US Army Corps of Engineers
Alaska District

DEFICIENCY CORRECTION EVALUATION REPORT
AND FINDING OF NO SIGNIFICANT IMPACT
WITH ENVIRONMENTAL ASSESSMENT

NAVIGATION IMPROVEMENTS
CHANNEL ROCK BREAKWATERS
SITKA HARBOR, ALASKA

March 2012

Executive Summary

Congress in 2005 and 2007 directed the Secretary of the Army acting through the Chief of Engineers to design and construct modifications to the Channel Rock Breakwaters navigation project at Sitka Harbor, Alaska to correct design deficiencies by adding to, or extending, the existing breakwaters to reduce wave and swell motion. This report recommends corrective action consisting of closing the 315-foot-long opening between the south and the main breakwaters. This report provides the necessary information to amend the existing Project Cooperation Agreement with the local sponsor, the City and Borough of Sitka.

The existing Channel Rock Breakwaters are composed of three breakwater segments, two vessel entrances, and two gaps along the shore. The primary purpose of the breakwaters is reduction of wave conditions throughout Sitka Harbor, primarily at the docks and floats within old Thomsen Harbor and Eliason Harbor (formerly new Thomsen Harbor). The sponsor has reported excessive wave energy throughout the harbor complex during fall and winter months.

Instrumentation that measured wave heights, periods, currents, and float accelerations was installed behind the Channel Rock Breakwaters during two fall/winter seasons, which the local users reported as extremely mild. The data collected was inconclusive and did not replicate reported adverse conditions. A physical model was constructed at the Corps' Coastal Hydraulic Laboratory of the Engineering Research and Development Center in Vicksburg, MS. The physical model was used to evaluate various breakwater modifications. The evaluation measured the percent of energy reduction behind Channel Rock Breakwaters at a number of points within Sitka Harbor. Two specific areas within Sitka Harbor were selected for use in the evaluation and comparison of alternative corrective actions. The Eliason Harbor area was selected because of local user reports of excessive wave energy causing undesirable float and vessel movements. The southwest harbor area near Japonski Island was selected because it is the community's preferred site for future relocation of the Sitka seaplane base.

Cost estimates were developed for a number of alternatives evaluated in the physical model. Cost effectiveness analysis was used to determine which alternative provided the best value, as determined by the cost to achieve the percentage of energy reduction. The design and construction of the recommended deficiency correction measure has a total project cost of $8,139,700 (1 October 2011 price level). Construction would be at full Federal expense, except for any lands, easements, rights-of-way, and relocations required. The recommended alternative measure consists of placing a rubble mound breakwater segment between the northeast end of the south breakwater segment and the western end of the main breakwater. The 315-foot breakwater segment placed in water depth of -45 feet MLLW would have the same top elevation +16.4 feet MLLW and similar breakwater section as the connecting breakwater segments.

The 2005 and 2007 legislation provided directive authority without a specified project cost to correct a design deficiency. The cost for the work involved in preparing this DCER/EA/FONSI and achieving its approval through 1 October 2011 is estimated at about $2,431,000. The design and construction activities are estimated at $8,139,700. Therefore, the total cost of the deficiency correction project will be about $10,570,700 (1 October 2011 price level).

The environmental impacts associated with the recommended action are expected to be short-term and not have any significant adverse impact on the area's fish and wildlife resources. Water circulation behind the breakwaters would be sufficient to not degrade water quality. A major environmental benefit associated with the project is that the breakwater rock, when recolonized with marine algae, will create additional Pacific herring spawning habitat and essential fish habitat. No endangered or threatened species are expected to be adversely impacted by this proposed project.

The environmental assessment and unsigned Finding of No Significant Impact were distributed for 30-day public review on April 5, 2011. Comments were received from the City and Borough of Sitka and the Sitka Tribe of Alaska, both of which commented on issues, subsequently resolved, regarding potential quarry sites. The Alaska Division of Coastal Management concurred with the Corps' determination that the proposed activities are consistent with the Alaska Coastal Management Program to the maximum extent practicable. The FONSI was revised and signed based on comments received.

The local sponsor is strongly in favor of the identified recommended alternative and has provided a letter of intent, dated 12 August 2011, and a certification of sponsor's financial capability.

Pertinent Data

Channel Rock Breakwaters Navigation Improvement

(From Report of the Alaska District Engineer, April 1992)

Design Parameters Original Project

Wave Height	5.3 feet	Design Vessel Beam	16.0 feet
Wave Period	4.2 seconds	Design Vessel Draft	7.0 feet
Wave Length	55.0 feet	Vessels Accommodated	315
Dredging Required	none		

Original Breakwaters

Length - North Breakwater	480 feet	Crest Elevation (all)	+16.4 feet MLLW
- Main Breakwater	1,200 feet	Crest Width (all)	6 feet
- South Breakwater	320 feet	Side Slope (all)	1V:1.5 H

Total Rock Volume (cy)	Neat Line	Plus Overage
Primary Armor	32,100	35,310
Secondary Armor	56,500	62,150
Core	175,100	196,917
Total	263,700	294,377

Recommended Deficiency Correction Measure-Close Gap South/Main Breakwaters

Rock Volume (cy)	Neat Line
Primary Armor	9,000
B Rock (Secondary Armor)	13,000
Core	30,000
Total	52,000

Total Project Modification Cost Estimate (October 2011 price level)

Construction Contract (including 27.9% contingency)	$ 7,028,600
Lands & Damages	$ 3,900
Planning, Engineering, and Design	$ 791,600
Construction Management	$ 316,600
Total Design & Construction Cost Estimate	$ 8,139,700
Total Projected Study Costs (FY 2005-FY2011)	$ 2,431,000
Total Modification Costs (study, design, & construction)	$10,570,700

Historical Funding Allocations, Channel Rock Breakwaters Construction

Fiscal Year	PED-Fed	Constr-Fed	Non-Federal	Total
1992	$ 50,000	$ 0	$ 0	$ 50,000
1993	$ 395,144	$ 0	$ 0	$ 395,144
1994	$ 0	$5,120,000	$1,238,400	$ 6,358,400
1995	$ -35	$1,083,000	$ 0	$ 1,082,965
1996	$ 0	$ -109,000	$ 0	$ -109,000
1997	$ 0	$ 100,000	$ 0	$ 100,000
1998	$ 0	$ 0	$ 0	$ 0
1999	$ 0	$ 0	$ 0	$ 0
2000	$ 0	$ -1	$ 325,500	$ 325,499
2001	$ 0	$ 0	$ 0	$ 0
2002	$ 0	$ -334,985	$ 0	$ -334,985
Total	$ 445,109	$5,859,014	$1,563,500	$7,422,914

Historical Funding Allocations for Deficiency Correction Studies

Fiscal Year	GI Funds	CG Funds	ARRA Funds	Total
2001	$ 65,000	$ 0	$ 0	$ 65,000
2002	$ 36,000	$ 0	$ 0	$ 36,000
2003	$ 0	$ 0	$ 0	$ 0
2004	$ 0	$ 63,000	$ 0	$ 63,000
2005	$ 0	$ 889,000	$ 0	$ 889,000
2006	$ 0	$ 0	$ 0	$ 0
2007	$ 0	$ 104,000	$ 0	$ 104,000
2008	$ 0	$ 350,000	$ 0	$ 350,000
2009	$ 0	$ 778,000	$ 45,530	$ 823,530
2010	$ 0	$ 49,999	$ 0	$ 49,999
2011	$ 0	$ 49,999	$ 0	$ 49,999
Total	$101,000	$2,238,998	$ 45,530	$2,430,528

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APPENDICES

1.0 INTRODUCTION

The Alaska District, U.S. Army Corps of Engineers, along with the City and Borough of Sitka (CBS), its non-Federal sponsor, completed construction of the Channel Rock Breakwaters feature of the Sitka Harbor project in 1995. The purpose of that project was to provide protection for Thomsen Harbor and to protect additional moorage that would be constructed in the natural anchorage and channel between Baranof and Japonski islands. During and after the feasibility study, this additional moorage was termed New Thomsen Harbor. The name of the expanded moorage area was later changed to its current name, Eliason Harbor.

After the Channel Rock Breakwaters were constructed, Sitka Harbor users and the city reported that excessive energy entering through the breakwater gaps adversely affected harbor use and damaged boats and harbor facilities during high tide and swell conditions. Congress provided the Corps funding from 2001 through 2003 to study the potential for excessive swell in the harbor. In May 2002, the Corps completed a Section 905(b) Analysis for Eliason Harbor, which recommended further study. Additional congressional legislation in 2005 and in 2007 stated that the damages being experienced resulted from breakwater design deficiencies and directed the Corps to modify the Channel Rock Breakwaters to correct those deficiencies to reduce wave and swell motion within the Sitka Harbor.

This Deficiency Correction Evaluation Report (DCER) responds to the 2005 and 2007 legislation. It presents available information about harbor problems, evaluates potential alternative corrective actions to reduce the potential problems, considers the environmental and social impacts of the actions, and recommends a plan to alleviate the identified problems.

1.1 Project Authority

The Sitka, Alaska, project is composed of four separable features: Harbor Rock Channel (authorized in 1935), Crescent Bay Basin (1945), Forest Service Basin (1954), and the Channel Rock Breakwaters (1992). Only the Channel Rock Breakwaters feature is the subject of this DCER. Congressional authorities associated with the Channel Rock Breakwaters feature are discussed in the following paragraphs.

The Channel Rock Breakwaters were authorized originally by Section 101(1) of the 31 October 1992 Water Resources Development Act, Public Law 102-580, as the *Southeast Alaska Harbors of Refuge, Alaska* project, as follows:

> *"Section 101. PROJECT AUTHORIZATIONS.*
> *Except as provided in this section, the following projects for water resources development and conservation and other purposes are authorized to be carried out by the Secretary of Army substantially in accordance with the plans, and subject to the conditions, recommended in the respective reports designated in this section:*

(1) SOUTHEAST ALASKA HARBORS OF REFUGE, ALASKA.—The project for navigation, Southeast Alaska Harbors of Refuge, Alaska: Report of the Chief of Engineers, dated June 29,1992, at a total cost of $15,013,000, with an estimated Federal cost of $11,250,000 and an estimated non-Federal cost of $3,763,000."

House Document 103-37, 103rd Congress, 1st Session, contained the Report of the Chief of Engineeers, dated June 29, 1992, which recommended protecting Eliason Harbor from wave action by constructing three rubble mound breakwaters, respectively, 480 feet, 1,200 feet, and 320 feet in length, located about 0.6 mile west to northwest of the harbor. Construction of the general navigation portion (the three breakwater segments) of the Channel Rock Breakwaters project was completed in 1995. This was followed in 1997 by completion of the local service facilities, the floats, and docks.

In 2005 Congress appropriated $1 million in the *Consolidated Appropriations Act, 2005, P.L. 108-447, Division C –Energy and Water Development Appropriations* directing the Corps to design and construct modifications to the breakwaters to correct the design deficiency at full Federal expense:

> *"…Provided further, That the Secretary of the Army, acting through the Chief of Engineers, is directed to design and construct modifications to the Federal navigation project at Thomsen Harbor, Sitka, Alaska, authorized by Section 101 of the Water Resources Development Act of 1992: Provided further, That the Secretary of the Army, acting through the Chief of Engineers, shall correct the design deficiency at Thomsen Harbor, Sitka, Alaska, by adding to, or extending, the existing breakwaters to reduce wave and swell motion within the harbor at an additional cost of $1,000,000 at full Federal expense:…"*

Section 3005 of the Water Resources Development Act (WRDA) of 2007 (Public Law 110-114, 112 Stat.1041) directed correction of deficiencies "as necessary" and provided an estimated cost for the modification:

> *"SEC 3005. SITKA, ALASKA.*
>
> *The Sitka, Alaska, element of the project for navigation, Southeast Alaska Harbors of Refuge, Alaska, authorized by section 101(1) of the Water Resources Development Act of 1992 (106 Stat. 4801), is modified to direct the Secretary to take such action as is necessary to correct design deficiencies in the Sitka Harbor Breakwater at Federal expense. The estimated cost is $6,300,000."*

1.2 Implementation Guidance

In response to Congress enacting Section 3005 of WRDA 2007, USACE Headquarters issued a memorandum, dated 15 May 2009, which provided guidance on how to implement Section 3005. This guidance was discussed and clarified in a vertical team teleconference on 16 June 2009, which involved District, Pacific Ocean Division, and Headquarters personnel. Further modification of the guidance was provided by

Headquarters email on 7 October 2009 and 7 January 2010. The consolidated guidance instructed the District to prepare a DCER, as follows:

- The Sitka project is classified as a completed Federal project. Therefore, ER 1110-2-1150 does not apply to the Sitka project modifications. Rather the District should follow ER 1165-2-119 as guidance, except for the DCER being completed at full Federal expense. The project is an acknowledged completed Federal project with design deficiencies; as such the DCER does not need to discuss a justification for declaring the project design deficient.
- A traditional economic analysis with a benefit-to-cost ratio should not be developed. Rather selection of the specific corrective action should use an incremental cost analysis to screen alternatives and select the recommended corrective action.
- The DCER will include, as a minimum:
  - Discussion of existing conditions
  - Identification of the problem
  - Recommended corrective action
  - Impacts of corrective action on prior environmental concerns and commitments
  - Documentation of any mitigation requirements resulting from implementing the corrective action
  - Documentation of coordination of the corrective action with applicable Federal and State agencies
- Any additional environmental compliance investigations/documentations should be completed in parallel with the DCER.
- DCER should be submitted to the POD RIT for report policy compliance review and approval by Headquarters.

Headquarters guidance included provisions for design and construction phase work, also to be performed at Federal expense (except for any required lands, easements, right-of-way, and relocations provided by the sponsor at no cost to the Government). The design and construction guidance is not further discussed in this DCER.

Agency Technical Review of the draft DCER/EA/FONSI was completed in February, 2011. All ATR comments, concerns, and questions were fully resolved with the exception of three related questions posed by the Cost Engineering Directory of Expertise (DX). These were not resolved and the District, the ATR team, and the DX agreed to elevate the questions for resolution by Headquarters. The unresolved questions were:

- What is the basis for the complete authorization of the project deficiency correction measure?
- Is there a 902 limit on the project, or does the wording provided in Section 3005 of WRDA 2007 that the Sitka project "…is modified to direct the Secretary to take such action as necessary to correct design deficiencies in the Sitka Harbor Breakwater at Federal expense…" provide all the necessary authority without a monetary limit?
- What is the proper "sunk cost" that should be included in the fully funded portion of the total project summary sheet for the recommended plan?

Alaska District Counsel provided a legal opinion giving criteria and guidelines for the study team to use in resolving the DX questions. The draft DCER submitted to HQUSACE on 24 August 2011 presented this analysis, proposing that the additional authority required beyond the original 1992 construction authority was provided by the 2005 and 2007 legislation, and that the deficiency correction project cost figures included in the two laws provided the basis for determining a Section 902 project cost limit.

HQUSACE provided additional guidance in the draft Policy Compliance Review Memorandum on 7 October 2011. As part of the guidance, Headquarters Office of Counsel addressed the questions raised by the Cost Engineering DX. The guidance confirmed that full authority for the DCER project was provided by the 2005 and the 2007 legislation, but that a formal project cost for use in determining a Section 902 project cost limit had not been set by Congress. The 2005 and 2007 enactments were not considered to be increases of the project's total authorized cost set in 1992 for Section 902 determinations, but rather separate directive authority without a specified project cost to correct a design deficiency. The rationale for this determination is provided in the following paragraphs.

Section 902 of WRDA 1986, as amended, applies only to a "total cost" for a project set forth in WRDA 1986 or later law, stating: "In order to insure against cost overruns, each total cost set forth with respect to a project for water resources development and conservation and related purposes authorized to be carried out by the Secretary in this Act or in a law enacted after the date of enactment of this Act, including the Water Resources Development Act of 1988, or in an amendment made by this Act or any later law with respect to such a project shall be the maximum cost of that project…" For purposes of Sitka Harbor, the Channel Rock Breakwaters project's total cost limit was enacted in Section 101(1) of WRDA 1992, which authorized the project to be carried out "at total cost of $15,013,000."

The Consolidated Appropriations Act, 2005, directed correction of a design deficiency at the project "at a total additional cost of $1,000,000 at full Federal expense." To the extent the 2005 enactment authorized an "additional cost" for the project, its language indicated that Congress understood it as necessary for the design deficiency correction itself and that it should be paid at full Federal expense, not that the original project needed a new total authorized cost limit under Section 902. Congress clarified its intent even further in Section 3005 of WRDA 2007, which directed correction of the design deficiency at full Federal expense and noted an estimated cost for the correction of $6.3 million. Neither the 2005 enactment nor the 2007 enactment either amended or referenced the "total cost" authorized in Section 101(1) of WRDA 1992. Moreover, while the 2005 Appropriations Act included a $1 million limit on the cost of further correction activity at full Federal expense, Section 3005 omitted any specific cost limitation. Instead, it merely cited a figure of $6.3 million and characterized it as an "estimated cost" of the correction.

As stated in 2005 and reiterated with further clarity in 2007, Congress explicitly declared the presence of a design deficiency at the project and unambiguously directed the Army to fix it at Federal expense. Moreover, Section 3005 of WRDA 2007 dispensed with any cost limit as expressed in the FY2005 Appropriations Act and instead directed completion of the correction with no explicit dollar limitation, other than noting its estimated cost at the time. Indeed, for the Corps to delay completion of the correction because the cost would exceed a number which Congress itself called an "estimate" would not only overstate the significance of that estimate, but frustrate Congress' clear direction to the Army to complete the correction.

Section 3005 by its own terms does not limit the Army's authority to accomplish the deficiency correction to any particular cost. To the contrary, it simply noted that the estimated cost in 2007 was $6.3 million. Section 3005 does not limit the Army's authority to the degree that had been assumed by the District in calculating a "Section 902" limit for the correction as discussed in the draft DCER, but allows the Corps more flexibility than that assumed by the District in applying a 20 percent cost increase limit as would apply under Section 902. While the District's calculation proposed in the draft DCER reflected a too-narrow limit on the Corps' authority, it showed that the recommended plan was projected to exceed the cost estimate noted in Section 3005 by more than a trivial amount. The total design and construction cost for the deficiency correction was projected to cost in excess of $8 million, on top of more than $2 million paid for the preparation of the DCER/EA. Given Congress' clear direction in statutory language that the design deficiency be corrected, and its omission of any explicit cost cap, the Corps' design and construction of the recommended plan within its currently projected cost of more than $8 million is a reasonable implementation of the authority provided by Congress' statutory directive.

Completion of the corrective work also remains subject to Congress making funds available to the Army for construction work under the authority of Section 3005. The recommended plan does not currently meet Corps policies required for it to be recommended to the Administration for budgeting, given that the report does not analyze whether the correction is economically justified and, pursuant to statutory direction, presumes the absence of any non-Federal cost sharing. The need for Congress to provide funds for implementation of the design deficiency correction will provide the opportunity for Congress to confirm its intended flexibility on the cost of the work. To the extent funds are provided, and implementation remains within the Corps current projected cost for completion, the Corps can utilize added funds to correct the deficiency, notwithstanding the estimated cost noted in Section 3005's language.

In summary, the answers to the questions posed by the Cost Engineering DX during ATR are:

- The Channel Rock Breakwaters deficiency correction project is fully authorized by the 2005 and 2007 legislation, with no additional Congressional authorization action required for implementation.

- The deficiency correction feature of the Channel Rock Breakwaters does not have a total project cost set by Congress to use in calculating a Section 902 cost limit. Project implementation is subject to Congress providing the necessary funding.
- Based on the two prior determinations, the "sunk costs" to be included in the fully funded total project cost estimate for the recommended plan (and alternative analysis) will be the cost to perform deficiency correction studies and prepare and gain approval of the DCER/EA/FONSI. The total project cost estimates in the DCER based on the 1 October 2011 price level will not be changed.

1.3 Project Location

Sitka is in the southeastern panhandle of Alaska (figure 1), 862 miles northwest of Seattle, 95 miles south southwest of Juneau, the State capitol, and 185 miles northwest of Ketchikan. The city of about 8,900 residents is on the eastern shore of Sitka Sound (figure 2), a bay on the western coast of Baranof Island in Southeast Alaska. The four elements comprising the Sitka, Alaska, navigation project are shown in figures 3, 4, and 5. Channel Rock Breakwaters cross the western channel area of Sitka Sound about 0.6 mile northwest of Eliason Harbor. The breakwaters provide wave protection for Eliason Harbor, Thomsen Harbor, and other shoreline facilities along Sitka Channel.

The study area is located in the Alaska Congressional District. The Congressional delegation is composed of:

Senator Lisa Murkowski (R)
Senator Mark Begich (D)
Representative Don Young (R)

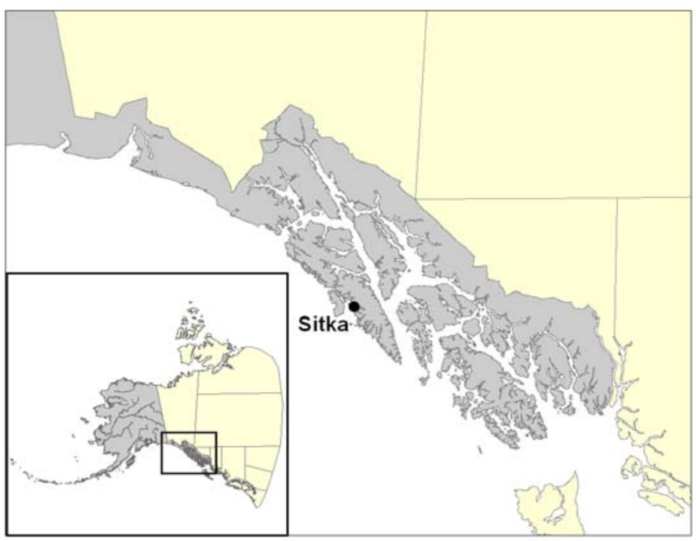

Figure 1. Sitka Location and Vicinity Maps. Sitka is on the Southeast Panhandle of Alaska, about midway by air between Seattle, Washington and Anchorage, Alaska.

Figure 2. Sitka Sound. Sitka is a city of about 8,900 residents on the west side of Baranof Island along the eastern shore of Sitka Sound.

