.12
10_ 3 Breakwater Construction								
10_ 3. 5 East Harbor Breakwater	63800 BCY	1,573,569	158,144	86,586	139,100	18,912	1,976,309	30.98
10_ 3.10 Entrance Gap Breakwater	11100 BCY	57,853	5,814	3,183	5,114	695	72,660	6.55
10_ 3.15 South Berm Armor	6100.00 BCY	236,274	23,746	13,001	20,886	2,840	296,746	48.65
TOTAL Breakwater Construction	2030.00 LF	1,867,696	187,703	102,770	165,100	22,447	2,345,716	1155.52
10_04 Navigation Foundation	2.00 EA	8,000	804	440	707	96	10,048	5023.76
10_05 Hydrographic Survey	3.00 EA	36,000	3,618	1,981	3,182	433	45,214	15071
TOTAL Breakwaters and Seawalls		2,366,521	237,835	130,218	209,195	28,442	2,972,210	
12 Navigation Ports & Harbors								
12_ 1 Ent. Channel								
12_ 1.2 Ent. Channel Dredging	93600 BCY	289,599	29,105	15,935	25,600	3,480	363,719	3.89
12_ 1.5 Ent. Channel Slope Armoring	3650.00 BCY	7,853	789	432	694	94	9,863	2.70
TOTAL Ent. Channel	244000 SF	297,452	29,894	16,367	26,294	3,575	373,582	1.53
12_ 2 Adj. Upland Fill Area								
12_ 2. 5 Upland Fill Area Protection Berm	28000 BCY	294,767	29,624	16,220	26,057	3,543	370,209	13.22
TOTAL Adj. Upland Fill Area	218317 SF	294,767	29,624	16,220	26,057	3,543	370,209	1.70
12_ 4 Hydrographic surveys	2.00 EA	15,000	1,508	825	1,326	180	18,839	9419.56
12_ 5 Mooring Basin								

4 07

	QUANTY UOM	DIRECT	FIELD OH	HOME OFC	PROFIT	BOND	TOTAL COST	UNIT
12_ 5. 5 Mooring Basin Dredging	210900 BCY	652,300	65,556	35,893	57,662	7,840	819,251	3.88
TOTAL Mooring Basin	440000 SF	652,300	65,556	35,893	57,662	7,840	819,251	1.86
12_ 8 Harbors (Inner Harbor Develop.)		3,839,203	0	0	0	0	3,839,203	
12_ 9 Harbors, Power, Lights & Water		317,008	0	0	0	0	317,008	
TOTAL Navigation Ports & Harbors		5,415,730	126,582	69,305	111,339	15,137	5,738,092	
TOTAL Seward SBH, South Upland		7,782,251	364,417	199,523	320,533	43,579	8,710,303	

Assessment of Non-Federal Sponsor's
Real Estate Acquisition Capability

Sponsor: *CITY OF SEWARD* Project: *Boat Harbor Project*

I. <u>Legal Authority</u>:

a. Does the sponsor have legal authority to acquire and hold title to real property for project purposes? *Yes. As a Home Rule city, Seward has legal authority by State statutes to acquire and hold title to real property.*

b. Does the sponsor have the power of eminent domain for this project? *Yes, by statute.*

c. Does the sponsor have "quick-take" authority for this project? *Yes.*

d. Are any of the lands/interests in land required for the project located outside the sponsor's political boundary? *No, all project lands are contained within the City's municipal boundaries.*

e. Are any of the lands/interests in land required for the project owned by an entity whose property the sponsor cannot condemn? ~~*No,*~~ YES *The city cannot condemn Alaska Railroad Corporation tidelands, however these lands will not be required* for Federal portion of proj *since they are subject to the Federal right of navigational servitude.*