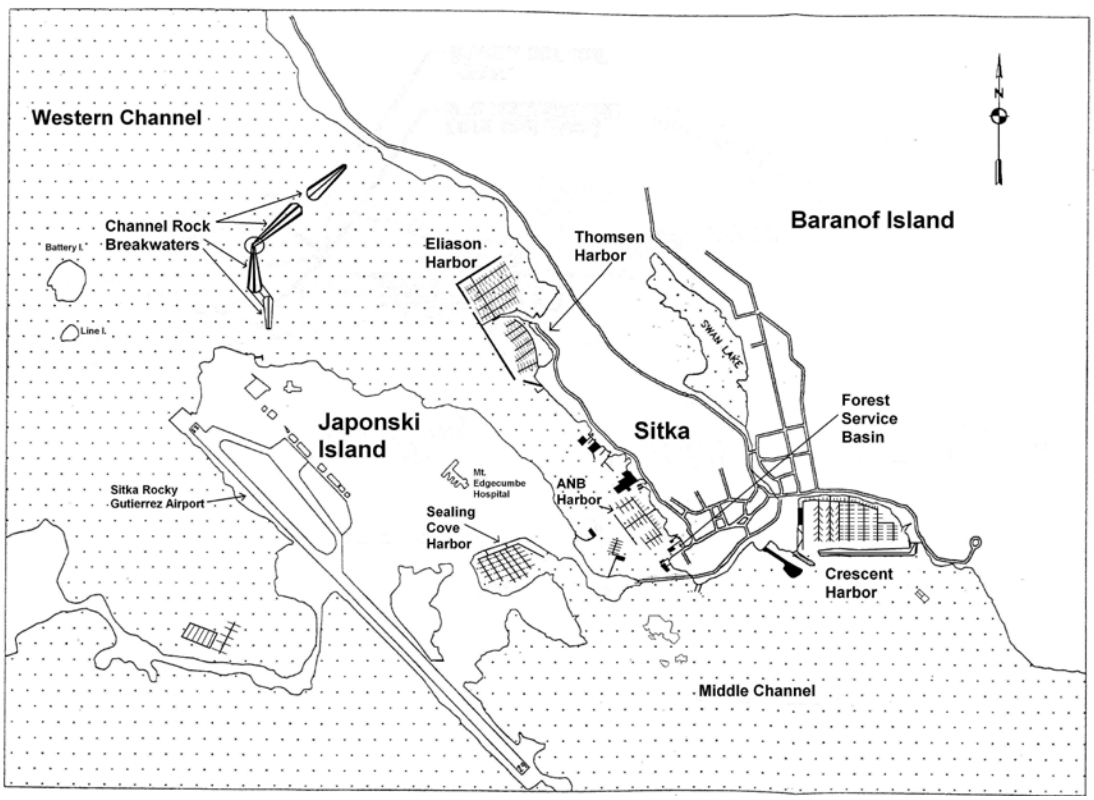

Figure 3. Sitka Harbors. The Middle Channel and the Western Channel form marine approaches to Sitka Harbors from Sitka Sound.

Figure 4. Sitka Harbors. Aerial photo from southwest, showing Thomsen Harbor, Eliason Harbor, Western Anchorage, and Channel Rock Breakwaters.

Figure 5. Sitka Harbor. Aerial photo from southeast along Harbor Rock Channel.

1.4 Related Reports and Studies

The Sitka Harbor Department of the CBS prepared a 2001 report, *Rubblemound Breakwater Project, Sitka, Alaska*, that reported problems in areas protected by the breakwater project. The Corps of Engineers Coastal Hydraulic Laboratory (CHL), a part of the Engineer Research and Development Center (ERDC), located at the Waterways

Experiment Station (WES), performed physical hydraulic model tests to help predict how Channel Rock Breakwaters modifications would perform to reduce wave energy. Their findings are reported in two documents: the *Physical Model Study of Wave Action in New Thomsen Harbor, Sitka, Alaska, ERDC/CHL Report TR-08-2, February 2008,* and a July 2009 unpublished Addendum to that report. Appendix B summarizes these reports and discusses the ERDC/CHL model tests.

1.5 Report Scope and Content

This DCER and environmental assessment (EA) are prepared in accordance with Engineer Regulation (ER) 1165-2-119 *Modifications to Completed Projects*, ER 1105-2-100 *Planning Guidance Notebook, Principles and Guidelines* adopted by the Water Resources Council, Council on Environmental Quality regulations and guidance for implementation of the National Environmental Policy Act, and ER 200-2-2 *Procedures for Implementing NEPA.*

This DCER presents available information related to:

- Existing conditions at Sitka, Alaska, related to the breakwaters
- Prior environmental concerns and commitments
- Identification of the current problem
- Recommended corrective action
- Environmental impacts of corrective action and recommendations to mitigate effects
- Coordination with other agencies

1.6 Study Participants

The CBS was the non-Federal sponsor for the Channel Rock Breakwaters project and is the principal proponent for action to reduce the residual wave and swell energy damage. The Corps' Coastal Hydraulics Laboratory provided physical modeling data essential to evaluation of alternatives. Tetra Tech, Inc. developed the cost estimates for alternative corrective measures. The DCER and EA/FONSI were prepared primarily by Alaska District personnel.

2.0 EXISTING CONDITIONS

2.1 Existing Socio-Economic Conditions

Sitka, Alaska (population 8,800) is a thriving coastal community with close ties to tourism and fishing. Boating for commercial fishing, commercial recreational activities, personal recreation and fishing, subsistence harvesting, tourism support, transportation of people and goods, and many other uses is a major part of the Sitka economic base. Protected moorage is essential to the continued success and growth of those activities. The CBS operates and maintains five boat harbors (figure 3): Crescent Harbor, Sealing

Cove Harbor, the Alaska Native Brotherhood Harbor, Thomsen Harbor, and Eliason Harbor. Other vessel moorage is available along the Sitka Channel along with the existing Sitka floatplane facility. The harbors provide moorage for a total of about 1,400 vessels. The CBS would like to continue to develop additional harbor facilities for both vessels and floatplanes. All harbors operate at maximum capacity year round. In February 2010, there was a waiting list of 300 vessel owners seeking a permanent moorage slip in one of Sitka's harbors and a waiting list of five floatplane owners seeking moorage at the State-owned floatplane facility located on Sitka Channel. Because of the limited moorage, many vessel owners trailer their boats to the two boat launch facilities in Sitka, at Crescent Harbor and at the University of Alaska Southeast-Sitka campus on Japonski Island, leading to overcrowding and delays at peak times. The Channel Rock Breakwaters feature of the Sitka Harbor, Alaska navigation project helps protect Thomsen Harbor, Eliason Harbor, and moorage and other facilities along the Sitka waterfront.

2.2 Tide Levels at Sitka Harbor

Tide data at Sitka were obtained from the National Oceanic and Atmospheric Administration (NOAA) Station ID: 9451600 (Sitka, Baronof Island, Sitka Sound) and were based on a 19-year-series from January 1983 to December 2001 for the Tidal Epoch of 1983-2001. Elevations of tidal datum referred to Mean Lower Low Water (MLLW) in feet are shown in table 1.

Table 1. Tidal Datums

Highest Observed Water Level (11/02/1948)	= 14.88 ft
Mean Higher High Water (MHHW)	= 9.94 ft
Mean High Water (MHW)	= 9.16 ft
Mean Tide Level (MTL)	= 5.31 ft
Mean Sea Level (MSL)	= 5.28 ft
Mean Low Water (MLW)	= 1.46 ft
Mean Lower Low Water (MLLW)	= 0.00 ft
Lowest Observed Water Level (01/01/1991)	= -4.02 ft

2.3 Design Wave for Channel Rock Breakwaters

Channel Rock Breakwaters armor stone was designed for 5.3-foot waves with a period of 4.2 seconds. This was based on a fetch limited wave from the north resulting from a 72-year wind event, which would have a 50 percent chance of occurring in any year during the project's 50-year economic life. The breakwaters have not required any major rehabilitation to date. Recent inspection indicates that there has been some armor displacement along the main breakwater near the main breakwater's north gap and along the south breakwater. A diffraction analysis of the design wave performed during design of the original breakwater project indicated that the incoming wave would result in a 3.0-foot wave being experienced behind the Channel Rock Breakwaters and a 2.5-foot wave in the area of Eliason Harbor.

2.4 Channel Rock Breakwaters Project Description

The Channel Rock Breakwaters element of the overall Sitka Harbor project was constructed as a result of a 1992 study that assessed the need for navigation improvements in Southeast Alaska to provide safe moorage for vessels. The Channel Rock Breakwater project was completed in 1995 and consists of three detached breakwaters, which are shown in figure 6.

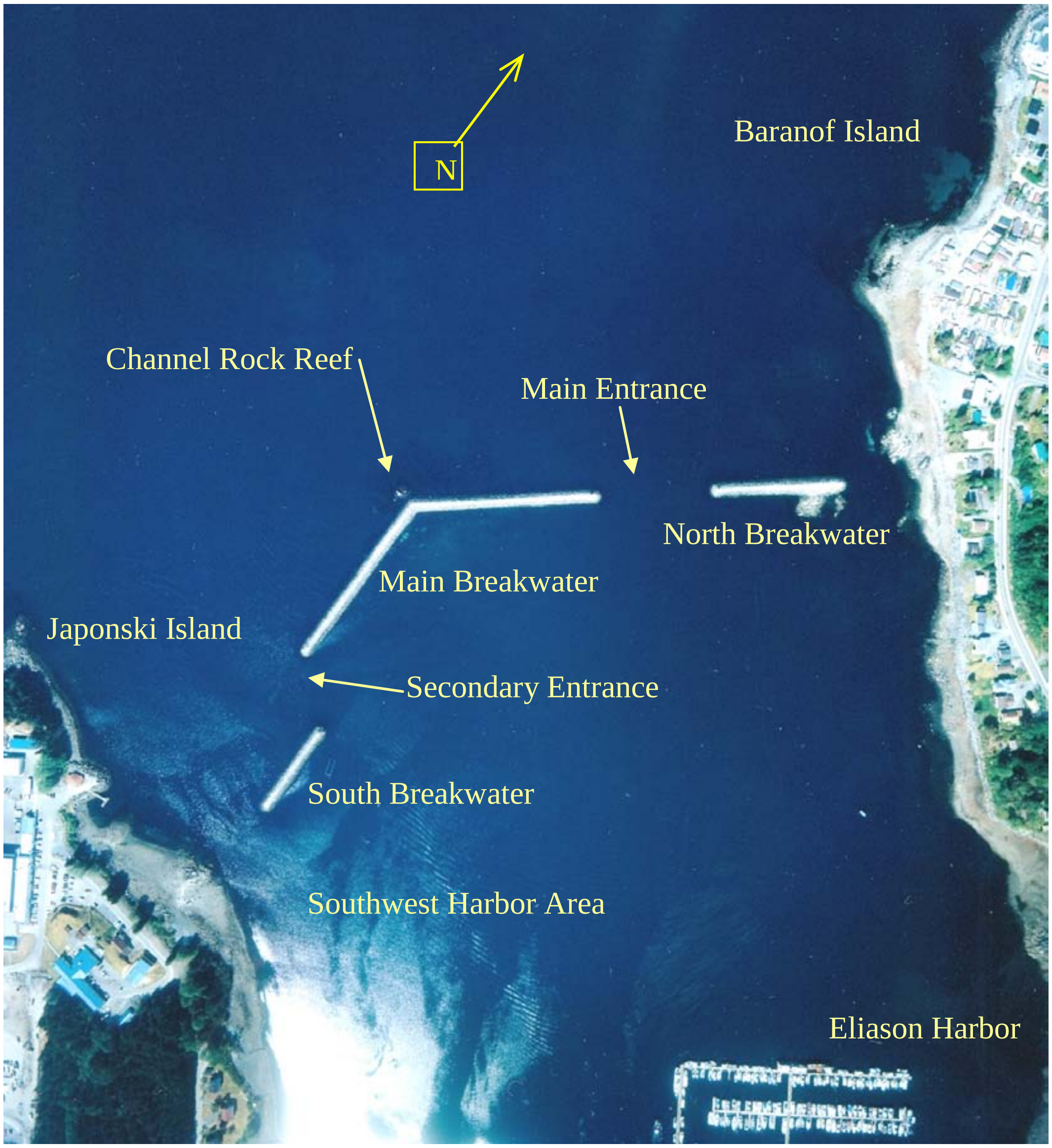

Figure 6. Channel Rock Breakwaters. Western Anchorage area of Sitka Harbor showing Channel Rock Breakwaters Feature.

The breakwaters are known as the south breakwater, which is 320 feet long and is detached from Japonski Island; the main breakwater, which is 1,200 feet long and consists of a breakwater with a bend in the center; and the north breakwater, which is 480 feet long and is detached from Baranof Island. The gaps between the breakwaters at MLLW are 190 feet between Japonski Island and the south breakwater (gap 1), 260 feet between the south breakwater and the main breakwater (secondary entrance, gap 2), 400 feet between the main breakwater and the north breakwater (main entrance, gap 3), and 175 feet between the north breakwater and Baranof Island (gap 4). The breakwater crest elevation is +16.4 feet MLLW.

The Channel Rock Breakwaters were located to take advantage of the Channel Rock Reef at the entrance to the western channel. This reef is a shallow protrusion in an area of otherwise deep bathymetry. The opportunity to use the reef in the breakwater construction allowed the breakwater rock quantities to be reduced. The deep surrounding bathymetry made dredging an entrance channel unnecessary. The reduced rock volume and the absence of dredging contributed greatly to keeping the construction costs down, resulting in a positive economic justification for the project.

Taking advantage of the cost cutting opportunities resulted in a breakwater located not immediately adjacent to the harbor it was protecting, unlike the typical breakwater design. The advantage of this design is that it provided a reduced wave climate for a large area behind the breakwater that, according to the Feasibility Study, "*…could be developed using minimal or no wave protection structures.*" No breakwater diffraction curves or wave height reduction plots behind the breakwater were generated as part of the 1992 feasibility study to delineate either where minimal wave protection was needed or where no wave protection was needed. It is likely that no diffraction analysis was performed for the north fetch limited wave during the feasibility study because the complicated wave interaction from the four breakwater gaps would have involved extensive numerical modeling to define the diffracted wave environment.

Additional design features of the original project are:

- Breakwaters were designed to be detached to avoid impacts to herring spawning.
- There was no federally designated navigation channel because of the naturally deep bathymetry.
- One large entrance was designed between the main and north breakwaters to accommodate log rafts.
- The second entrance between the main breakwater and the south breakwater was included to provide vessel separation when log rafts or barges were being towed through Western Anchorage to a local pulp mill.

The Alaska Pulp Mill shut down operations shortly after the breakwaters were constructed. The redundant navigational passages through the breakwaters no longer serve their original purpose. All vessels that currently transit Sitka Channel through Western Anchorage can safely operate through the main passage between the middle and north breakwaters.

As part of their share of the construction of the original Channel Rock Breakwater project, the local sponsor was responsible for providing the required local service facilities that would be needed to achieve projected project benefits. These included the existing floats and docks then in place in Thomsen Harbor and future floats and docks for the new expanded moorage in Eliason Harbor. The Eliason Harbor docks are typical of those used through the state based on generic designs prepared by the Alaska Department of Transportation and Public Facilities and were expected to be adequate to serve typical design conditions, as they have elsewhere throughout Alaska. However, the waves and swell both entering Sitka Harbor and generated inside the Channel Rock Breakwater have proven to not be typical. Therefore, to address project deficiency correction measures, the District focused its efforts on decreasing the non-typical wave and swell conditions.

2.5 Environment and Cultural Resources

A detailed description of Sitka Harbor's environment is provided in the environmental assessment (Appendix A). A summary of that information follows.

The marine environment in and around Sitka Harbor supports a wide variety of marine habitat ranging from calm protected embayments to high energy wave-swept exposed coastlines. Much of the developed Sitka waterfront area has a rocky shoreline. The seafloor in the project area contains a mosaic of bottom types including a mixed-soft bottom (mixture of silt, sand, pebbles, cobbles, boulders, and shell) and bedrock outcrops. All these habitats support a wide variety of fish and wildlife species, including those important for commercial, sport, and subsistence uses.

Marine mammals are commonly observed in and around Sitka Harbor, including Steller sea lions, sea otters, and harbor seals. Marine surveys conducted in the area discovered blue mussels, cockles, butter clams and horse clams in the rocky, sandy and muddy intertidal zone, as well as many species of worms, marine snails, chitons, abalone, seastars, crabs, sea urchins, and octopus in other coastal habitats.

The following National Marine Fisheries Service (NMFS)-managed Endangered Species Act (ESA) species may occur in the project area: humpback whale (endangered); Steller sea lion (threatened eastern population and endangered western population); and Pacific herring Southeast Alaska Distinct Population Segment (candidate). No U.S. Fish and Wildlife Service (USFWS)-managed ESA species exist in the project area.

Many species of fish and shellfish reside in the project area. Chief among them are Pacific salmon and herring, various species of bottomfish, and several species of crab, shrimp, and other shellfish. Pacific herring is an ecologically and commercially important fish species that occurs abundantly in the Corps' project and surrounding area. Pacific herring support a roe fishery in Sitka that remains one of the largest and most valuable roe fisheries in Alaska.

Marine waters in Sitka Sound are classified by the Alaska State Water Quality Standards for a variety of uses, including aquaculture, seafood processing, industrial water supply, water contact and secondary recreation, growth and propagation of fish, shellfish, aquatic life and wildlife, and harvesting for consumption of raw aquatic life. However, Sitka Harbor is classified by the Alaska Department of Environmental Conservation as a

Category 3 waterbody, which means that sufficient data or information does not exist to determine the water quality standards for any of the aforementioned designated uses.

More than 97 percent of Sitka households use subsistence resources, and estimated per capita harvest of subsistence resources is more than 200 pounds. Based on subsistence harvest data collected by the Alaska Department of Fish and Game (ADF&G), subsistence collection by Sitka residents includes marine and riverine resources such as salmon, halibut, herring roe, eulachon, rockfish, sea otters, sea lions, harbor seals, seaweeds, and kelp.

Sitka has an extremely rich history from both pre-contact and post-contact periods. Buildings and artifacts of Native American occupation, including petroglyphs and totems; remnants of early Sitka as a center of Russian culture and government in the New World; and early American military, commercial, and settlement activities are found throughout the town.

3.0 PROBLEM IDENTIFICATION

3.1 Without Project Conditions

The without project conditions for the Sitka Harbor (Channel Rock Breakwaters) Deficiency Correction are generally the same as described for the existing conditions discussed in section 2. Economic information given in section 2.1 and environmental and cultural information from section 2.5 also describe the without-project conditions. The problem experienced by harbor users is excessive float/vessel motions resulting from excessive swell, as discussed in following paragraphs. This current condition is expected to continue in the future if no action is taken to modify the existing Channel Rock Breakwaters.

Sitka Harbor users make a distinction between long period swells that occur as a result of storms in the Gulf of Alaska and local wind generated short period waves. They have consistently requested breakwater improvements to reduce the effects of long period residual swell that sets the harbor floats in motion. This is also identified by Congress in the authorization language, "…by adding to, or extending the existing breakwaters to reduce wave and swell motion within the harbor…." As the waves leave the storm area, they become more regular and develop into swell. This swell travels long distances across the Gulf to the Sitka Harbor area. The "wave energy" from Gulf storms noted in the report refers to the swell energy that is able to travel to Eliason Harbor. Swell passes through the Channel Rock Breakwaters' openings and is directed to the Eliason Harbor area through diffraction and refraction.

The primary reported problem by the harbor users is excessive float motion caused by swell passing through the Channel Rock Breakwaters' openings on both sides of the south breakwater after a storm has passed through the Sitka Harbor area. In the past, the harbor users have said that it is not excessive motion during the actual storm event itself that is their primary concern. The fetch from the Channel Rock Breakwaters to Eliason Harbor is long enough that local winds can create wave action behind the breakwaters.

However, these waves are not the focus of the corrective action being pursued. To address the short period, locally generated wind waves, harbor practices, such as developing a plan so transient vessels tied to the outside float are moved before a local wind or wave event, should be considered by Sitka.

Because of the small wave height associated with the swell, when consideration of deficiency correction measures began, the District developed a strategy to consider measures to reduce wave energy transmitted past the breakwaters openings and to evaluate and compare measures based on reduction in wave energy and not the more traditional reduction in wave height. Corps staff has observed dock movement with little noticeable accompanying wave height. Therefore, energy was thought to provide the more descriptive and proper presentation of the exciting mechanism. The wave height is a manifestation of wave energy given by the equation $E=1/8\ \rho g\ H^2$, where E is the energy density, ρ is the density of water, g is gravity, and H is the wave height

Previously, Sitka Harbor experienced a similar swell problem following Corps construction of the Crescent Harbor breakwater, which is shown on figure 3. Interviews with local harbor users indicated that Crescent Harbor, when it was first constructed, experienced a motion problem similar to that currently experienced at Eliason Harbor. Swell entered the harbor and caused excessive motion to occur at the outer vessels and floats. The adopted solution for Crescent Harbor was to modify that breakwater to reduce wave energy by extending the end of the breakwater at the entrance channel. Once the entrance channel breakwater at Crescent Harbor was extended, excessive vessel and float motion after storms was significantly reduced. This breakwater modification reduced the entrance channel width and wave energy entering the harbor, resulting in dampened float motion. Eliason Harbor and Crescent Harbor are both located where they could experience similar long period swell from Gulf storms.

The State Department of Transportation and Public Facilities inspected the harbor on July 28, 1999 and reported, “Although protected by a rubble mound breakwater and floating breakwaters, this facility is subject to swell, wind-generated waves and boat wakes." Waves generated by wind and boat wakes between the Channel Rock Breakwaters and moorage at Sitka are outside the scope of this report and are not addressed further herein. The longer period swells or surges that come through the gaps in the Channel Rock Breakwaters are addressed in the remainder of this section.

The Sitka Harbor Department in 2001 reported on a tidal swell experienced in Eliason Harbor on floats 3 through 8, the main float, and the north floating breakwater to be in excess of 2 feet with 12-second intervals. A harbormaster’s office movie of a strong-motion event shows that several wave trains impact the floats resulting in short period dock motion (3 to 5 seconds) coupled with longer period motion and large vertical displacement. However, actual wave heights cannot be reasonably estimated from the video. The Sitka Harbormaster has stated that, on average, the harbor experiences significant motion 0 to 3 times a year.

Wave energy penetrating into areas protected by the Channel Rock Breakwater causes excessive motion that affects the mooring facilities and moored vessels. The city, harbormaster, and users describe the motion as a swell or surge that at times results in strong vertical and horizontal oscillations. The oscillations can make walking on the floats difficult or dangerous, and it causes floats to twist, rub, and strain so they require more frequent maintenance and replacement. Vessels moored to the floats also tend to oscillate, which causes excessive rubbing and wear, and in severe cases, snapped mooring lines.

Sitka Harbor Department, State of Alaska coastal engineers, and people who live or moor boats in the Eliason Harbor generally agree in their observations about strong-motion events in Eliason Harbor. They note that:

- Those events coincide with high or near-high tides during or after storm events in the Gulf of Alaska.
- The majority of the wave energy enters through the gaps on either side of the south breakwater.
- Most of the strong-motion events occurred in the September through January time frame when Pacific low pressure systems often generate storms that impact southeastern Alaska.

A site visit to Sitka Harbor by members of the study team during a moderate offshore storm event on December 4, 2009, identified a definite relationship between harbor and dock motion and energy entering the gaps between breakwaters. The float motion resulting from storms in the Gulf of Alaska related by the local users was confirmed to some extent by this event. Although wave activity entering the harbor was modest, float motion was extensive, but modest in displacement. Consequently, the study's basic assumption, that any reduction in wave energy entering through the Channel Rock Breakwaters would result in decreased movement of the floats, appeared reasonable.

The economic impacts to Sitka and harbor users from the wave energy and excessive motion can be summarized as follows and are explained more completely in Appendix F – Economic Considerations:

- The life expectancy of the inner harbor float system is reduced by half. The accelerated replacement costs have an average annual value of $96,000 as opposed to an expected average annual value of $30,500 – a savings of $65,500 annually if wave and surge problems did not exist.
- Annual maintenance of the inner harbor float system is twice normal expectations for an Alaskan harbor, $232,000 versus $119,000 – a potential savings of $113,000 if wave and surge problems were minimized.
- Underutilized float system and unrealized revenues to the city as a result of the dangerous wave energy on the outer floats.
- Vessel owners must replace lines, cleats, fenders, and bumpers on a more frequent basis. The estimate of these avoided damages to vessel owners is approximately $20,000 annually.

- The existing situation is an impediment to marine facility management and development. Case in point is the delayed addition of floatplane moorage and constraints to rebuilding and changing the composition of users within Crescent Harbor. A value has not been placed on these delays.
- There are safety issues for the live-aboard vessel owners as wave energy in the harbor sometimes necessitates vacating their vessels when conditions become uncomfortable.

3.2 Problem Statement

In its 2005 legislation, Congress defined the problem resulting from the design deficiency as "wave and swell motion within the harbor." Congress further identified the general design deficiency correction measure to be employed: "by adding to, or extending, the existing breakwaters." Since Congress legislatively has defined the problem and directed the general solution, the DCER concentrates on developing a cost effective deficiency correction action for implementation.

3.3 Planning Objective

The planning objective for this DCER is to reduce the existing wave and swell motion in Sitka Harbor behind the Channel Rock Breakwaters to a reasonable degree in a cost effective manner for the remaining life of the project.

3.4 Planning Constraints

Planning Constraints are restrictions that limit the planning process and can be legal, policy, or resource driven. The planning constraints identified as applicable to this DCER are:

- Congress has determined in law that a design deficiency exists, that the deficiency causes excessive wave and swell events in Sitka Harbor, and the directed solution is a measure that would add to or extend existing breakwaters. Thus, the planning process will not look at a wide range of alternatives but will concentrate on developing a cost effective measure(s) to add to or extend existing breakwaters.
- Any deficiency correction measure will be required to avoid adversely affecting the identified Endangered Species Act species that may inhabit the harbor area (Steller sea lion, humpback whale, Pacific herring) or their designated critical habitat.

3.5 Planning Opportunities

Planning opportunities are positive conditions that could be improved through implementation of a Corps project. While the DCER is focused on the conditions experienced by vessel owners at Eliason Harbor (Thomsen Harbor), any modification of the Channel Rock Breakwaters project has the potential to further improve adverse conditions experienced throughout the Sitka Harbor complex. Specifically, any modification improving the situation for Eliason Harbor also could further reduce wave and swell action in the southwest harbor area along Japonski Island inside the Channel

Rock Breakwaters, an area being considered by the CBS for a relocated floatplane facility for the Sitka community.

4.0 HYDRAULIC STUDIES OF SITKA HARBOR

4.1 Instrumentation Placed at Sitka

A hindcast was not performed for the DCER work. When the deficiency correction evaluation began, there was high confidence that an event that causes the excessive float motion described by harbor users could be measured by putting instrumentation in the Sitka Harbor area. Measuring actual events was considered a better course than developing a detailed hindcast for the harbor. Eliason Harbor was instrumented to measure "surge" events associated with strong motions at the docks for two fall/winter (2004-2005 and 2005-2006) seasons. During the 2004-2005 instrumentation effort, the maximum significant wave height measured was 6 inches, with a period of 11.6 seconds inside the area protected by the Channel Rock Breakwaters. During the 2005-2006 instrumentation effort, the maximum significant wave height measured just outside Eliason Harbor was 7.5 inches, with a 12-second period. Conversations with the harbormaster indicated that the 2004-2005 and the 2005-2006 measurement seasons were some of the calmest seasons he had ever seen, so the collected data was not analyzed further. The instrumentation was intended to provide data for a physical model, but there were no events during the two seasons the instruments were deployed that caused excessive dock motion. The decision was then made to move forward with the physical model with the thought that the high motion event would be evident during the modeling.

4.2 Physical Model at ERDC

A physical model was constructed at the Corps' Hydraulics and Coastal Laboratory at the Waterways Experiment Station to determine the amount of wave energy that reaches Eliason Harbor and to aid development of alternatives to reduce wave energy. Data collected in 2004-2006 were not large enough in magnitude to develop a transfer function for modeling that could link the dock motion with the incoming wave train. Without a transfer function, the study proceeded under the premise that a reduction in wave energy impacting the harbor area would result in reduced float motion. A range of wave heights and periods were run in the physical model to simulate storm waves originating in the Gulf of Alaska. All wave heights observed in the harbor area when the wave generator was simulating swell from a Gulf of Alaska storm were below 1.5 feet at Eliason Harbor. Swell ranges from 6 to 16 seconds were tested and the swell in the range between 10 and 14 seconds became the focus of testing.

The existing armor stone on the Channel Rock Breakwaters were designed for moderate overtopping from a 5.3-foot design wave, 4.2 second period, based on a single wind speed, wind direction, and fetch. Swell was accounted for in the 1992 Feasibility Report Hydraulics & Hydrology Appendix by using the wave period from a single hindcast point in the Gulf of Alaska to set the breakwater crest height. Because of the small wave height associated with the swell, wave energy reduction rather than the traditional wave height reduction was used for evaluation and comparison of a deficiency correction measure's effectiveness since the wave height is a manifestation of the wave energy.

An idealized wave was used for the physical model testing. A 5-foot wave height was selected for the majority of the runs. The breakwaters have not required any major rehabilitation to date and there have been no reports of the breakwaters being overtopped, so a 5-foot wave was determined to be an adequate wave height. The physical model was run with different breakwater configurations to determine how alterations to the breakwater might reduce energy from waves. Wave periods ranged from 4 to 18 seconds, but the focus of the study was on the 10 to 14-second period waves. A water level of +11 feet MLLW, which is 1 foot higher than MHHW, was used to be conservative and still represent a reasonably common event. Three different wave directions were evaluated during the physical model study. The model was used to simulate storms from the Gulf of Alaska, strong wind events out of the north, and waves out of the Gulf of Alaska that could be steered through the breakwater gaps nearest Japonski Island (figure 7). Results were reported in the 2008 ERDC report (see section 1.4). Evaluation of observations, model data, breakwater configuration, harbor configuration, and bathymetry indicates that there are several possible contributors to the excessive motion experienced at the harbor:

- Wave energy from Gulf storms enters the harbor through the gaps between the breakwaters, where it is realigned by bathymetry and reflection so it excites the main float in Eliason Harbor (see figure 7).
- At higher still water levels the breakwater entrance and gaps are wider in the upper water column, so higher levels of energy can enter the harbor area than at lower still water levels.
- At higher water levels the incoming waves retain energy because they are less affected by refraction, diffraction, and wave breaking.
- The rocky shoreline is more reflective at high water and provides a surface that conserves wave energy and reflects the longer period waves.
- The harbor float system and its moorage facilities appear to be very responsive to incoming wave energy.
- Harbor pilings, which are long, slender, and generally loose, are susceptible to horizontal movement at the water surface when they are loaded laterally by waves or moored vessels during high tides.
- There is an area with a high bathymetric elevation that acts like a lens that can focus incoming wave energy in the harbor.
- Waves and wind stress on vessels moored to the floats cause vessel motions that are transferred to the dock in a non-linear manner, resulting in adverse dock motions.

The combination of these factors results in dock motion that causes excessive maintenance costs, vessel damage, and potentially dangerous walking conditions.

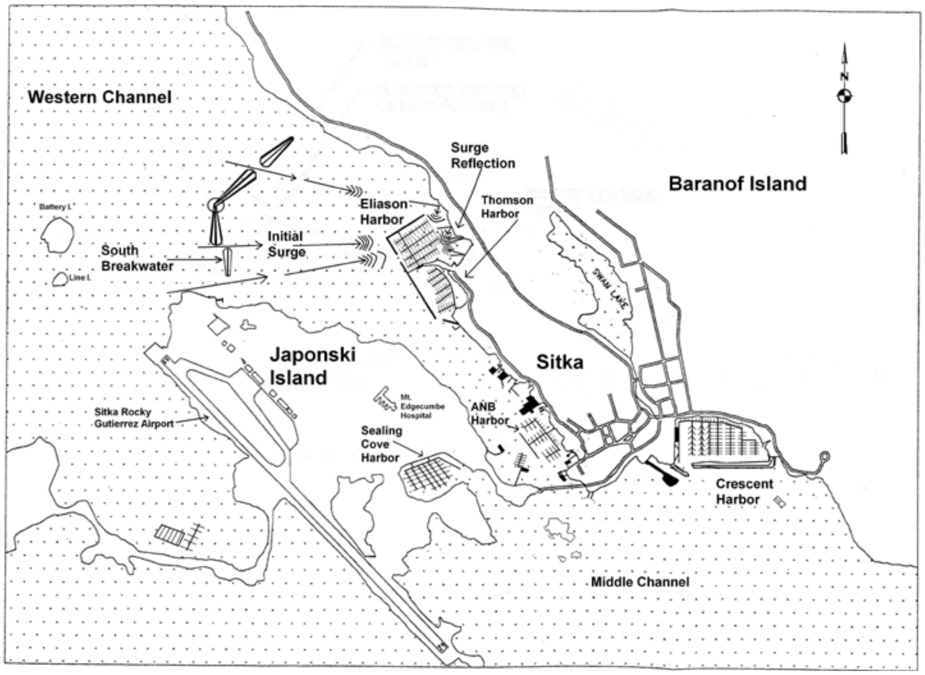

Figure 7. Eliason Harbor Storm Surge. The surge enters through the breakwater gaps from the west. Some surge energy impacts Baranof Island and reflects back into Eliason Harbor from the east.

4.3 Alternative Corrective Actions Tested in Physical Model

Results of the physical model study for the wave generator configured are documented in the ERDC report: ERDC/CHL TR-08-2 *Physical Model Study of Wave Action in New Thomsen Harbor, Sitka, Alaska*. In the absence of a measured extreme event, the working assumptions for evaluating the physical model results were:

- Wave energy entering the harbor is the exciting mechanism for the harbor floats and vessels.
- Reducing wave energy impacting the harbor floats will result in a corresponding reduction in harbor float motion.

Physical modeling measured wave energy reduction that could be realized by extending existing breakwater features or constructing new energy reduction measures at or near the Channel Rock Breakwaters. Some of the measures directed at reducing wave energy in the Eliason Harbor area also can reduce wave energy in the southwest harbor area. ERDC modeled wave energy reduction for 19 different configurations/conditions. First, they modeled the existing Channel Rock Breakwaters with a still water elevation of +11 feet MLLW to serve a base condition for comparisons. They then modeled 18 different configurations/conditions. Of these, 17 were action plans using the +11-foot MLLW water level and one (plan 11) ran the base condition configuration with a still water elevation of +7 feet MLLW. Wave measuring gages were placed in three general locations (figure 8):

- Offshore near the wave generator (gages 1-3) to record the incident reference wave condition (these are located to the west, outside figure 8).
- In a linear array position (gages 4-15) directly over the position of the main floating dock of Eliason Harbor (gage 8 measured the most severe movement along the string of gages).
- In the immediate lee of the south breakwater (gages 16-19) just north of Japonski Island.

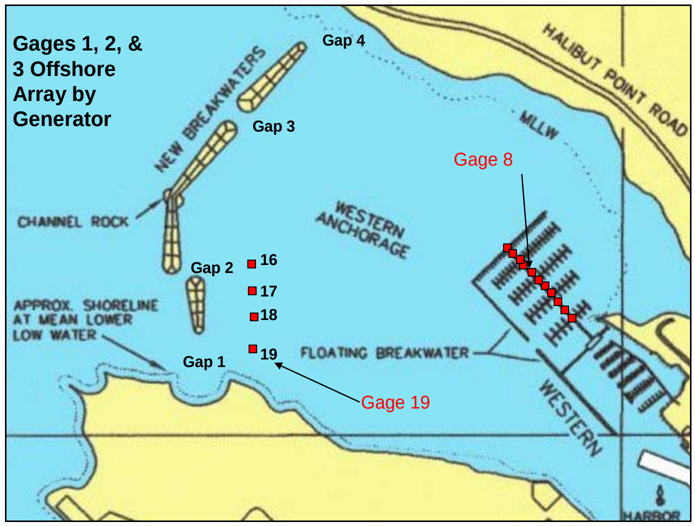

Figure 8. ERDC Physical Model Gage Locations. Location of wave measurement gages in ERDC physical model. Gages 8 and 19, identified by red lettering, are used in the hydraulic analysis as representative of the conditions in Thomsen Harbor and in the vicinity of a site for a relocated seaplane facility, respectively.

A still water level of +11 feet MLLW was used to start the model. The wave generator created a scaled wave of 5.0 feet with various periods ranging from 4 to 16 seconds, depending on the run. Three periods were selected for use in the alternative evaluation and screening since they spanned the wave period (12 seconds) that Sitka reported causing problems in the harbor. The model was run for each combination of conditions. Then the model was run with each modification in place. The project modification evaluated in each test series is shown in figures 9 though 26. The associated energy reduction at both gage 8 and gage 19 for 10-second, 12-second, and 14-second wave periods is listed on pages 11 to 28 of Appendix B. Gage 8 was chosen to evaluate the energy reduction in the harbor area since it typically recorded the largest wave height during testing. Gage 19 was chosen to evaluate the energy in the southwest harbor area. Results are compared with the conditions associated with the existing breakwater configuration starting at the same still water elevation of +11feet MLLW. They are expressed as the percentage of energy reduced by each measure or combination of measures. Wave heights for all of the options and all gages are shown in the hydraulic appendix. Plan 11 is the existing breakwater configuration but run at the lower tidal stage of +7 feet MLLW. Plan 11 results show how water surface elevation strongly influences wave energy to the lee of the breakwaters. A summary of the energy reduction measured during modeling is reported in table 2 on page 29. Each plan is shown superimposed on the base condition showing the approximate location and orientation of the plan feature and is not to accurate scale or shape.

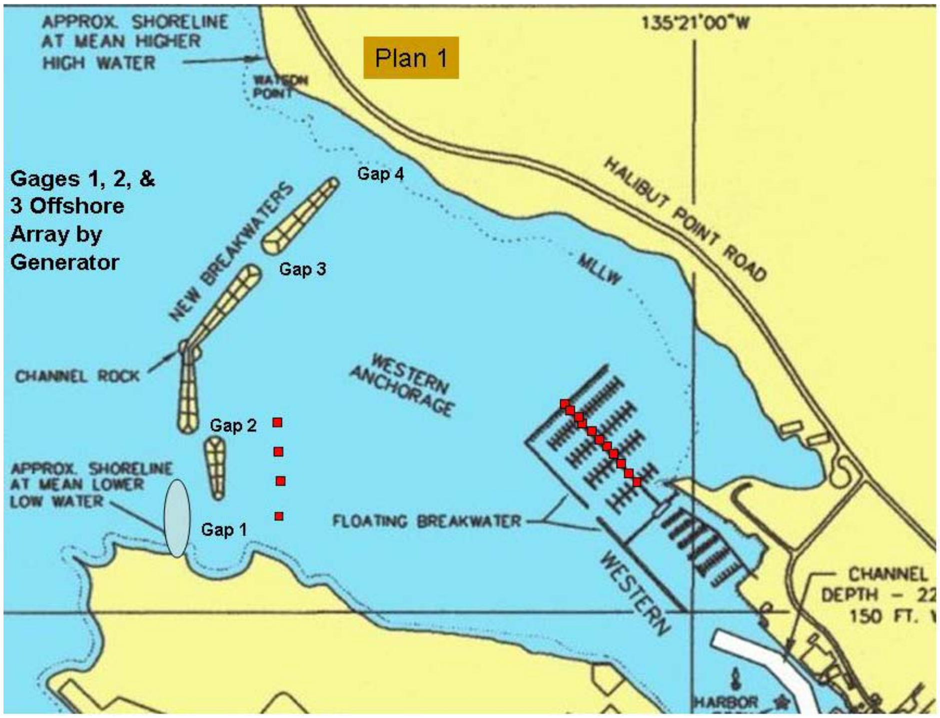

Figure 9. Plan 1 is a 500-foot-long breakwater extending north from Japonski Island.

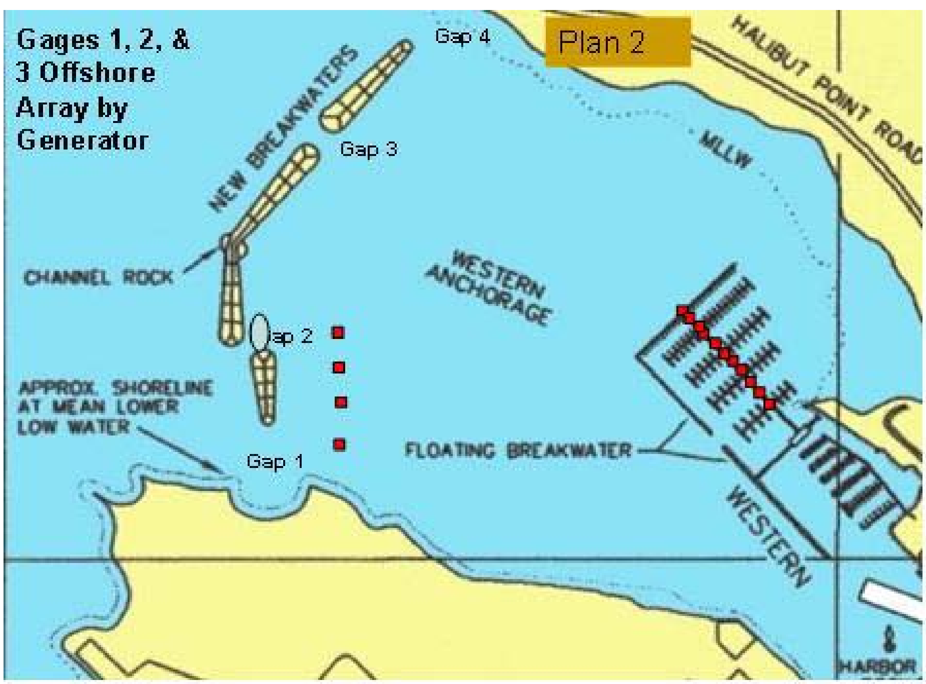

Figure 10. Plan 2 is a 330-foot-long extension to the north of the north end of the south breakwater, overlapping the main breakwater on the inside.

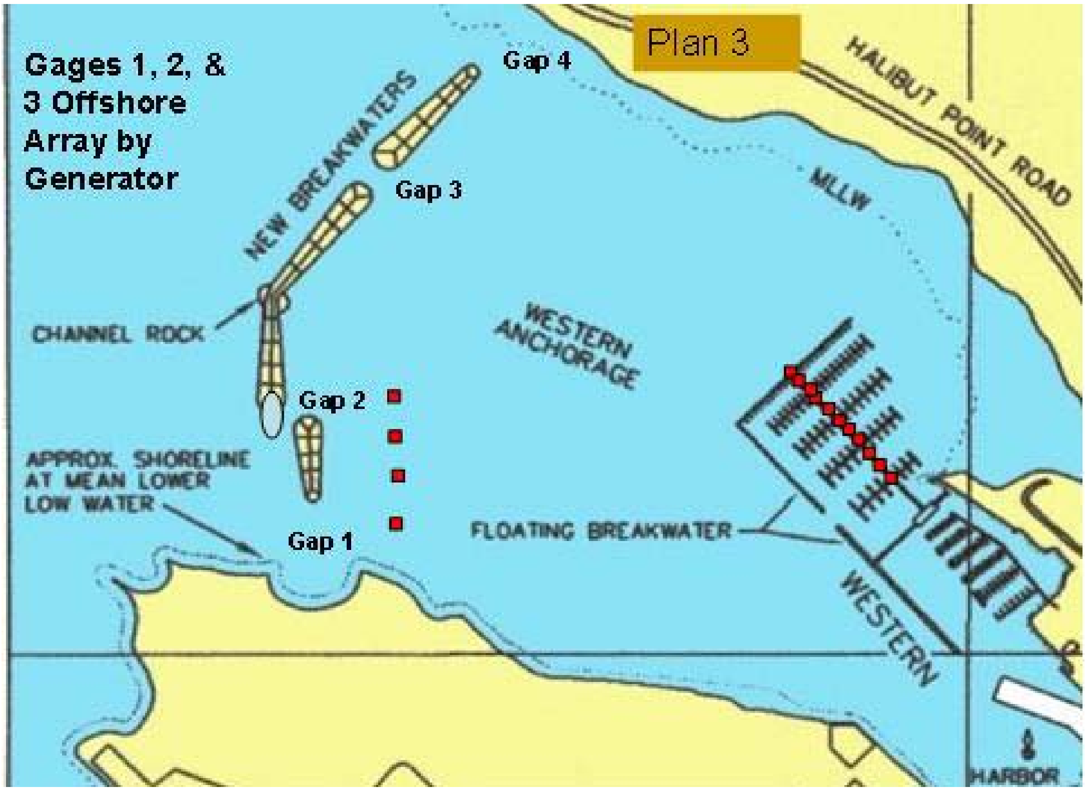

Figure 11. Plan 3 is a 330-foot-long extension of the south end of the main breakwater to the south, overlapping the south breakwater on the inside.