II. <u>Human Resource Requirements</u>:

a. Will the sponsor's in-house staff require training to become familiar with the real estate requirements of Federal projects including PL 91-646, as amended? *Yes, although no PL 91-646 acquisitions or relocations are anticipated.*

b. If the answer to II.a. is yes, has a reasonable plan been developed to provide such training? *Yes. Discussion has already begun and materials have been provided.*

c. Does the sponsor's in-house staff have sufficient real estate acquisition experience to meet its responsibilities for the project? *The City has in-house staff with extensive real estate management experience. The District Real Estate staff, as always, will assist as much as possible.*

d. Is the sponsor's projected in-house staffing level sufficient considering its other work load, if any, and the project schedule? *Yes.*

e. Can the sponsor obtain contractor support, if required, in a timely fashion? *Yes, with the support of the District Real Estate Division.*

f. Will the sponsor likely request USACE assistance in acquiring real estate? *No.*

III. <u>Other Project Variables</u>:

a. Will the sponsor's staff be located within reasonable proximity to the project site? *Yes.*

b. Has the sponsor approved the project/real estate schedule/milestones? *Specific dates for the project schedule have not been finalized, although the schedule is expected to allow one month to complete real estate certification (no acquisition is anticipated). The general schedule for real estate has been discussed with the City and they concur.*

IV. <u>Overall Assessment</u>:

a. Has the sponsor performed satisfactorily on other USACE projects? *Yes, the existing harbor was constructed under local coop with the city.*

b. With regard to this project, the sponsor is anticipated to be: highly capable/ ***<u>fully capable/</u>*** moderately capable/ marginally capable/ insufficiently capable.

V. <u>Coordination</u>:

a. Has this assessment been coordinated with the sponsor? *The undersigned has been in telephone contact with the City to review these questions and discuss the issues and responses.*

b. Does the sponsor concur with this assessment? *Yes.*

Source:
Tylan Schrock
City of Seward
Telephone: (907) 224-3331
FAX: 224-4038

Prepared by:

[signature] 4/13/98
Douglas B. Trosper, Appraiser

Reviewed/approved by:

[signature]
Dennis E. Klein
Chief, Real Estate Division

Real Property Interests

The reconnaissance report for this project was completed in July 1996. The proposed project will modify the existing Seward Harbor, which was previously constructed in 1965 under local cooperation with the City of Seward. The general navigation features of the proposed project include partial removal of existing breakwaters, construction of a new breakwater and an entrance channel. A temporary staging area and disposal areas will be required during construction of the general navigation features. The Federal Government owns lands underlying the existing harbor, which currently are in the process of being re-conveyed to the city. The Federal property boundary in relation to the proposed project is identified on the real estate map at Exhibit __.

The City of Seward, as sponsor, will provide all lands necessary for the project (Alternative 2). The upland requirements anticipated for the Federal portion of the project will be a temporary two year work area easement for a 0.4 acre parcel currently owned in fee by the sponsor. There is no significant commercial mineral activity in the area that would adversely impact the project or acquisition process. Lands needed for the breakwater, entrance channel, disposal areas, and a portion of the staging area lie below mean high water and are subject to the Federal right of navigation servitude. No PL 91-646 relocations are anticipated. Public access is currently available to the project site. No relocations of public facilities or utilities are anticipated.

Table I – ***Land interests required for essential portions of project***

Federal Portions of the Project:

Feature	Acres	Owner	Interest	
Staging Area (Above MHW)	0.4	City of Seward	Temporary Easement Standard Estate #15	
Staging Area (Below MHW/ Tidelands)	2.5	City of Seward, Alaska Railroad/ Suneel	Navigation Servitude	
Entrance Channel (Below MHW)	6.2	Corps of Engineers City of Seward	Navigation Servitude	GNF
Breakwaters (Below MHW)	6.1	City of Seward, Alaska Railroad, Corps of Engineers	Navigation Servitude	GNF
Disposal Areas (Below MHW)	5.0	City of Seward, Corps of Engineers, State of Alaska	Navigation Servitude	

Non-Federal Portions of the Project:

Feature	Acres	Owner	Interest
Mooring Basin (Below MHW/ Tidelands)	11.7	City of Seward Alaska Railroad/Suneel, Corps of Engineers	Perpetual Easement
Disposal Areas (Below MHW)	5.0	City of Seward, Alaska Railroad/Suneel, Corps of Engineers	Temporary Easement