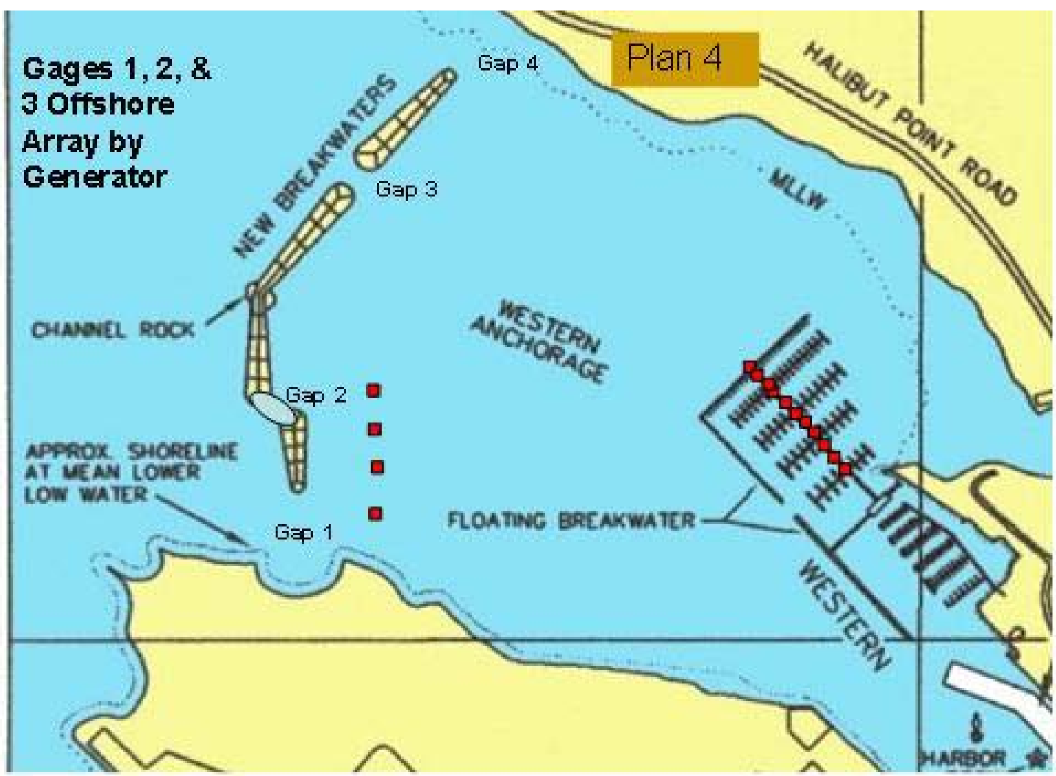

Figure 12. Plan 4 is a 315-foot-long closure of the gap between the south and the main breakwater.

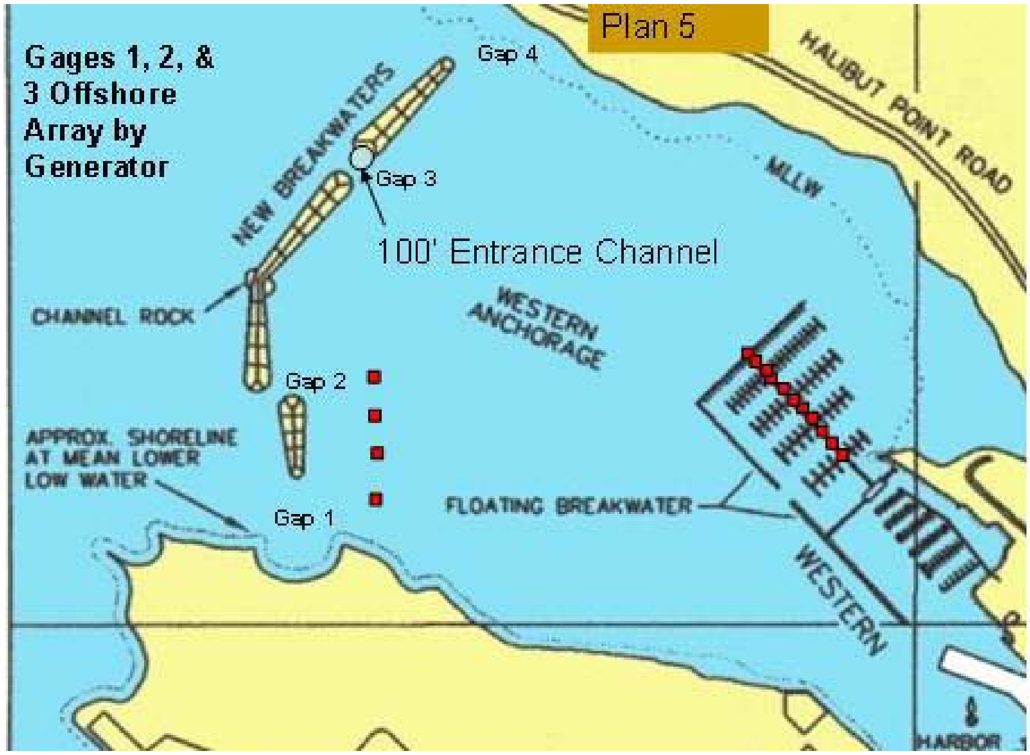

Figure 13. Plan 5 is a 300-foot-long extension of the SW end of the north breakwater, reducing the main navigation channel to 100-feet-wide.

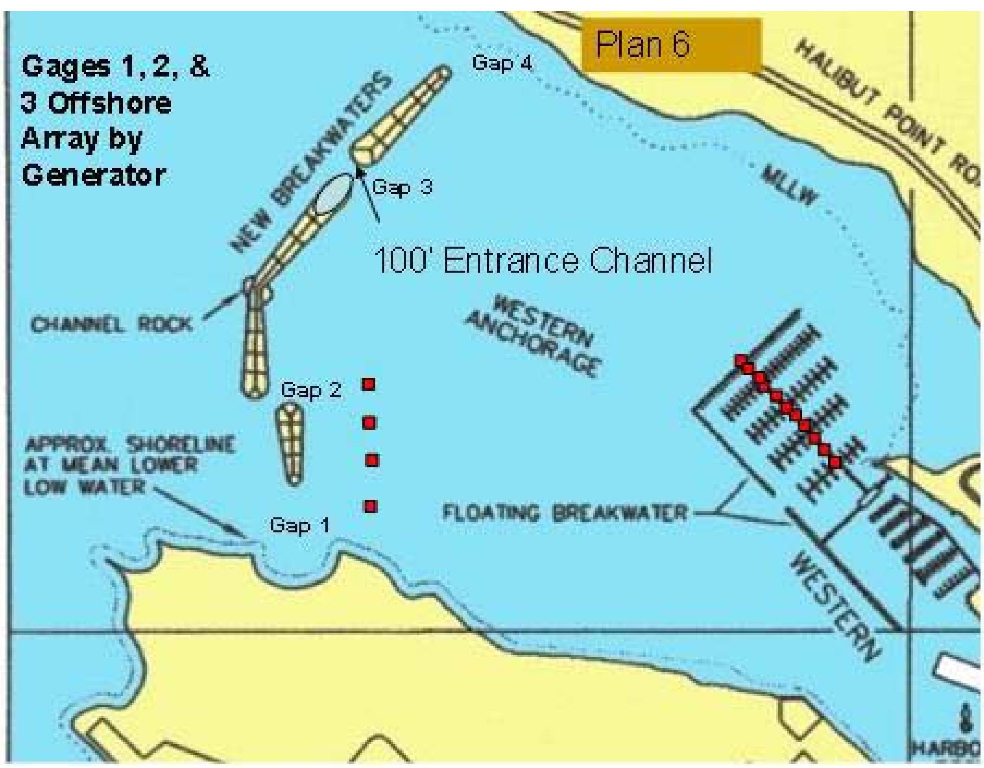

Figure 14. Plan 6 is a 300-foot-long extension of the NE end of the main breakwater, reducing the main navigation channel to 100-feet-wide.

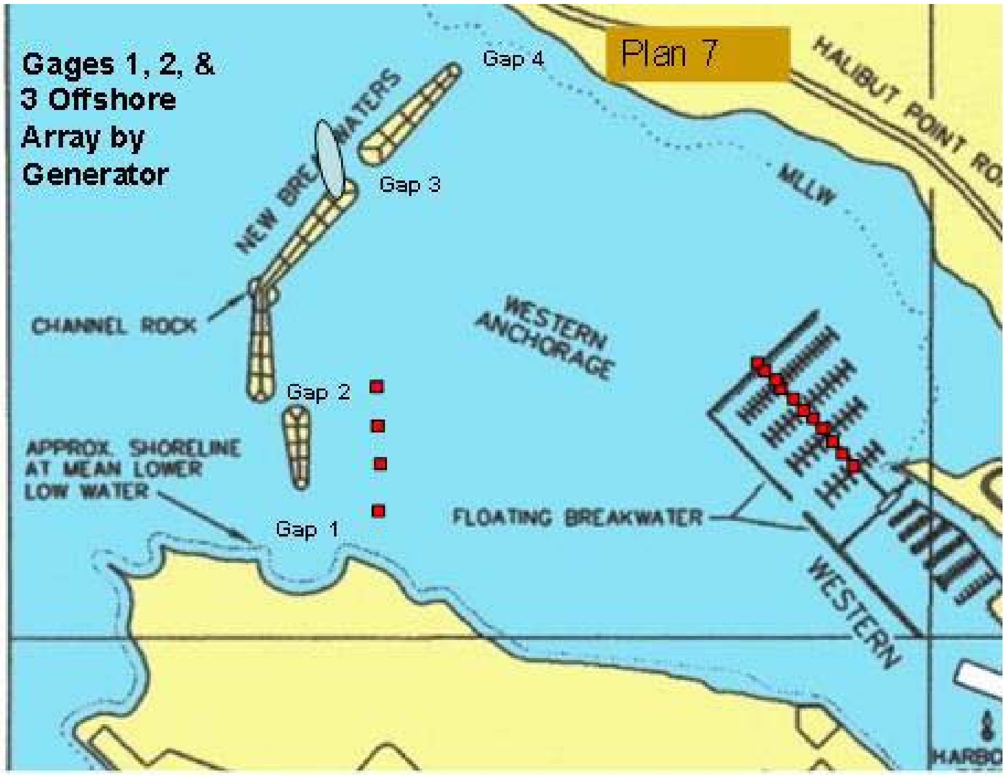

Figure 15. Plan 7 is an extension of the NE end of the main breakwater to the north.

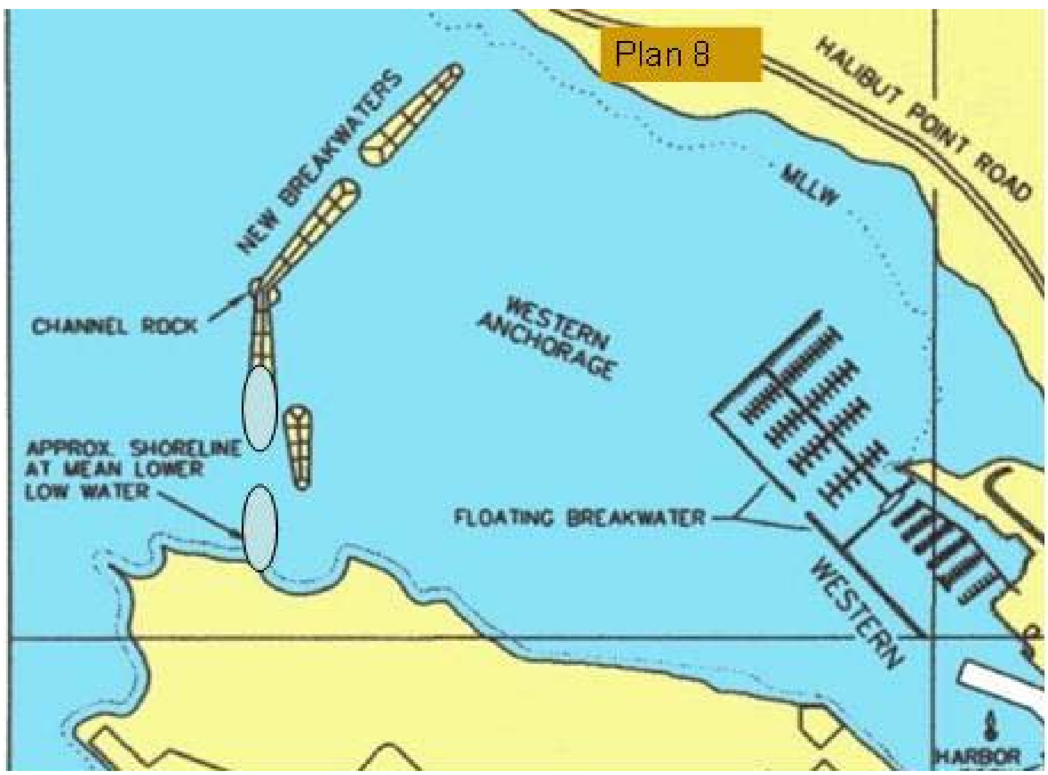

Figure 16. Plan 8 is a combination of Plan 1 and Plan 3.

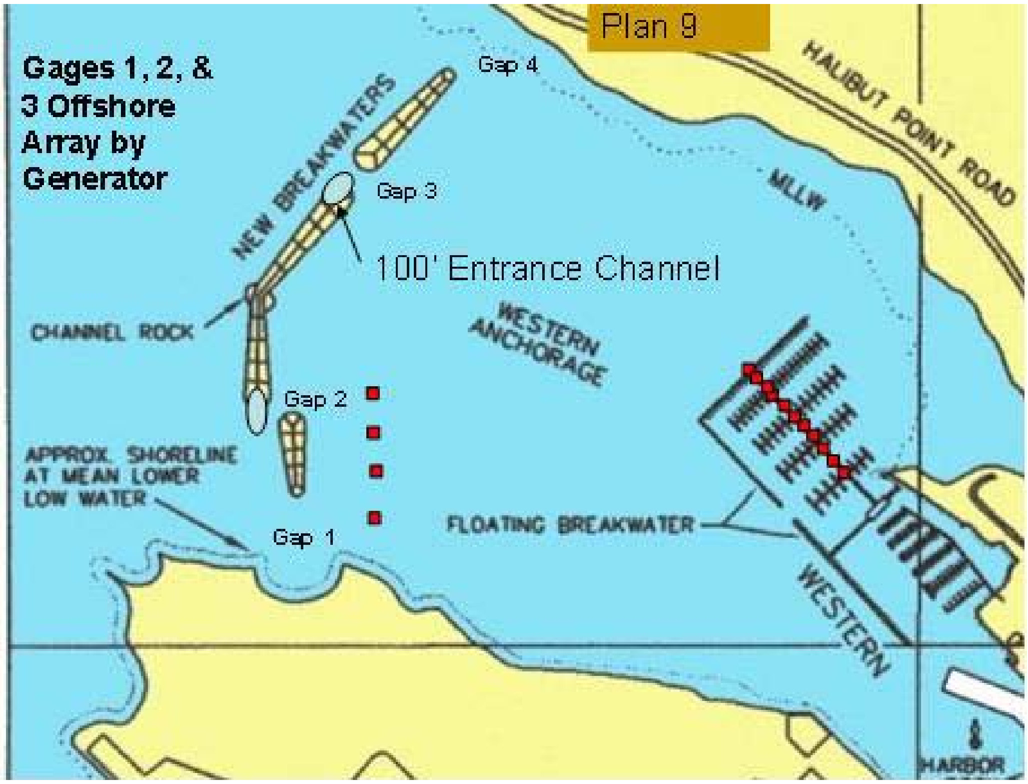

Figure 17. Plan 9 is a combination of Plan 3 and Plan 6.

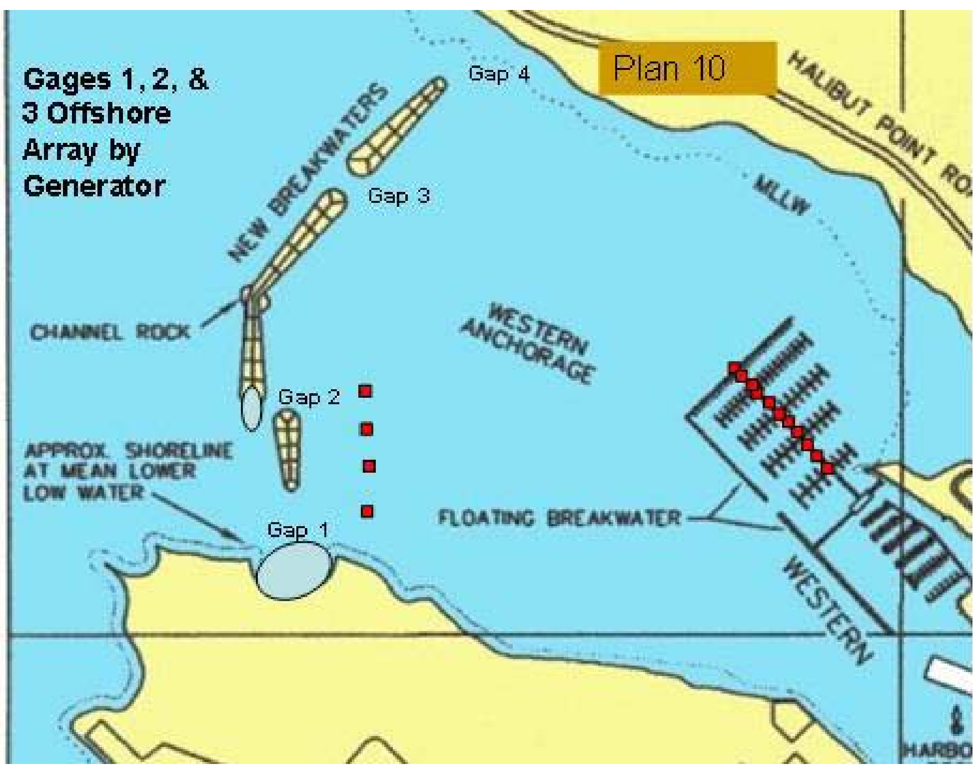

Figure 18. Plan 10 is a combination of Plan 3 and Plan 17.

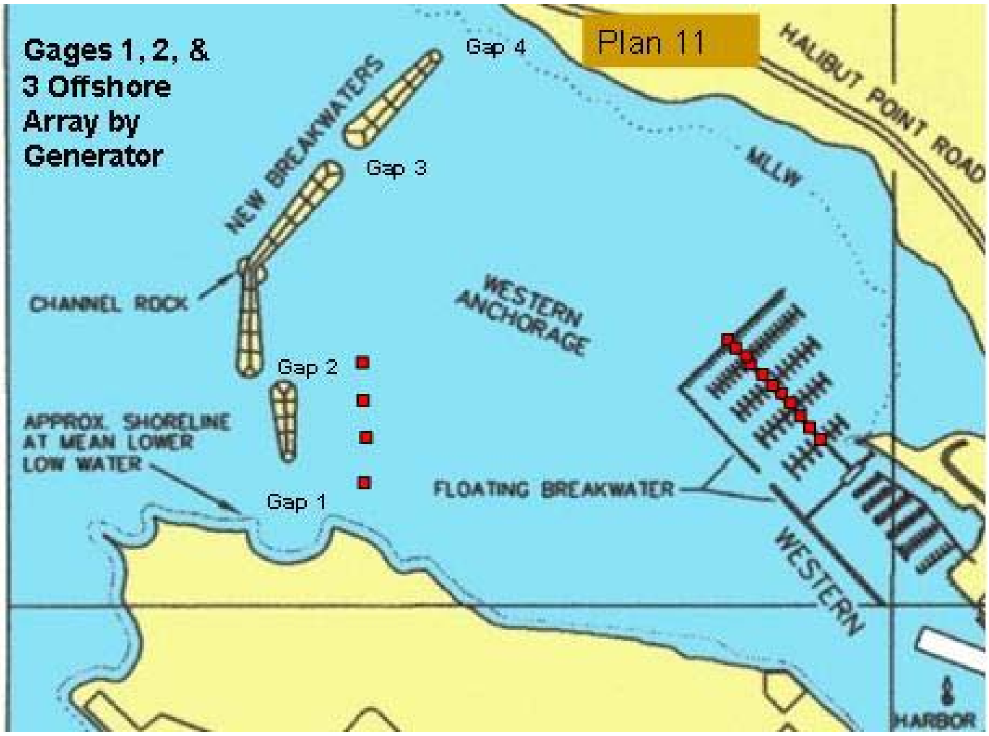

Figure 19. Plan 11 retains the existing configuration for the breakwaters, but uses a starting still water elevation of +7 ft. MLLW.