*GNF = General Navigation Features (Federal portions of project)

Table II – *Real estate costs*

Federal Portions of the Project:

Item	Federal	Local	Subtotal	Total
Administration	$7,500	$ 2,500	$10,000	
Lands	-0-	$20,000	$20,000	$30,000

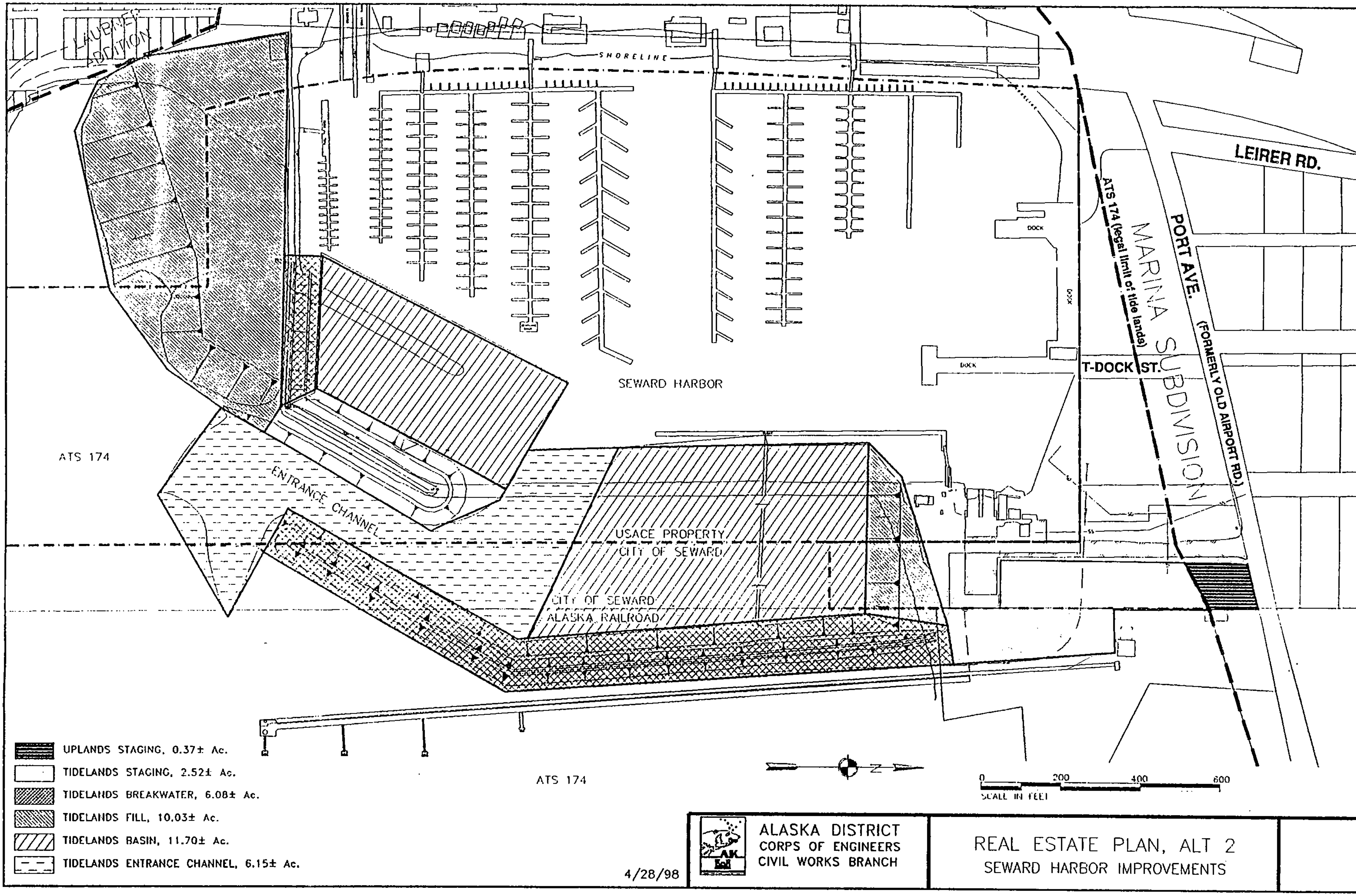
Non-Federal Portions of the Project:

Item	Federal	Local	Subtotal	Total
Administration	-0-	$ 5,000	$ 5,000	
Lands	-0-	$10,000	$10,000	$15,000

Table III – *Real estate milestones (Federal Portions of Project)*

Activity	COE Initiate – Complete	LS Initiate – Complete
1. Receipt of final drawings from Engineering/Project Manager	5/99	
2. Execution of PCA	5/99	
3. Formal transmittal of final ROW drawings to LS and instruction to acquire LER	5/99 ---- 6/99	
4. Mapping, legal descriptions, title evidence		6/99 ---- 6/99
5. Conduct negotiations & closing (N/A)		
6. Certify all necessary LER is available for construction	7/99	
7. Submit credit requests		8/99 --- 10/99
8. Review & approve or deny credit requests	9/99 ---- 11/99	

The Assessment of the City of Seward (Non-Federal Sponsor) Real Estate Acquisition Capability is at Appendix _.


LEIRER RD.
PORT AVE.
(FORMERLY OLD AIRPORT RD.)
MARINA SUBDIVISION
ATS 174 (legal limit of tide lands)
T-DOCK ST.
DOCK
SHORELINE
SEWARD HARBOR
ATS 174
ENTRANCE CHANNEL
USACE PROPERTY
CITY OF SEWARD
CITY OF SEWARD
ALASKA RAILROAD
ATS 174
N
0
200
400
600
SCALE IN FEET
UPLANDS STAGING, 0.37± Ac.
TIDELANDS STAGING, 2.52± Ac.
TIDELANDS BREAKWATER, 6.08± Ac.
TIDELANDS FILL, 10.03± Ac.
TIDELANDS BASIN, 11.70± Ac.
TIDELANDS ENTRANCE CHANNEL, 6.15± Ac.
4/28/98
ALASKA DISTRICT
CORPS OF ENGINEERS
CIVIL WORKS BRANCH
REAL ESTATE PLAN, ALT 2
SEWARD HARBOR IMPROVEMENTS

Attachment A-1

Agenda Statement

Meeting Date: Nov. 28, 1994

From: City Manager Tyler Jones TJ

Agenda Item: Resolution 94-205
Termination of Nash Road Small Boat Harbor Development Agreement

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BACKGROUND & JUSTIFICATION:

A development agreement for the Nash Road Small Boat Harbor was approved by the City Council Feb. 14, 1994. The agreement authorized Al Schafer and Afognak Logging to pursue development of the long-sought boat harbor with conditions and with commitments from the City of Seward.

As Council knows very well, Mr. Schafer developed his project Master Plan and worked to respond to Council comments on it. The primary obstacle impeding further progress of the project and Mr. Schafer's plan was a requirement in the development agreement that Mr. Schafer obtain written consent from adjacent property holders. The absence of such consent from the adjacent and most significantly impacted property holder causes termination of the agreement under Section 2.4(B).

Council has been willing to be flexible concerning timing requirements. However, since an agreement was not reached by Mr. Schafer and the impacted adjacent property holder, and since both have indicated a reluctance to initiate or pursue further any mutually agreeable resolution(s), formal termination of the Nash Road Boat Harbor DevelopmentAgreement is in order.

The administration worked closely with all parties and their respective consultants to bring the adjacent property holders to a meeting of the minds. We enjoyed considerable community interest and support in this endeavor and we are confident that future Nash Road boat harbor proposals will come forth due in part to the work done recently.

While it is regrettable that the parties were unable to arrive at an accommodation, much has been gained by this exercise. We now have in the public domain a well-reviewed project Master Plan. We have received comments from engineers, architects and planners concerning the plan and we have preliminary engineering information on project utilities.

RECOMMENDATION: Council approval of Resolution 94-205 terminating the Nash Road Small Boat Harbor Development Agreement.

Ordinance No. 94-54, repealing SCC §7.05.125, approval as to form by city attorney, was introduced and public hearing was set for December 12, 1994;

Ordinance No. 94-55, amending SCC §8.20.010, vehicles for hire, was introduced and public hearing was set for December 12, 1994;

Resolution No. 94-204, appropriating funds from retained earnings for construction of the Nash Road 12.5 KV Distribution Feeder, was approved;

Resolution No. 94-205, terminating the Nash Road Small Boat Harbor Development Agreement, was approved;

Resolution No. 94-206, approving the purchase of materials for construction of exterior floats for the northeast harbor launch ramp, was approved; and

Resolution No. 94-208, approving a settlement agreement between the city and J. W. T. Anderson, was approved.

BOROUGH ASSEMBLY REPORT

Kenai Peninsula Borough Assembly Member Michael Wiley gave a verbal report of the last three assembly meetings. He noted that the assembly was considering sales tax exemptions for air taxi businesses, child care centers and long term leases.

SPECIAL ORDERS AND PUBLIC HEARINGS

Ordinance No. 94-41, amending SCC §15.10.415.D regarding remands of appeals to the board of adjustment that allege new evidence

Carol Giles explained that this would streamline the procedure on appeals by allowing administrative remand of a matter that included new evidence to the Planning and Zoning Commission rather than bringing it before Council as the Board of Adjustment.

Notice of public hearing as posted and published as required by law was noted, and the public hearing was opened. No one appeared in order to be heard, and the public hearing was closed.

MOTION (Sieminski/Deeter) **Enact Ordinance No. 94-41.**

Motion Passed. **Unanimous**

Ordinance No. 94-42, amending SCC §3.15.060, overtime

CITY OF SEWARD
P.O. BOX 167
SEWARD, ALASKA 99664-0167

- Main Office (907) 224-4050
- Police (907) 224-3338
- Harbor (907) 224-3138
- Fire (907) 224-3445
- Fax (907) 224-4038

June 9, 1998

Col. Sheldon L. Jahn
Commander & District Engineer
U.S. Army Corps of Engineers, Alaska District
P.O. Box 898
Anchorage, AK 99506-0898

Dear Mr. Jahn:

Attached is our Statement of Financial Capability for Seward Harbor Improvements. The City of Seward strongly supports this project. There is a great demand for additional moorage in the Seward Harbor, and we look forward to completing the Corps of Engineers' feasibility study portion of the project so we can continue to move forward.

The City is capable of executing the Project Cooperation Agreement based on the attached Statement of Financial Capability. The City believes that it has access to sufficient non-federal funds for the project when needed. Funding will come from sources that are detailed in the Statement. Primarily the City will be using revenue bonds matched by state and borough grants.

We look forward to hearing from you in the near future. The members of the Corps of Engineers that have worked on this project to date should be commended. They have moved the study along expeditiously and have been a source of ideas rather than obstacles. Please feel free to contact me should you have questions or find it necessary to make adjustments to the Statement of Financial Capability.

Sincerely,

City of Seward, Alaska

W. S. Janke
City Manager
907.224.4047
citymgr@seward.net

WSJ:tcs

Enclosures

Statement of Financial Capability

The City of Seward (City) and the Army Corps of Engineers (COE) are in the process of finalizing the feasibility study on the Seward Harbor Improvements project (East Harbor). PED is scheduled to begin January 1999 and the COE is striving to meet the timeline for the Water Resource Development Act of 1998. An integral part of the process is a statement from the City on how it proposes to meet its financial commitments as the non-federal local sponsor that is estimated to be $9,193,000. The fully funded project is projected to be $12,102,000.

The City has a number of financial resources that allow it to fulfill the local sponsor's commitment to the project. First, the City has begun the process of establish a cash balance to be applied to the project in addition to the other available resources. Assuming construction begins in FFY 99, the City should have $900,000 in our East Harbor Fund to be applied to the project. The fund is to be generated by the sale of upland harbor properties and tidelands owned by the City.