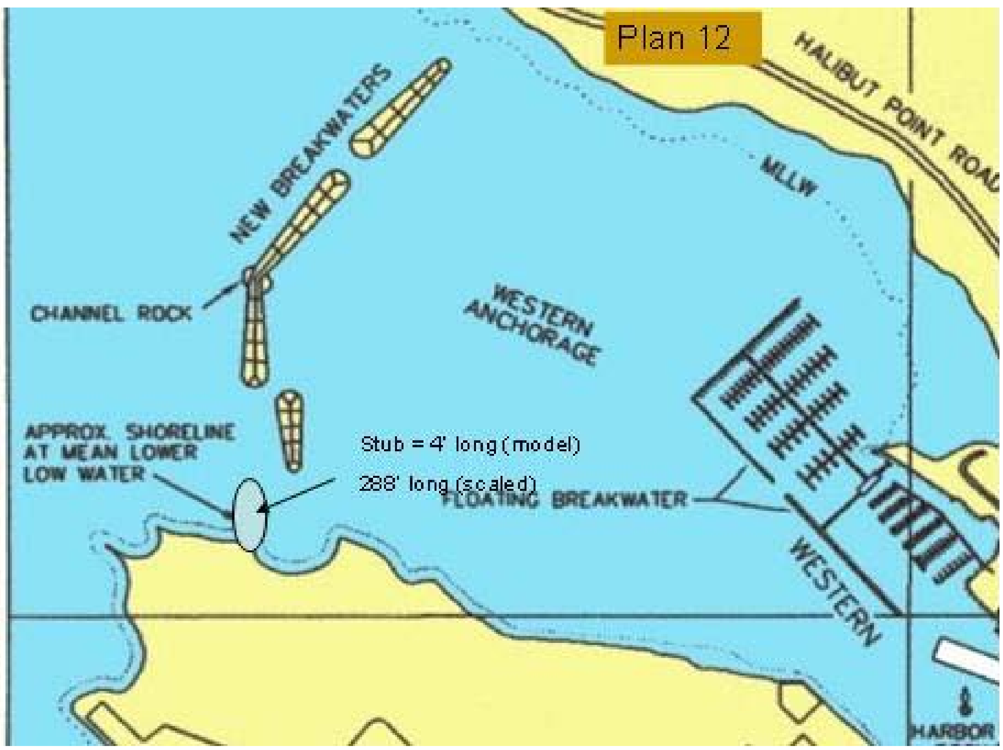

Figure 20. Plan 12 is a 288-foot-long breakwater extending north from Japonski Island.

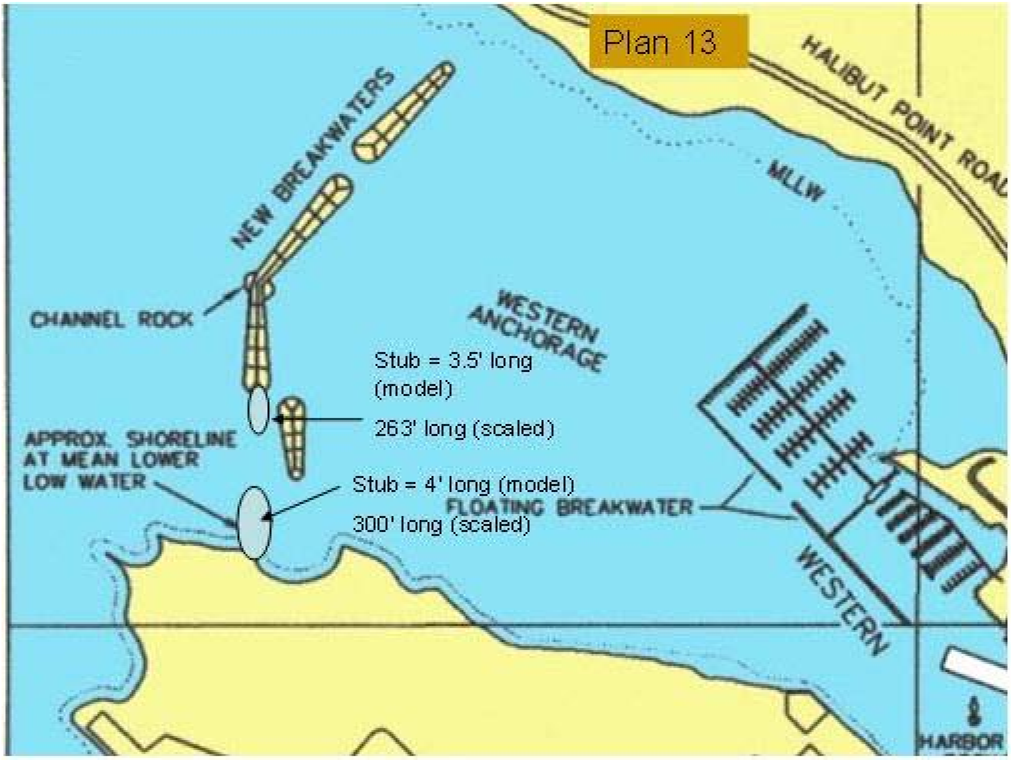

Figure 21. Plan 13 is a combination of a 300-foot-long breakwater extending north from Japonski Island and a 263-foot-long extension of the south end of the main breakwater.

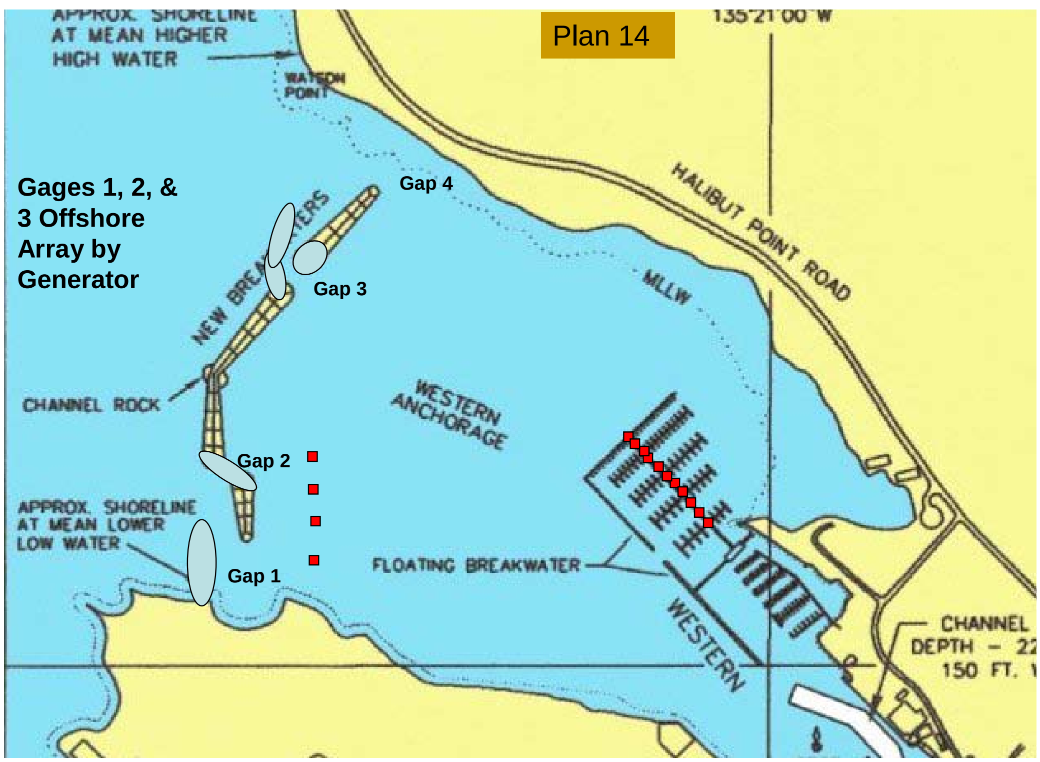

Figure 22. Plan 14 is a combination of Plan 1, Plan 4, and Plan 15.

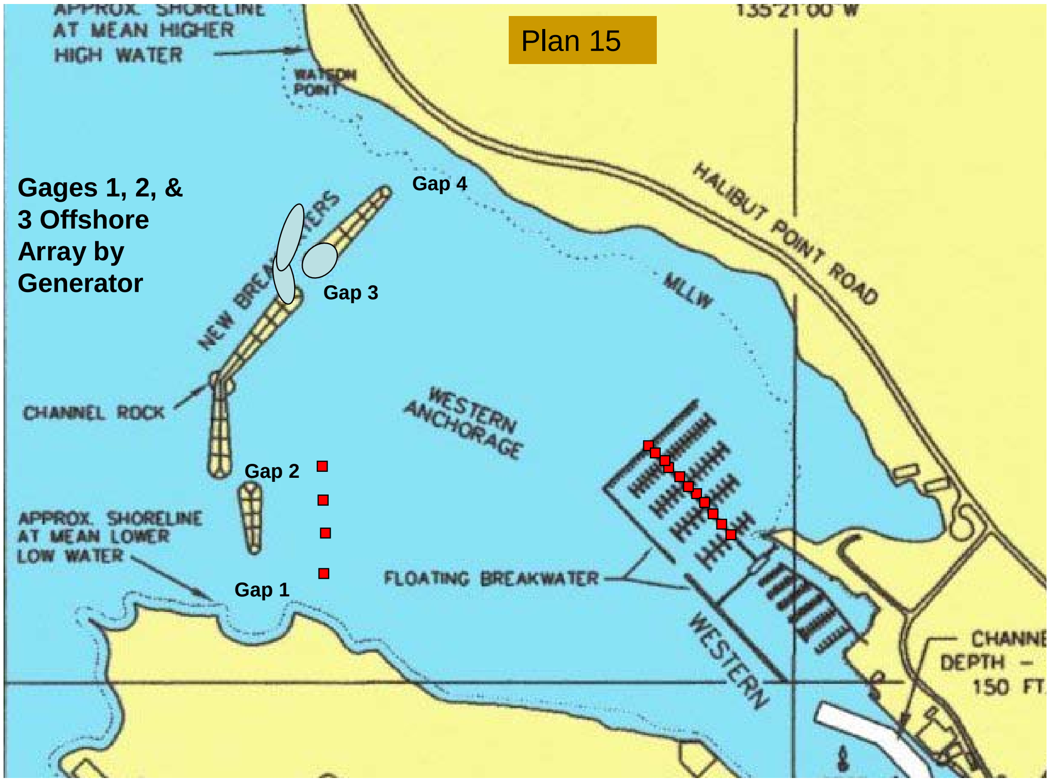

Figure 23. Plan 15 is a combination of a 450-foot-long angled extension of the NE end of the main breakwater along with a 60-foot-long extension of the SW end of the north breakwater.

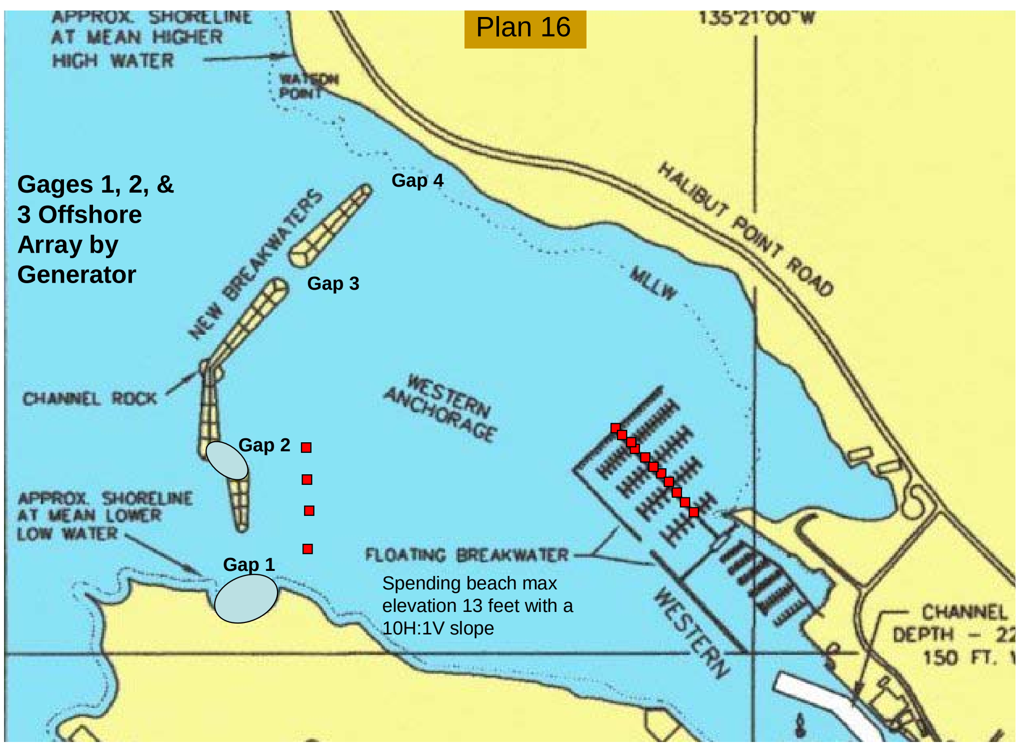

Figure 24. Plan 16 is a combination of Plan 4 and Plan 17.

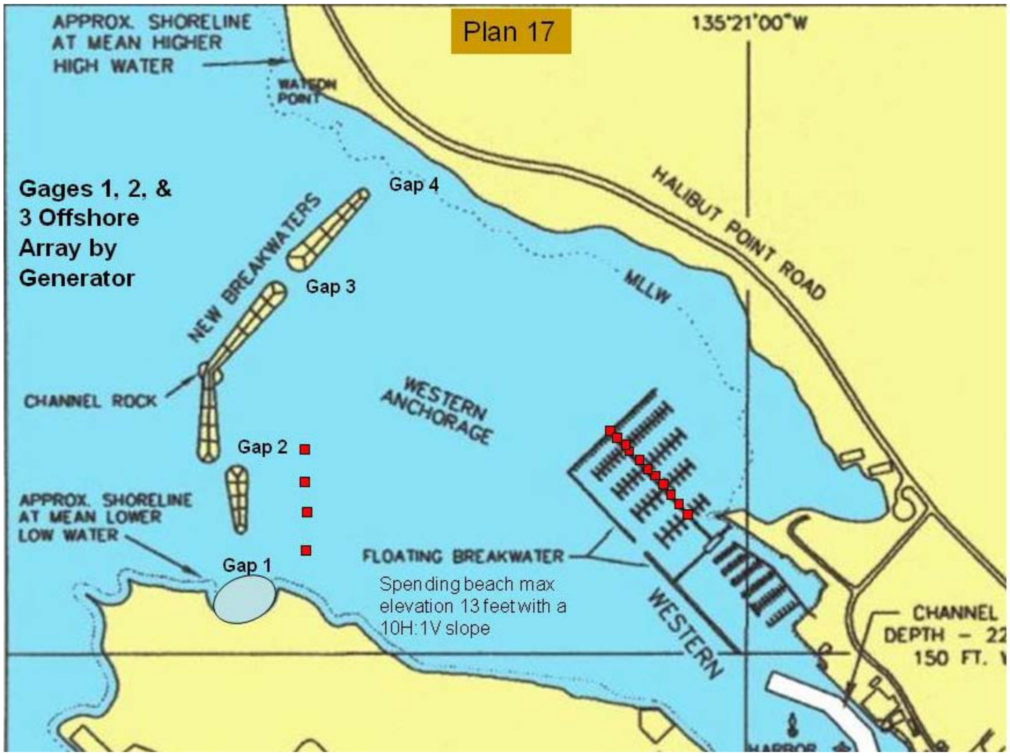

Figure 25. Plan 17 is a spending beach on Japonski Island, which is designed to bleed off wave energy passing through the near shore gap by raising the bathymetry to steer the incoming waves around the spending beach and into the shoreline.

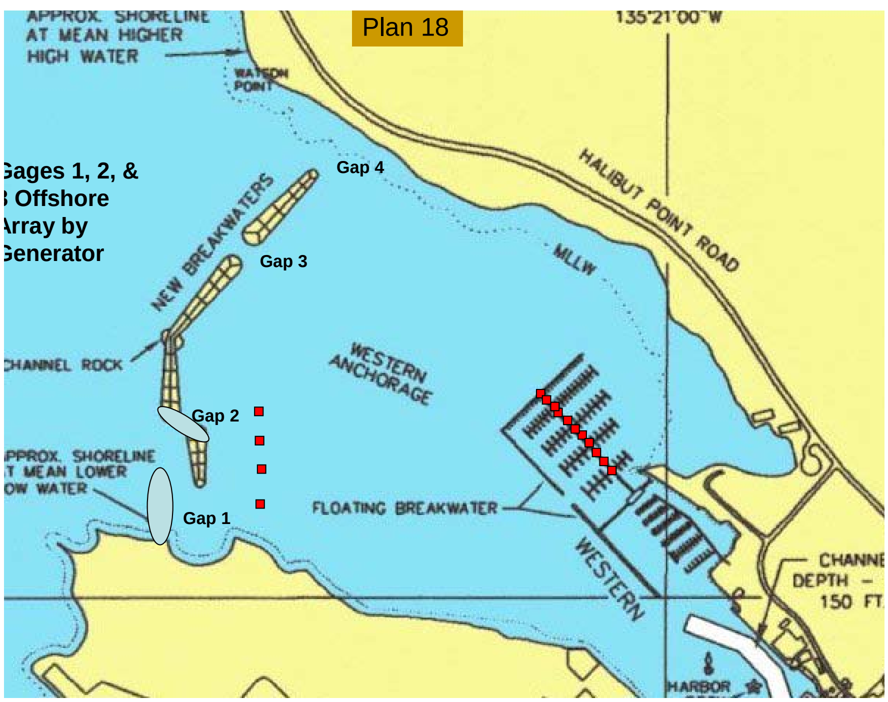

Figure 26. Plan 18 is a combination of Plan 1 and Plan 4.

4.4 Circulation

A qualitative circulation study was performed using the physical model of the Eliason Harbor at the ERDC WES. The study looked at the circulation associated with a falling tide only. Circulation associated with wind or wave activity in addition to the tide was not examined. This resulted in a conservative evaluation. Thirteen variations of breakwater configurations were tested and each configuration exhibited circulation being set up and flushing of the Western Anchorage area. An example of the circulation pattern set up during the test is shown in figure 27. Movie loops of the circulation were made using time lapse photography. These loops were presented to the environmental resource agencies for coordination on plan selection. After reviewing the filmed circulation patterns, State and Federal environmental resources agencies agreed with the Corps' assessment that water quality parameters in Eliason Harbor would not be adversely impacted by the different breakwater configurations.

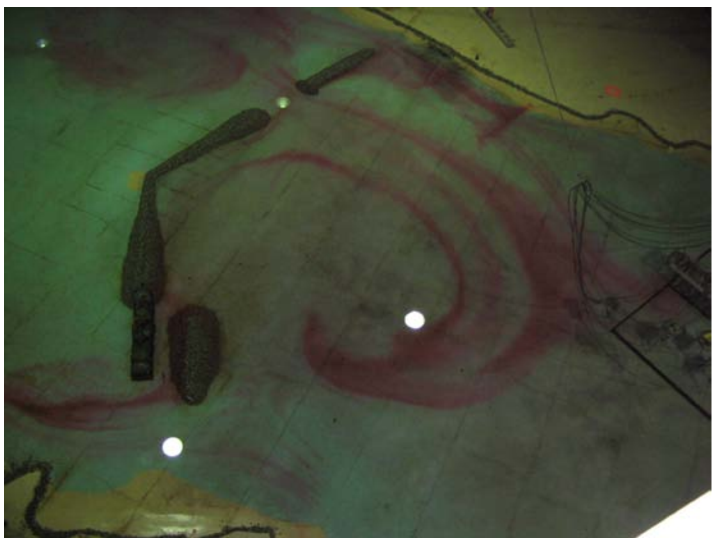

Figure 27. Circulation Pattern in ERDC Model.

5.0 COST EFFECTIVENESS ANALYSIS

5.1 Initial Alternative Corrective Action Screening

Plan formulation is based on information generated by physical modeling at WES and costs estimated by Tetra Tech, Inc. A physical model was used to evaluate action plans that were reasonably expected to reduce excessive float motion in the harbor. The 17 action plans looked at single measures or combinations of measures, such as:

- Extending breakwaters
- Adding additional breakwaters
- Adding a spending beach

This study addresses problems within Sitka Harbor, particularly at two sites of particular interest to the local sponsor. ERDC modeling provided estimates of wave energy reduction, achieved by each plan for those two areas: the dock/float area in Eliason Harbor (gage 8) and the southwest harbor area near Japonski Island, southeast of the south breakwater (gage 19). Construction cost estimates were developed for plans that best represented corrective actions to reduce wave energy. Seventeen action plans were run in the physical model. Ten were single measure plans (Plans 1, 2, 3, 4, 5, 6, 7, 12, 15, and 17), six were dual measures (Plans 8, 9, 10, 13, 16, and 18), and one was a three-measure plan (Plan 14). Plan 11 is not shown in table 2 since it represents the existing condition at a different still-water elevation (+7 feet MLLW vs. +11 feet MLLW) and is not an action plan. In addition, a cost estimate was developed for Plan 19 (combination of Plans 4, 15, and 17), but, since it was not run in the model, it is not shown in table 2. Table 2 provides information for each action plan, including a summary description of the plan feature, estimated construction cost (for 9 selected plans), and the percent of energy reduction for 10-second, 12-second, and 14-second waves for both the Eliason Harbor area and the southwest harbor area near Japonski Island.

Table 2. Deficiency Correction Plans' Energy Reduction Measured in Sitka Harbor Model.

Plan	Description	Construction Cost	Percentage Energy Reduction at Specific Locations					
			Gage 8 – Eliason Harbor			Gage 19 – Southwest Harbor		
		wave period =	10-sec	12-sec	14-sec	10-sec	12-sec	14-sec
1	500' Stub off J.I.	$6,981,000	17%	14%	22%	2%	10%	4%
2	330' N end SBW	$10,390,000	25%	4%	27%	45%	31%	35%
3	330' S end MBW	$10,861,000	43%	17%	24%	44%	29%	18%
4	315' SBW-MBW	$8,140,000	50%	32%	35%	70%	58%	44%
5	300' S end NBW	not estimated	23%	4%	25%	2%	21%	4%
6	300' N end MBW	not estimated	19%	22%	22%	6%	9%	24%
7	200' N end MBW	$10,211,000	50%	52%	52%	16%	none	4%
8	Plan 1 + 3	not estimated	30%	12%	27%	56%	54%	4%
9	Plan 3 + 6	not estimated	47%	37%	44%	50%	45%	63%
10	Plan 3 + 17	not estimated	35%	17%	35%	48%	23%	47%
12	288' Stub off J.I.	not estimated	8%	10%	19%	2%	none	8%
13	260' #3 + Plan 12	not estimated	23%	6%	17%	51%	41%	44%
14	Plan 1 + 4 + 15	$25,522,000	67%	74%	43%	75%	70%	68%
15	450' N end MBW	$14,401,000	54%	48%	41%	10%	4%	4%
16	Plan 4 + 17	$12,461,000	32%	20%	2%	60%	58%	53%
17	Spending Beach	$6,954,000	12%	5%	14%	13%	14%	11%
18	Plan 1 + 4	$12,488,000	36%	17%	7%	67%	74%	38%
Note: JI = Japonski Island, SBW = South Breakwater, MBW = Main Breakwater, NBW = North Breakwater								

The 17 action plans were compared using a modified cost effectiveness analysis. The comparison first looks at how the model shows plans affecting existing improvements in Eliason Harbor, and then considers the effects each plan would have on the southwest harbor area, the potential seaplane facility, and finally looks at the harbor as a total unit. While the relative relationships determined by the above criteria can be identified in table 2, they are easier to understand and can be visually apparent when graphing the output (energy reduction) of each plan versus the cost of each plan.

The information from table 2 for plan cost and respective energy reduction at Eliason Harbor is displayed in figure 28, which is a cost effectiveness graph. The vertical axis is the cost of the plan, and the horizontal axis is the percent of energy reduction measured at

Eliason Harbor (gage 8). Values are shown for each of three wave periods for each plan. The no-action plan's position on the graph (not shown) is at the origin since it has no implementation cost and provides no energy reduction. Lines are drawn from the graph origin through the successive cost effective plans for each of the wave periods considered.

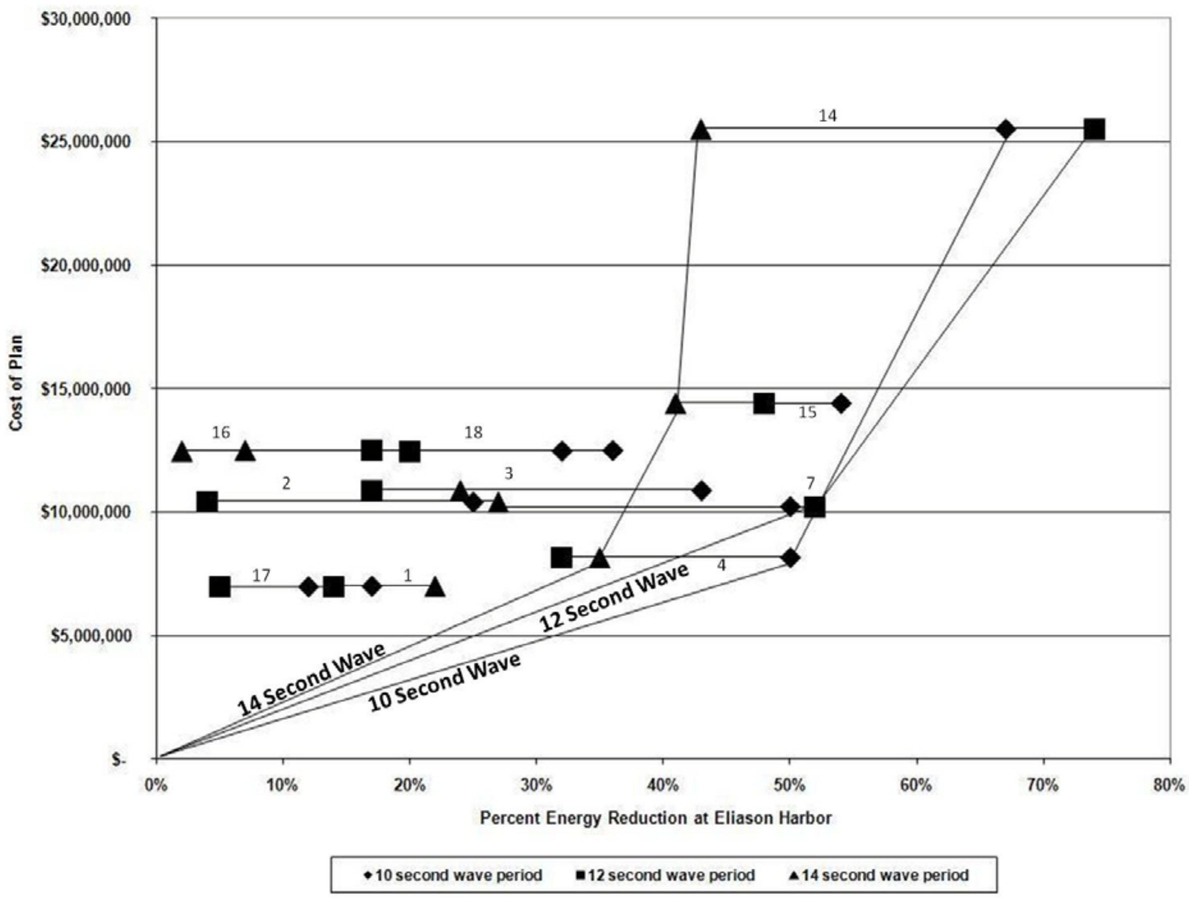

Figure 28. Eliason Harbor Area Energy Reduction. The cost effectiveness graph shows the sequence of cost effective plans in order of increasing output (increasing energy reduction at Eliason Harbor) for the three selected wave periods.

Similar information from table 2 for the plan cost and energy reduction for the southwest harbor area is shown in figure 29. For this location, the general analysis is similar to that for Eliason Harbor, but the relative relationships between plans are different.

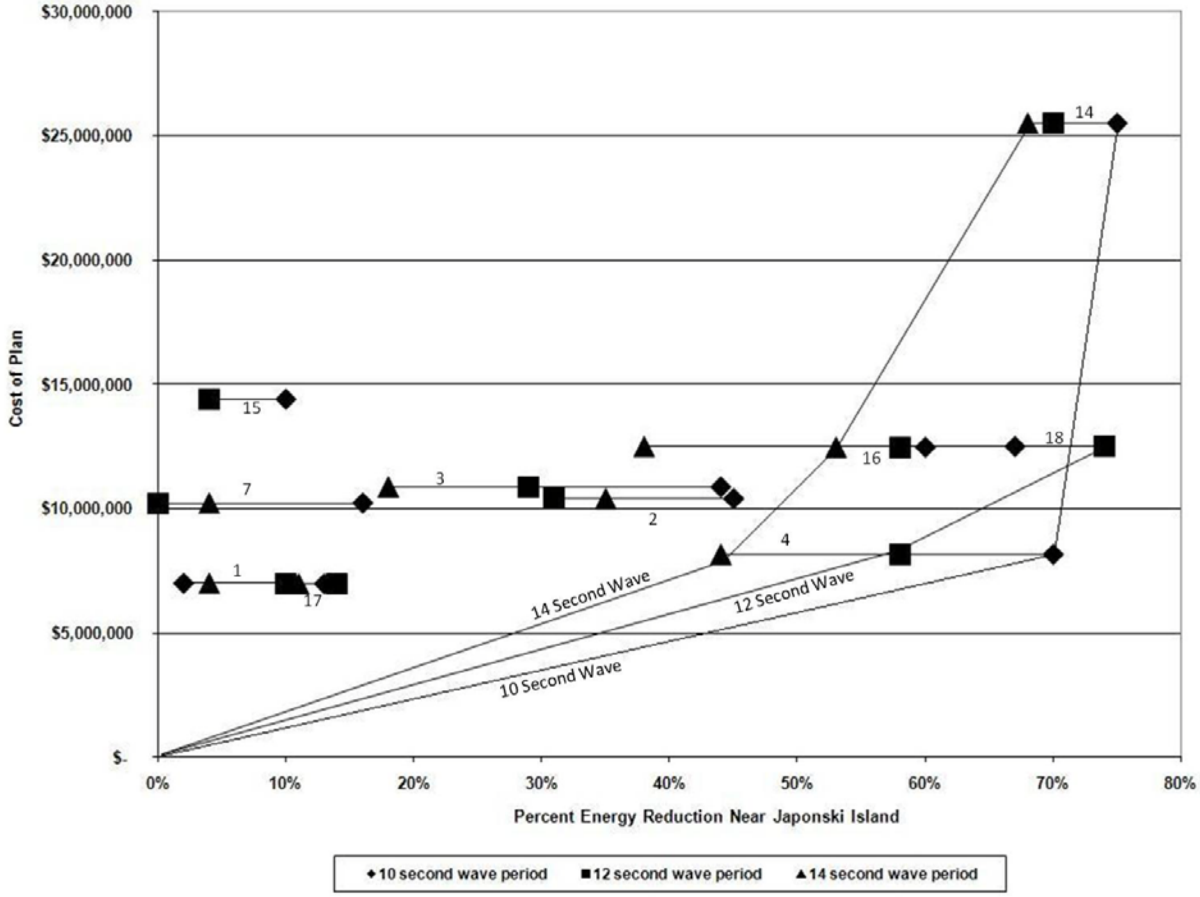

Figure 29. Southwest Harbor Area Energy Reduction. The cost effectiveness graph shows the sequence of cost effective plans in order of increasing output (increasing energy reduction near Japonski Island) for the three selected wave periods.

In cost effectiveness analysis, plans are screened out that:

- Produce the same output level as another plan, but cost more
- Cost either the same amount or more than another plan, but produce less output

Figure 28 displays the plans' cost effectiveness for energy reduction for Eliason Harbor. The horizontal line for each of the plans delineates the range of energy reduction values that could be obtained by each plan at the three specified wave periods. Plans 2, 3, 16, and 18 can be screened out since they lie above and/or to the left of other, more cost effective plans. All of these plans cost more than other plans that provide equal or greater energy reduction (Plans 17, 1, 4, 15, and 14). Effects can be considered individually for each wave period. For the 10-second wave, the sequence of cost effective plans is: Plans 17, 1, 4, 7, 15, then Plan 14. For the 12-second period wave, the sequence is the same. For the 14-second period wave, the sequence is 17, 1, 4, 15, and 14. All other considerations aside, all plans above and to the left of the cost effectiveness lines should be dropped from further consideration as not being cost effective. Thus Plan 2, Plan 3, Plan 16, and Plan 18 should be screened out of further analysis if the decision is based only on effects in the Eliason Harbor area.

Figure 29 displays the plans' cost effectiveness for energy reduction for the southwest harbor area. Notably, Plan 16 and Plan 18 perform significantly better for this location than at Eliason Harbor, and Plans 7 and 15 perform substantially worse. Plans 2, 3, 7, and 15 cost more than other plans that provide equal or greater energy reduction (Plans 1, 17, 4, 16, 18, and 14). For the 10-second wave, the sequence of cost effective plans is: Plans 17, 4, and 14. For the 12-second period wave, the sequence is: Plans 17, 4, and 18. For the 14-second period wave, the sequence is: Plans 17, 4, 16, and 14. For this location, Plan 1, Plan 2, Plan 3, Plan 7, and Plan 15 should be screened out of future analysis if the decision is based only on effects in the southwest harbor area near Japonski Island.

The cost effectiveness analysis shows that Plan 2 and Plan 3 are clearly not cost effective for either area for the wave periods considered and therefore are screened out of further consideration.

Plan 4, Plan 14, and Plan 17 appear cost effective for both sites and should be considered for further analysis. However, Plan 17 provides a maximum 14 percent energy reduction for both sites for only one of the three wave periods (range is 5-14%). Since the outputs provided by Plans 4 and 14 are significantly greater than provided by plan 17 (32-70% and 43-75%, respectively), Plans 4 and 14 are retained for further analysis and Plan 17 is screened out.

Both Plan 16 and Plan 18 are clearly not cost effective when compared with the other alternatives for reducing wave energy in the Eliason Harbor area. Although they are excellent for reducing wave energy in the southwest harbor area (ranges: 53-60% and 38-74%, respectively), for Eliason Harbor they provide significantly less energy reduction (ranges: 2-32% and 7-36%, respectively). Plan 7 provides good energy reduction for the Eliason Harbor area (range 50-52%), but relatively little for the southwest harbor area (range 0-16%). Therefore, Plan 7, Plan 16, and Plan 18 are screened out.

Regarding the seven plans for which cost estimates were not developed, Plans 5, 6, and 12 provide relatively low energy reduction at either site for any of the three wave periods considered (ranges are: 4-25%, 6-24%, and 0-19%, respectively) . Plan 13 provides a range of 6 to 23 percent for the Eliason Harbor area. Plans 8, 9, and 10 are combinations of Plan 3 with plans 1, 6, and 17, respectively. Plan 3 by itself is clearly not cost effective, and its combination with Plan 1 and Plan 17 provides even less energy reduction than Plan 3 would by itself. Plan 9 appears potentially promising because its energy reduction percentages are roughly additive between Plans 3 and 6 (range 37-63%). However, Plan 3 costs of about $25+ million make it not cost effective when compared with Plans 1, 14, or 15.

Plan 14 is the only three-measure plan, combining Plan 1 with Plan 4 and Plan 15. Therefore, since all four of these plans are cost effective for Eliason Harbor and form building blocks for one of the alternatives, all four should be retained for the final alternative array, along with the no-action alternative. Another reason for retaining Plan 1 is that the local sponsor has indicated their belief that building a short breakwater on

Japonski Island either alone, or in combination with other measures (Plan 8, 15, and 18), would reduce the problems they experience at Eliason Harbor.

5.2 Detailed Alternative Corrective Action Screening

The remaining four action plans, Plan 1 (500-foot-long breakwater extending from Japonski Island), Plan 4 (315-foot-long gap closure between the south and main breakwaters), Plan 14 (combination of Plan 1, Plan 4, and Plan 15), and Plan 15 (415-foot-long angled extension of main breakwater and 60-foot-long extension of north breakwater) are developed into more detailed alternatives. The no-action alternative also is considered in detail.

5.2.1 Description of Detailed Alternative Corrective Actions

This section discusses the four actions plans from section 5.1 that are cost effective, most responsive to project objectives, and have the best potential to be constructed and maintained. The alternative numbering system is the same as the plan numbering. The plans are referred to as alternative corrective actions (alternatives) in the remainder of this DCER. Potential environmental impacts are addressed for each detailed alternative. A more extensive discussion is in section 4 of Appendix A, the environmental assessment (EA). This section also introduces no-action as an alternative. Table 3 provides the information from the prior discussion comparing the four alternative deficiency correction plans selected for detailed alternative analysis. The cost comparisons are made based on construction costs. Each of these plans also will require some operation and maintenance work, primarily replacing a small portion of the armor rock during the project life. The O&M costs vary directly as the plans' total rock volumes. These costs are relatively small and not significant in the plan comparison and alternative selection process.

Table 3. Energy Reduction, Sitka Harbor Physical Modeling for Final Detailed Alternatives.

Plan	Description	Construction Cost	Percentage Energy Reduction at Specific Locations					
			Gage 8 – Eliason Harbor			Gage 19 – Southwest Harbor		
		wave period =	10-sec	12-sec	14-sec	10-sec	12-sec	14-sec
1	500' Stub off J.I.	$ 6,981,000	17%	14%	22%	2%	10%	4%
4	315' SBW-M BW	$ 8,140,000	50%	32%	35%	70%	58%	44%
14	Plan 1 + 4 + 15	$25,522,000	67%	74%	43%	75%	70%	68%
15	450' N end MBW	$14,401,000	54%	48%	41%	10%	4%	4%

No-Action Alternative

The alternative of no further Federal action is considered in each Corps water resources project analysis. No project design changes or construction is associated with the no-action alternative. Existing Channel Rock Breakwaters features would remain in place and unaltered. No construction cost is associated with the no-action alternative. However, users of the harbor would continue to experience adverse conditions resulting in damage to vessels and harbor facilities. Benthic and associated algal communities, fish communities, and essential fish habitat (EFH) would continue to be affected by harbor and shoreline development activities requiring intertidal/subtidal fill. Local marine mammal and avian populations would continue to use the breakwater area and be affected by vessel traffic and ongoing harbor and urban activities. Future shoreline/in-water developments might affect endangered and threatened species and their habitat. Subsistence harvesting of herring and herring eggs would continue unabated. Urban runoff and permitted wastewater discharges would continue to affect local water quality, but harbor circulation is expected to be sufficient enough to prevent degradation. Future terrestrial developments may affect cultural, historical, and archaeological resources. Coastal development, such as seaplane base relocation, mariculture expansion, and harbor moorage expansion, accompanied by increased harbor use is likely. Safety improvements for Sitka's airport on the west side of Japonski Island will include intertidal fill.

Alternative 1 – Stub Breakwater from Japonski Island
Alternative 1 would involve constructing a 500-foot-long stub breakwater from Japonski Island to provide a 100-foot overlap of the existing south breakwater. Plan views of this alternative are shown in figure 30, cross sections for the trunk of the breakwater in figure 31, and for the nose of the breakwater in figure 32. Approximately 7,000 cubic yards of 2,000-pound armor stone, 10,000 cubic yards of B rock, and 21,000 cubic yards of core material would be required for this alternative. Marine benthic habitat (soft bottom and rocky substrate) of 1.6 acres would be unavoidably lost by fill activities, while there would be a net gain of 1.4 acres of rocky substrate provided by the breakwater modification, which would support associated algal communities, fish communities, EFH (Pacific herring spawning habitat), and additional habitat for seabirds.

The less than a year construction season would result in a temporary disturbance of ambient noise and increased suspended sediment conditions. These, in association with vessel noise, vessel transits, and ongoing harbor and urban activities would cause marine mammals, fish communities, and avian species near the construction site to temporarily move away from the area. Construction activities have the potential to cause avoidance, disturbance, or displacement of Steller sea lions and humpback whales from Sitka Harbor during peak Pacific herring spawning activities. However, the action would not modify or adversely affect designated critical habitat and may affect, but is not likely to adversely affect, Steller sea lions, humpback whales, or Pacific herring. Subsistence harvesting of herring and herring eggs would have a short-term impact. Urban runoff and permitted wastewater discharges would continue to affect local water quality. Modeled circulation for this alternative indicated conditions similar to or better than existing conditions, and therefore, Alternative 1 is not expected to produce water quality/circulation "dead zones." No impacts are anticipated on customary and traditional cultural practices or on historical and archaeological features. The amount of fill involved in the breakwater modification represents a minor change relative to prior intertidal/subtidal fills. This alternative, in concert with past, present, and foreseeable actions, is not likely to have any significant cumulative adverse impacts on Sitka Harbor fish, wildlife, and human resources.

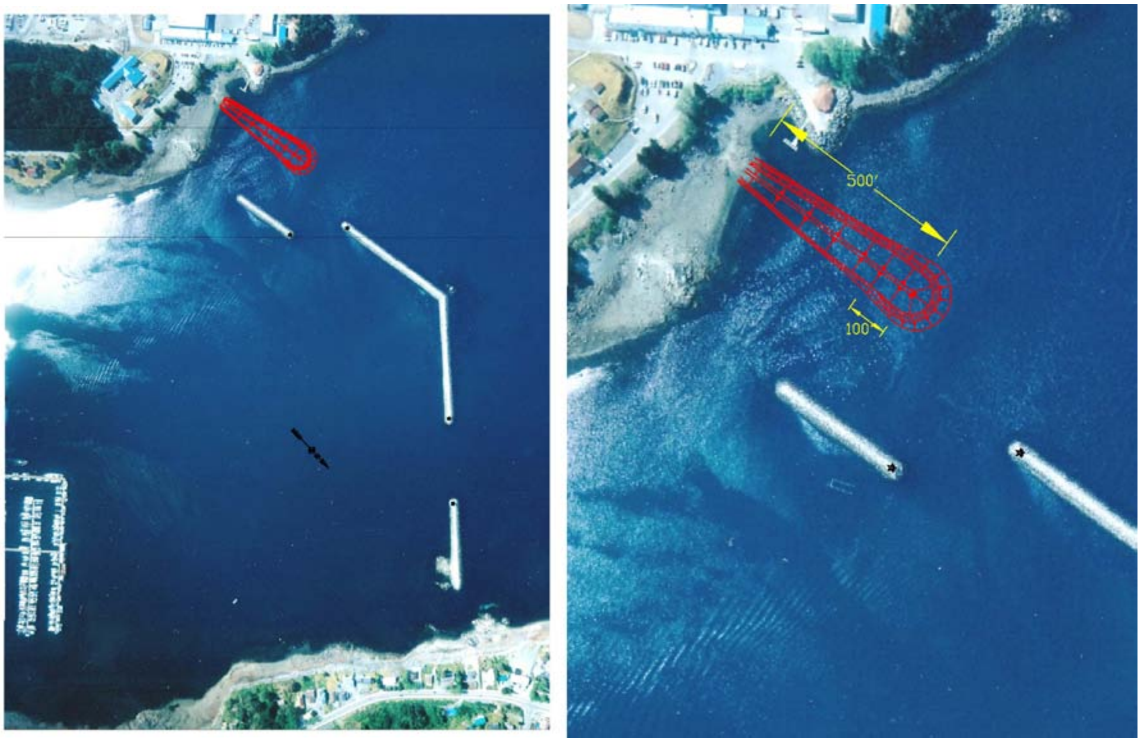

Figure 30. Alternative 1 - Stub Breakwater from Japonski Island would extend from the Japonski Island shore northward to form a 100-foot overlap with the south breakwater–drawings not to scale.

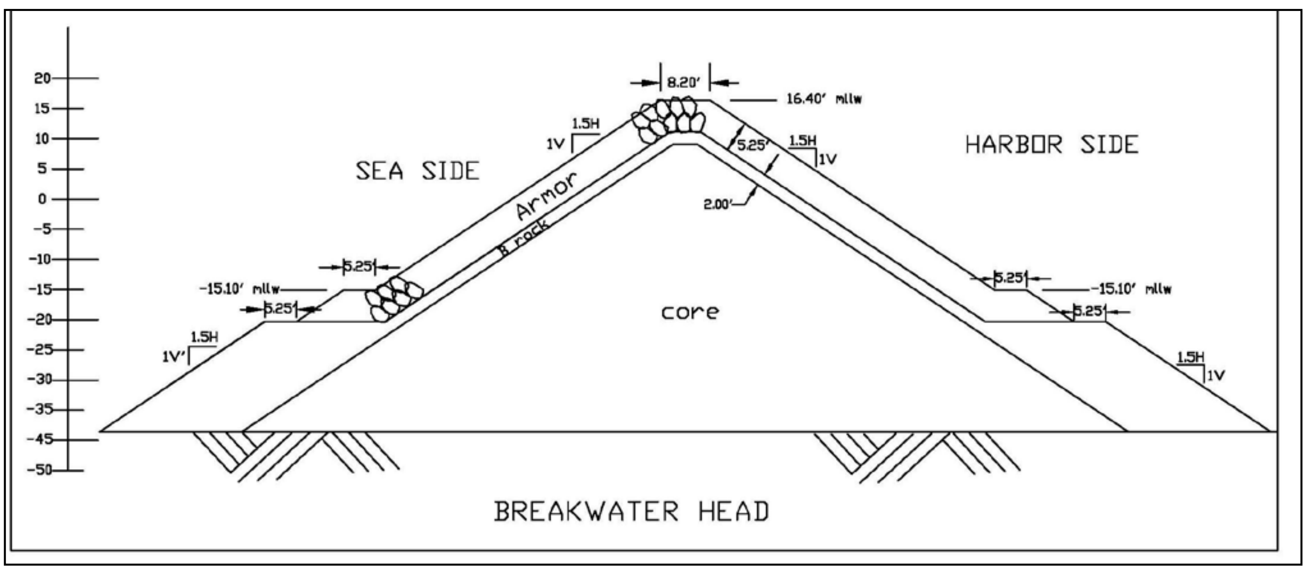

Figure 31. Breakwater Head Cross Section for Alternatives 1 and 14.