Second, the City has a proven record of both GO and revenue bonding, through the Alaska Municipal Bond Bank, for this scale of project. In this case the City will issue revenue bonds in the amount of $4.5 million. Previous examples of projects that have been revenue bonded by the City include the Spring Creek Correctional Facility ($45 million), the Alaska SeaLife Center ($17.5 million), and an electrical transmission line upgrade ($3.2 million).

Based on projections included in the draft feasibility study, the expansion can support a revenue bond of $4.5 million with revenues generated from additional moorage at a rate of $35 per foot. The annual debt service on a 20-year, $4.5 million bond, at a nominal rate of 6.5%, is $405,251.46 (see attached). Operating expenses are projected to be $112,000 (includes salaries and benefits, utilities, insurance, maintenance, and administrative costs). Thus total expenditures are projected to be $517,251.46. Annual revenues attributed to the expansion would be $534,240, as calculated in the Corps draft feasibility study, which will cover expenditures including debt service. Moorage rates will be reviewed, and adjusted as necessary, at 5-year intervals to cover additional operating expenses and inflation.

The remaining balance of the project would come from State of Alaska and Kenai Peninsula Borough grants. The state has demonstrated willingness to fund projects that exhibit local financial involvement and do not represent long-term financial liability to the state. The local match to this project for the non-federal portion is in excess of 50%. The Borough has a reserve balance in excess of $70 million making it capable of funding a match to this project.

SEWARD, ALASKA
ASSESSMENT OF SPONSOR'S FINANCING CAPABILITY

The Harbor Improvements project in Seward, Alaska, is proposed for authorization in fiscal year 1999. The City of Seward will be the non-federal sponsor for this project.

The cost estimate indicates that the fully funded cost for the project will be $13,101,000, including non-federal costs of $8,961,000. The Federal Government will provide 80 percent of the cost of the general navigation features. Federal costs are estimated at $4,140,000; the local sponsor will provide the remaining 20 percent ($1,035,000) plus additional costs that are 100 percent local, estimated at $7,926,000. The city has developed a statement of financial capability that utilizes grants from the State of Alaska and the Kenai Peninsula Borough, and funds generated by the City of Seward.

The City of Seward has developed a financial plan, which utilizes State of Alaska and Kenai Peninsula Borough funds. The Alaska Department of Transportation and Public Facilities (ADOT) has expressed support of the project. Projects supported by the ADOT typically receive 50 percent of the local share. Sources for the City of Seward contribution include cash, moorage fees for port and harbor use, and revenue bonds.

The financial capability statement submitted by the City of Seward appears to provide adequate proof of funding availability for the project. The local sponsor appears to have the capability to finance its portion of the project costs.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
222 W. 7th Avenue, #43
Anchorage, Alaska 99513-7577

August 19, 1998

Colonel Sheldon L. Jahn
U.S. Army Corps of Engineers
Alaska District
CEPOA-EN-CW-ER (Abadie)
P.O. Box 898
Anchorage, Alaska 99506-0898

Re: Seward, Alaska
Navigation Improvements
Environmental Assessment

ATTN: Mr. William D. Abadie

Dear Mr. Jackson,

The National Marine Fisheries Service has reviewed the above referenced Environmental Assessment and Finding of No Significant Impact (ER 98-26) which includes practicable mitigation measures. We concur with your Preferred Alternative 2 and the mitigation findings of your EA (pages EA-41&42). Therefore, we offer no further recommendations at this time.

Please contact Mr. Matthew P. Eagleton at (907) 271-6354 if there are any questions or additional information is needed.

Sincerely,

for Jeanne L. Hanson
Acting Supervisor
Western Alaska Field Office
Habitat Conservation Division

cc: ADFG, ADEC, ADGC, EPA, USFWS - Anchorage
City of Seward Harbor Master Office (Beckham)

RECEIVED
AUG 24 1998
REGULATORY BRANCH
Alaska District, Corps of Engineers