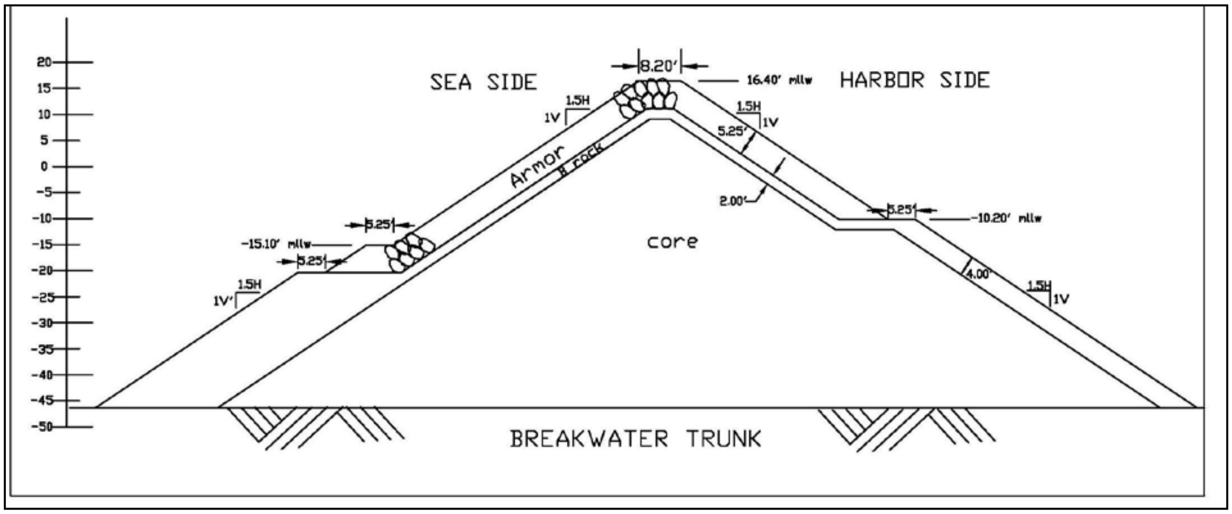

Figure 32. Breakwater Trunk Cross Section for Alternatives 1, 4, and 14.

Alternative 4 – Breakwater Closure between Main and South Breakwater

Alternative 4 would construct a 315-foot-long extension to connect the main breakwater and the south breakwater. The cross section of the breakwater extension trunk is illustrated in figure 32. Plan views of this alternative are shown in figure 33. Approximately 9,000 cubic yards of armor stone, 13,000 cubic yards of B rock, and 30,000 cubic yards of core material would be required for this alternative. The armor and B rock on the existing breakwater would be removed where the extension begins. Approximately 3,000 cubic yards of armor stone and 1,100 cubic yards of B rock would be removed at the southern end of the main breakwater and used in construction of the extension. Marine benthic habitat (soft bottom and rocky substrate) of 0.6 acre would be unavoidably lost by fill activities, while there would be a net gain of 0.5 acre of rocky substrate provided by the breakwater modification, which would support associated algal communities, fish communities, EFH (Pacific herring spawning habitat), and additional habitat for seabirds.

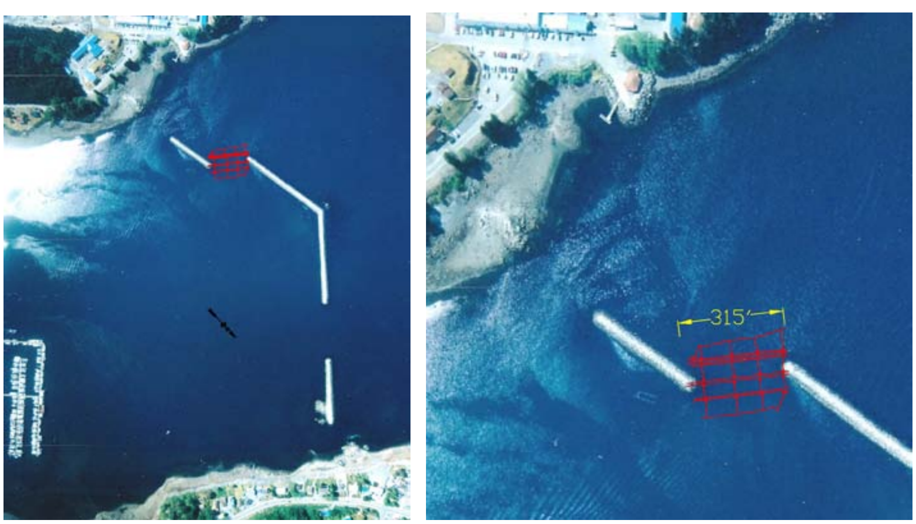

Figure 33. Alternative 4 - Breakwater Closure between Main and South Breakwaters – drawing not to scale.

The less than a year construction season would result in a temporary disturbance of ambient noise and increased suspended sediment conditions. These, in association with vessel noise, vessel transits, and ongoing harbor and urban activities, would cause marine mammals, fish communities, and avian species near the construction site to temporarily move away from the area. Construction activities have the potential to cause avoidance, disturbance, or displacement of Steller sea lions and humpback whales from Sitka Harbor during peak Pacific herring spawning activities. However, the action would not modify or adversely affect designated critical habitat and may affect, but is not likely to adversely affect, Steller sea lions, humpback whales, or Pacific herring. There would be a short-term impact on subsistence harvesting of herring and herring eggs. Urban runoff and permitted wastewater discharges would continue to affect local water quality. Modeled circulation for this alternative indicated conditions similar to or better than existing conditions, and therefore, Alternative 4 is not expected to produce water quality/circulation "dead zones." No impacts are anticipated on customary and traditional cultural practices or on historical and archaeological features. The amount of fill involved in the breakwater modification represents a minor change relative to prior intertidal/subtidal fills. This alternative, in concert with past, present, and foreseeable actions, is not likely to have any significant cumulative adverse impacts on Sitka Harbor fish, wildlife, and human resources.

Alternative 14 – Stub Breakwater from Japonski Island, Main/South Breakwater Closure, and Main and North Breakwater Extensions

Alternative 14 would expand the existing breakwaters and close or reduce gaps with four construction features, which would be as follows:

- A 500-foot-long stub breakwater from Japonski Island would overlap the gap between Japonski Island and the south breakwater and reduce wave energy through this gap.
- A 315-foot-long breakwater extension would connect the main breakwater and the south breakwater to reduce wave energy focused through this area from the Gulf of Alaska.
- The north end of the main breakwater would be extended 450 feet at an angle to overlap the north breakwater by 100 feet and reduce wave energy through the main entrance channel.
- The south end of the north breakwater would be extended 60 feet to further reduce entrance channel width and wave energy through it.

A cross section for the head and trunk of the breakwater is shown in figure 31, and the trunk of the breakwater is shown in figure 32. Plan views of this alternative are shown in figure 34. Larger armor stone would be used for the angled extension of the main breakwater at the entrance channel because modeling shows it would be struck by waves traveling down the length of the main breakwater. Approximately 21,000 cubic yards of 4,800-pound armor stone, 16,000 cubic yards of B rock, and 48,000 cubic yards of core material would be used for the angled extension. Approximately 21,000 cubic yards of 2,000-pound armor stone, 28,000 cubic yards of B rock, and 58,000 cubic yards of core material would be required for the remainder of the breakwater modifications. The armor and B rock on the existing breakwater would be removed at the junction of the extension and would be used in construction. Marine benthic habitat (soft bottom and rocky substrate) of 4.9 acres would be unavoidably lost by fill activities, while there would be a net gain of 4.1 acres of rocky substrate provided by the breakwater modification, which would support associated algal communities, fish communities, EFH (Pacific herring spawning habitat), and additional habitat for seabirds.

The 2-year construction season would result in a temporary disturbance of ambient noise and increased suspended sediment conditions for about twice as long as the other action alternatives. These, in association with vessel noise, vessel transits, and ongoing harbor and urban activities, would cause marine mammals, fish communities, and avian species near the construction site to temporarily move away from the area. Construction activities have the potential to cause avoidance, disturbance, or displacement of Steller sea lions and humpback whales from Sitka Harbor during peak Pacific herring spawning activities. However, the action would not modify or adversely affect designated critical habitat and may affect, but is not likely to adversely affect, Steller sea lions, humpback whales, or Pacific herring. There would be a short-term impact on subsistence harvesting of herring and herring eggs. Urban runoff and permitted wastewater discharges would continue to affect local water quality. Modeled circulation for this alternative indicated conditions similar to or better than existing conditions, and therefore, Alternative 14 is not expected to produce water quality/circulation "dead zones." No impacts are anticipated on customary and traditional cultural practices or historical/archaeological features. The amount of fill involved in the breakwater modification represents a minor change relative to prior intertidal/subtidal fills. This alternative, in concert with past, present, and foreseeable actions, is not likely to have any significant cumulative adverse impact on Sitka Harbor fish, wildlife, and human resources

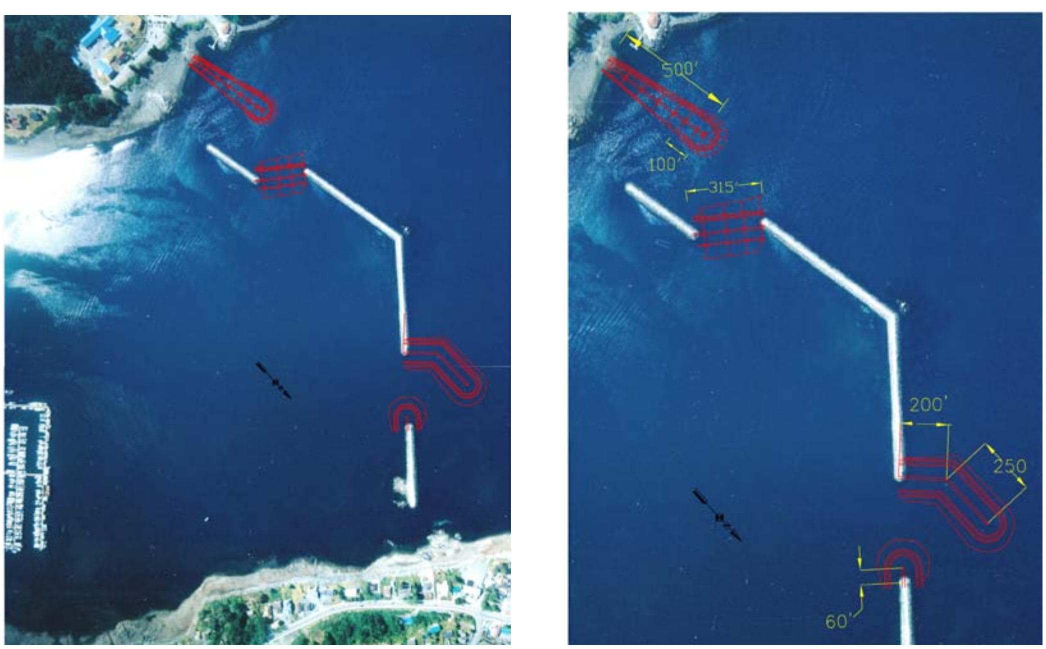

Figure 34. Alternative 14 – Combination of Alternatives 1, 4, and 15– drawing not to scale.

Alternative 15 – Main and North Breakwater Extensions

Alternative 15 would construct an angled extension on the main breakwater and extend the north breakwater with a stub to narrow the large gap. The angled extension would be 450 feet long and the stub extension would be 60 feet long. Plan views of this option are shown in figure 35, and a cross section for the angled extension is shown in figure 36. The north breakwater extension cross section also is shown in figure 36. A larger wave height was used to size the armor stone for the angled extension because waves travel along the length of this breakwater and would be forced to turn at the extension. Approximately 21,000 cubic yards of 4,800-pound armor stone, 16,000 cubic yards of B rock, and 48,000 cubic yards of core material would be required for this option. The stub extension would require 5,000 cubic yards of 2,000-pound armor, 5,000 cubic yards of B rock, and 7,000 cubic yards of core material. The armor and B rock on the existing breakwater would be removed where the extension begins. Approximately 3,500 cubic yards of armor and 1,000 cubic yards of B rock would be removed and used for construction of the north breakwater extension. Marine benthic habitat (soft bottom and rocky substrate) of 2.7 acres would be unavoidably lost by fill activities, while there would be a net gain of 2.4 acres of rocky substrate provided by the breakwater modification, which would support associated algal communities, fish communities, EFH (Pacific herring spawning habitat), and additional habitat for seabirds.

The less than a year construction season would result in a temporary disturbance of ambient noise and increased suspended sediment conditions. These, in association with vessel noise, vessel transits, and ongoing harbor and urban activities, would cause marine mammals, fish communities, and avian species near the construction site to temporarily move away from the area. Construction activities have the potential to cause avoidance, disturbance, or displacement of Steller sea lions and humpback whales from Sitka Harbor during peak Pacific herring spawning activities. However, the action would not modify or adversely affect designated critical habitat and may affect, but is not likely to adversely affect, Steller sea lions, humpback whales, or Pacific herring. There would be a short- term impact on subsistence harvesting of herring and herring eggs. Urban runoff and permitted wastewater discharges would continue to affect local water quality. Modeled circulation for this alternative indicated conditions similar to or better than existing conditions, and therefore, Alternative 15 is not expected to produce water quality/circulation “dead zones.” No impacts are anticipated on customary and traditional cultural practices or historical/archaeological features. The amount of fill involved in the breakwater modification represents a minor change relative to prior intertidal/subtidal fills. This alternative, in concert with past, present, and foreseeable actions, is not likely to have any significant cumulative adverse impact on Sitka Harbor fish, wildlife, and human resources.

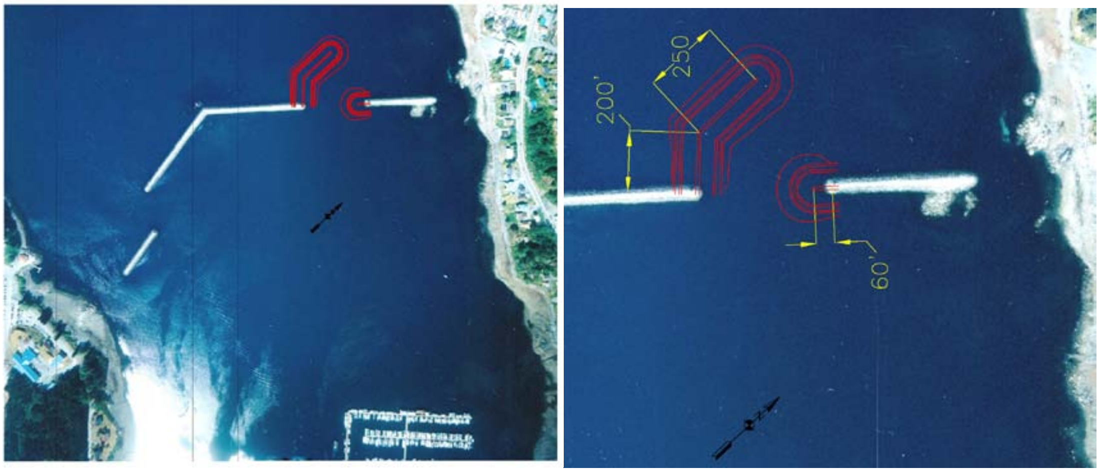

Figure 35. Alternative 15 – Main and North Breakwaters Extensions would provide an angled extension to the main breakwater and a straight extension to the north breakwater, creating a 100 foot overlap – drawing not to scale.

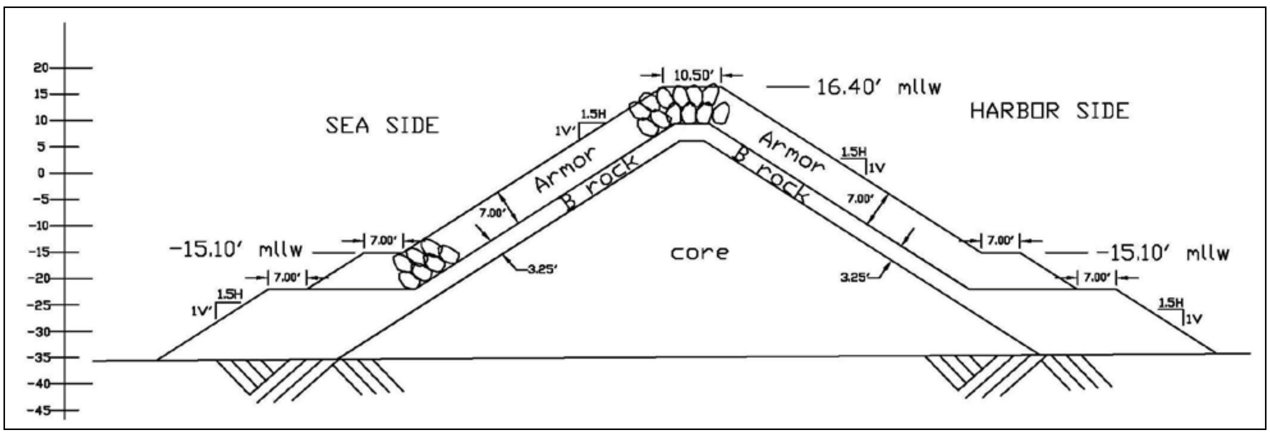

Figure 36. Main and North Breakwaters Extensions Cross Section for Alternative 15.

5.2.2 Cost of Detailed Alternative Corrective Actions

Cost estimates were developed for each of the alternatives considered in detail. For the purpose of developing reasonable cost estimates, the existing commercial quarry on Kasiana Island, 2 miles north of the breakwaters, was used as a typical example of a quarry in the area to develop cost estimates. Which quarry is actually used for supplying materials for construction is proposed by the construction contractor, who must specify the quarry, which is required to have all necessary local/state quarry permits and sufficient quantities of the materials to be supplied in accordance with contract specifications. Depending upon which quarry is proposed by the contractor, additional environmental compliance analysis may be required. The quantities were based on neat-line sections with allowances for waste-loss. The detailed preliminary cost estimates are based on an October 2011 price level and are presented in Appendix C. Estimated first costs from Appendix C are summarized in table 4. The cost estimates include allowances for real estate, planning, engineering and design, construction management, and appropriate USCG aids to navigation. No explicit, specific environmental mitigation measures are required, except for construction procedures that minimize short-term construction impacts to the extent practicable.

Table 4. Detailed Alternative Corrective Action Cost Estimates.

	Alternative Corrective Action Implementation Costs ($1,000)			
Feature	**Alternative 1**	**Alternative 4**	**Alternative 14**	**Alternative 15**
Construction Contract	$5,860	$7,028	$23,926	$13,131
Lands & Damages	$13	$4	$13	$4
PE&D	$792	$792	$792	$792
Construction Management	$317	$317	$792	$475
TOTAL	$6,981	$8,140	$25,522	$14,401

5.2.3 Comparison of Detailed Alternative Corrective Actions

Table 5 compares the first cost of the detailed alternatives with the reduction achieved in wave energy at Eliason Harbor by each alternative for a 5-foot wave with 10-, 12-, and 14-second wave periods. The energy reduction reported is from the model for each wave period with still water elevation at +11 feet MLLW. At this time it is not possible to quantify the frequency of occurrence of waves with periods of 10 to 14 seconds. A hindcast that details the percent occurrence of the wave periods and heights that impact the harbor area from Gulf of Alaska storms has not been performed. Note that for the no-action plan, the concept of incremental analysis is not applicable because it entails making no changes. The third column shows the incremental cost of advancing from each cost level/output level to the next successive level. The fifth, seventh, and ninth columns show the cost to achieve a 1 percent reduction in energy level at Eliason Harbor for each of the three periods considered. Also, the table shows the values computed for the incremental cost per one percent of energy decrease for each increment in the analysis.

Table 5 shows that alternative 4 is the incremental “first-added,” “best buy” of the options considered for energy reduction at Eliason Harbor. It would produce the most benefit per dollar spent among the alternatives modeled by ERDC. It would perform better than most, more expensive plans tested, and it would respond well to conditions that were identified both by modeling and by empirical observations by harbor users and the harbormasters office. While Alternative 4 performed well in a relative comparison with other plans, there is no certainty that it would fully meet identified needs or sufficiently resolve identified problems because reductions in wave energy may not translate directly into reduction of movement by mooring facilities and boats. Alternative 4 could be supplemented by additional measures, either at a later date or implemented along with Alternative 4. Waiting until after Alternative 4 was constructed and in place would avoid potential unnecessary construction, but overall costs would be higher due to the need for separate, expensive mobilization and demobilization.

Constructing additional measures at the same time Alternative 4 was constructed would avoid the higher costs. Given the information available, a definitive determination of the “second added” plan should not be done without further data collection and analysis. Inability to determine the “second added” feature, however, should not preclude the recommendation for implementing Alternative 4.

Table 5. Incremental Cost Screening of Detailed Alternative Corrective Actions for Eliason Harbor.

Option	First Cost ($K)	Incremental Cost ($K)	10-second Period		12-second Period		14-second Period	
			% Energy Reduction	Cost per1% Reduction ($K)	% Energy Reduction	Cost per 1% Reduction ($K)	% Energy Reduction	Cost per 1% Reduction ($K)
No Action	$0	N/A	none	N/A	none	N/A	none	N/A
1	$6,981		17%	$410	14%	$499	22%	$317
Increase	$6,981	$6,981	17%	$410	14%	$499	22%	$317
1	$6,981		17%	$410	14%	$499	22%	$317
4	$8,140		50%	$163	32%	$254	35%	$233
Increase		$1,159	33%	$338	18%	$19	13%	$89
4	$8,140		50%	$163	32%	$254	35%	$317
15	$14,401		54%	$267	48%	$300	41%	$351
Increase		$6,261	4%	$1,565	16%	$391	6%	$1,044
4	$8,140		50%	$163	32%	$254	35%	$233
14	$25,522		67%	$381	74%	$345	43%	$594
Increase		$17,382	17%	$1,022	42%	$414	8%	$2,173

A plot of the energy reduction in the Eliason Harbor area versus the estimated initial construction costs is shown in figure 37 as a comparison. The plots show the greatest energy reduction for the least cost is closing the main/south breakwater gap (Alternative 4). After implementation of Alternative 4, under certain tide and wave conditions, some energy will continue to come through the main entrance between the main and north breakwaters; implementing additional alternatives could further reduce such energy. Alternative 15, which narrows and alters the main entrance, provides a slightly higher wave energy reduction for the 10 and 14-second waves, and a larger reduction for the 12-second waves than Alternative 4. Alternative 14, which closes the south/main breakwater gap, narrows and alters the wave direction at the main entrance, and adds a stub breakwater on Japonski Island, provides the greatest energy reduction, but it also has the highest cost. The plot indicates that the alternative with the greatest impact and least cost that addresses the band of waves in the 10-second to 14-second range is Alternative 4. Wave energy associated with a 10 to 14-second period will likely remain persistent, but at a much lower energy level until its path through the main entrance is addressed.

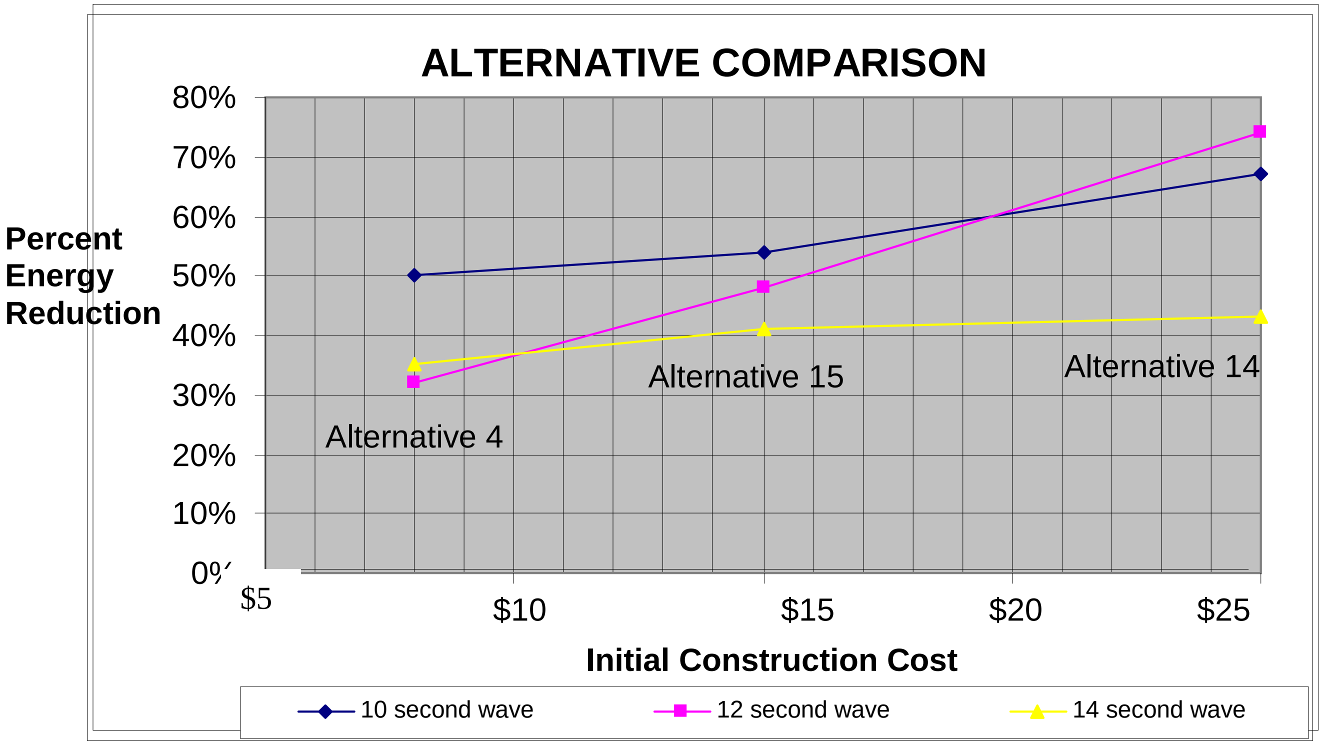

Figure 37. Alternative 4, 14, and 15 Comparison. The graph shows that alternative 15, at about 1.5 times the cost of alternative 4, does not provide commensurately better energy reduction. Likewise, Alternative 14, costing more than twice as much as alternative 4, does not provide more than twice as much energy reduction, with the possible exception of 12-second wave conditions.

Table 6 provides a summary comparison of the environmental and cultural impacts of the alternatives. In general, all the action alternatives have similar effects with impacts somewhat proportional to the project cost. Unique for this breakwater modification, the long-term net environmental gains also increase as the project size and cost increases. Thus, trade-off of beneficial economic and social effects from the reduction of wave and swell energy in the harbor with adverse environmental impacts is not required. In addition, for construction of the breakwater modifications, there is no need for specific mitigation measures beyond those aimed at avoidance of adverse impacts during the construction period, which are discussed in section 6.2.6.

Table 6. Comparison of Environmental & Social Impacts of Alternatives

Item	No Action	Alt 1	Alt 4	Alt 14	Alt 15
Benthic Habitat Lost	none	1.6 ac.	0.6 ac.	4.9 ac.	2.7 ac.
Net Gain of Rocky Substrate	none	1.4 ac.	0.5 ac.	4.2 ac.	2.4 ac.
Construction Length	none	< 1 year	< 1 year	< 2 years	< 1 year
Marine Mammals	Affected by ongoing harbor & urban activities	Temporary disturbance for < 1 year	Temporary disturbance for < 1 year	Temporary disturbance for < 2 year	Temporary disturbance for < 1 year
Net gain of EFH (Pacific herring spawning habitat)	none	1.4 ac.	0.5 ac.	4.2 ac.	2.4 ac.
Subsistence Resources	Herring & egg harvest continues unabated	Short term impact on harvesting herring & eggs	Short term impact on harvesting herring & eggs	Short term impact on harvesting herring & eggs	Short term impact on harvesting herring & eggs
Water quality & circulation	Circulation sufficient to prevent WQ degradation	Temporary WQ degradation, Future circulation same or better than existing	Temporary WQ degradation, Future circulation same or better than existing	Temporary WQ degradation, Future circulation same or better than existing	Temporary WQ degradation, Future circulation same or better than existing
Avian populations	Affected by ongoing vessel traffic & harbor activities	Short-term displacement from project area	Short-term displacement from project area	Short-term displacement from project area	Short-term displacement from project area
ESA (Steller sea lion, Humpback whale, Pacific herring)	Future developments might affect ESA habitats	Doesn't modify designated critical habitat, Not likely to adversely affect ESA species	Doesn't modify designated critical habitat, Not likely to adversely affect ESA species	Doesn't modify designated critical habitat, Not likely to adversely affect ESA species	Doesn't modify designated critical habitat, Not likely to adversely affect ESA species
Cumulative Impacts	Coastal development with increased harbor use likely	Not likely to have any significant cumulative impacts	Not likely to have any significant cumulative impacts	Not likely to have any significant cumulative impacts	Not likely to have any significant cumulative impacts
Environmental Justice	Future projects required to determine impacts on minority and low-income populations	No disproportional high or adverse effects on minority and low-income populations	No disproportional high or adverse effects on minority and low-income populations	No disproportional high or adverse effects on minority and low-income populations	No disproportional high or adverse effects on minority and low-income populations

5.2.4 Selection of Recommended Corrective Action

Modeling results indicate that by closing the main/south breakwater gap the wave energy at Eliason Harbor from the 12 and 14-second waves will be reduced by more than 30 percent and from the 10-second wave by up to 50 percent. Model tests also show closing the main/south breakwater gap would significantly reduce wave energy in the southwest harbor area near Japonski Island for all three wave periods: 70 percent for the 10-second wave, 58 percent for the 12-second wave, and 44 percent for the 14-second wave. This action would also result in the net gain of 0.5 acre of rocky substrate, which would provide essential fish habitat for Pacific herring spawning and benefits for other marine species without any significant adverse impacts on Sitka Harbor's fish, wildlife, and human resources. The recommended course of action is to select Alternative 4, closing the opening between the main and south breakwaters by adding a similar breakwater segment, as the recommended corrective action.

6.0 RECOMMENDED CORRECTIVE ACTION

6.1 Detailed Description of the Recommended Deficiency Correction Action

6.1.1 Breakwater Layout and Quantities

Alternative 4 would construct a breakwater to connect the east end of the southwestern breakwater with the west end of the middle breakwater, closing off the secondary navigation channel. This breakwater would be about 315 feet long. Cross sections and side slopes would be similar to the existing Channel Rock Breakwaters. Side slopes are 1V:1.5H. The breakwater would be constructed in about -45 feet MLLW and have a crest elevation of +16.4 feet MLLW. The top of the core rock would be at +9.15 feet MLLW, with a 2-foot layer of B rock and 5.25 feet of armor rock. Breakwater quantities would be 9,000 cubic yards of armor rock, 13,000 cubic of B rock and 30,000 cubic yards of core rock. Figure 38 provides the detailed layout for filling the gap between breakwaters.

6.1.2 Geotechnical Investigations

A geophysical survey, conducted in the fall of 1988, mapped the sea floor bottom at Sitka and determined bedrock elevation. All mapping was referenced to Alaska State Plane Coordinates and MLLW elevation. Depth to the bedrock was determined by using shallow reflection geophysical techniques and complementing the results with jet probing. The geophysical investigation indicates a maximum overburden thickness of 20 feet of granular soils. Eleven jet probes were located beneath or in proximity to the Channel Rock Breakwaters. The probes indicate thin granular overburden over competent Sitka graywacke. The jet probes were advanced to a maximum depth of 5.8 feet. Refusal due to bedrock or dense soil deposit was encountered to depths as shallow as 1 foot below the mudline.

A comprehensive soil investigation involving wash rotary method of drilling was conducted in the summer of 1993 prior to construction of the existing Channel Rock Breakwaters. The drilling operation was supervised by an engineer from the Alaska District, Soils and Geology section. A total of 16 test borings were drilled to refusal or bedrock. Two of the 16 test borings were near the proposed breakwater modification. Boring AP-184M encountered refusal at a depth of 21 feet and Boring AP-185M encountered refusal at a depth of 3 feet. These refusal depths are consistent with the jet probes and geophysical investigation conducted in 1988. Split spoon soil samples were procured on the surface of the seabed or mudline. Laboratory testing of the samples indicated coarse grained soils classifying as well-graded sand with silt (SW-SM), poorly graded gravel with silt and sand (GP-GM), and silty sand (SM). The fines constituents of these soils ranged from 11 to 19 percent. Blow counts indicated a relative density of very loose.

Adverse settlement of the breakwater modification is not anticipated. Minimal settlement on the order of several inches should occur during the early stages of construction due to soft surficial soils. The soils under the proposed breakwater modification should perform similarly to the existing Channel Rock Breakwaters. The existing breakwaters have performed well and did not settle excessively during or since construction.

6.1.3 Dredged Material Management Plan

The District does not expect any maintenance dredging to be required near the breakwaters. Therefore, a maintenance dredging plan is not required.

6.1.4 Real Estate

Following is a brief summary of the real estate necessary for the project. Details can be found in Appendix D – Real Estate Plan. The new breakwater segment between the existing south and main Channel Rock Breakwaters would be constructed on lands subject to navigational servitude. Therefore, no real estate acquisition would be required for construction of the deficiency correction. No disposal areas would be utilized since dredging would not be required. No known uplands staging area would be used since all construction can take place from barges. However, upon completion of the Channel Rock Breakwaters deficiency correction measure, there would be no new, additional requirements for non-Federal Operation & Maintenance beyond those required for the original breakwater project.

6.1.5 Aids to Navigation

Currently, there are aids to navigation placed by the US Coast Guard (USCG) on both sides of the two gaps/openings between the Channel Rock Breakwaters segments. The main navigation channel passes through the northeastern gap/opening, which has breakwater lights (Light 7 - USCG No. 25025 and Light 3 – USCG No. 25026) at the top of the armor slope on both sides of the gap/opening. A secondary navigation channel passes through the southwestern gap, which has a breakwater light (Light 8 - USCG No. 25020) at the top of the armor slope on the middle breakwater and a daybeacon (Beacon 4 - USCG No. 25027) at the top of the armor slope on the southwest breakwater segment. As part of closing the southwestern gap, it is anticipated that both the breakwater light and the daybeacon at that location would be removed by the USCG. Foundations for these two aids could remain and would not need to be removed. No other changes are anticipated.

6.1.6 Value Engineering Analysis

Since the preliminary, estimated cost of construction for the recommended deficiency correction alternative was anticipated to be about $13 million, a value engineering (VE) analysis was required by Corps regulations and policy in effect at that time. The Value Engineering Study Report (VESR) was prepared by the Buffalo District Value Engineering Officer (VEO) as part of the Agency Technical Review process of the draft DCER/EA. The VE study reviewed the measures and alternatives described in this DCER, performed a function analysis, developed additional potential measures for consideration, and analyzed and evaluated the possible ideas. The VESR stated that

"This report validates and documents the use of the Value Engineering process in the preparation of the study. The outcome of this report has validated that realistic VE cost savings from newly developed technology may not be readily cost effective, but that existing practices have provided operational options to USACE to provide for the beneficial and continued use of the existing breakwater cross section and alignment, thereby, resulting in an extension to the usable life of the harbor at a cost considerably lower than constructing a new harbor infrastructure." The VESR did not recommend any changes to the recommended deficiency correction alternative.

The VE study noted the design and operational characteristics of the local service facility floats and docks, which seem to be very responsive to the incoming wave energy. The VE study identified several potential preventative measures, which the local sponsor could use to better identify and reduce problems, if any, that might be caused by the floats themselves. These included: an underwater inspection of the contact between the pile and bedrock to see if a grouting program might better stabilize the piles, a reconfiguration of floats to reduce impacts of remaining wave energy, and a harbor user survey to determine factors impacting wave energy distribution and formulate a plan for safer use of harbor facilities and appropriate vessel traffic regulations. The final VE team Study Report has been reviewed and was approved through the POA/POD VE Officers on May 2, 2011.

6.1.7 Deficiency Correction Design and Construction Costs

The cost estimate for the design and construction of the recommended deficiency correction measure was developed in 2009, updated in 2010, and reflects a price level of 1 October 2011. The first cost for the design and construction of the deficiency correction measure is $8,139,700, as detailed in the cost estimates provided in Appendix C – Cost Estimates. These costs were developed using the MCASES 2nd Generation cost estimating in accordance with guidance in Corps engineering regulations. A summary of the cost is provided in table 7. The cost estimate for the construction contract includes a 27.9 percent contingency determined using an abbreviated risk analysis process, as directed for this report by the Cost Engineering Directory of Expertise, to cover design changes and uncertainties in quantities and unit prices.

Table 7. Recommended Project Design Deficiency Correction Cost Estimate.

Cost Category	**Cost Estimate**
Breakwaters	$7,027,600
Navigation Aids	$ 0
sub-total (includes 27.9% contingency)	$7,027,600
Lands & Damages	$ 4,000
Planning, Engineering & Design	$ 791,600
Construction Management	$ 316,600
Total Construction Costs (1 Oct 11 pl)	$8,139,700

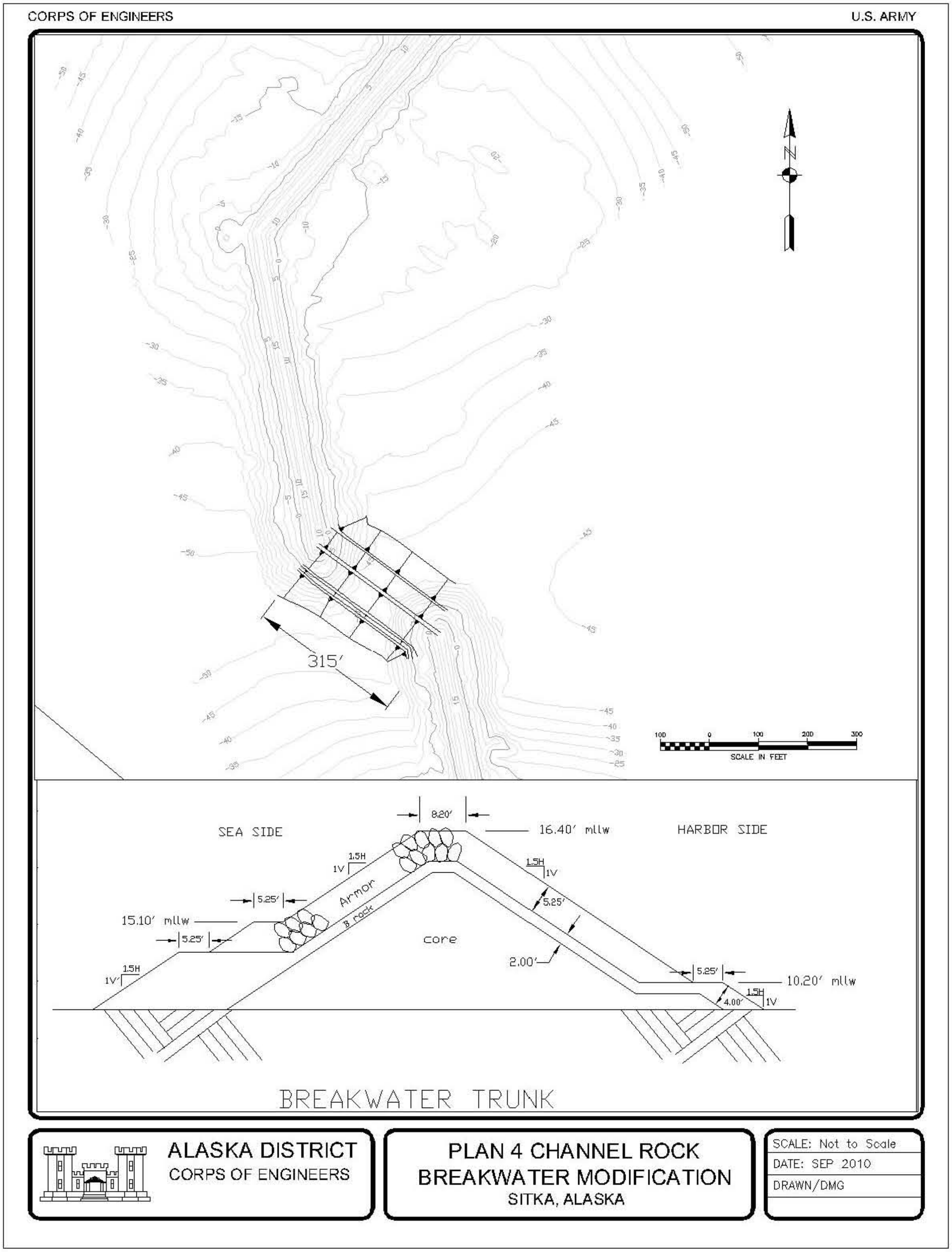

Figure 38. Layout of Recommend Corrective Action (Alternative 4).

6.1.8 Risk and Uncertainty

Since this is a post-authorization design deficiency correction report, some uncertainty has been reduced by the local community watching the performance of the original project since its completion more than a decade ago. However, there are several physical factors that also could have a bearing on project performance and are only partially understood. Factors that could affect project performance were uncertainty resulting from the physical modeling process itself and actual wave climate at Sitka. Outside of these factors specifically considered in developing this report, other less likely factors of risk and uncertainty regarding harbor performance include possible effects associated with the following: tsunami, seismicity and seismic subsidence, and sea level rise. The following paragraphs discuss each of these.

6.1.8.1 Physical Modeling

The basis of all physical modeling is the idea that the model behaves in a manner similar to the real world (prototype) it is intended to emulate. A properly validated physical model can be used to predict the prototype under a specified set of conditions. However, physical model results may not be indicative of prototype behavior due to scale or laboratory effects. Similarity between the prototype and a small-scale model of a coastal study area is achieved when all major factors influencing reactions are in proportion between prototype and model or are so small as to be insignificant to the process. For coastal shortwave models, three general conditions must be met to achieve model similitude: geometric, kinematic, and dynamic similarity. Geometric similarity exists between two objects or systems if the ratios of all corresponding linear dimensions are equal (similarity in form, undistorted model). Kinematic similarity indicates a similarity of motion between particles in model and prototype, when the ratio between the components of all vectorial motions for the prototype and model is the same for all particles at all times. In a geometrically similar model, kinematic similarity gives particles paths that are geometrically similar to the prototype (wave motions and flow kinematics correctly replicated). Dynamic similarity between two geometrically and kinematically similar systems requires that the ratios of all vectorial forces in the two systems be the same (constant prototype-to-model ratios of all masses and forces acting on the system). Fortunately, many coastal problems and flow regimes are adequately modeled by an imperfect similitude where inertia and gravity forces dominate while all other forces are small in comparison.

Scale effects in coastal hydrodynamic models result primarily from the Froude scaling assumption that gravity is the dominant physical force balancing the inertial forces. Other physical forces of viscosity, elasticity, and surface tension are incorrectly scaled with the belief that these forces contribute little to the physical processes. Scale effects in physical models are analogous to decreased accuracy that occurs in numerical models when complex physical processes are represented by numerical approximation to equations, round-off and truncation errors, and computer speed, memory, and availability. Laboratory effects in coastal physical models are primarily related to:

- Physical constraints on flow in the model caused by the need to represent a portion of the prototype in a finite amount of space.

- Mechanical means of wave and current generation introducing unintentional nonlinear effects.
- Simplified prototype forcing conditions where only a subset of all possible conditions can be selected for testing.

The key laboratory effects in the Eliason Harbor physical model were related either to wave generation, water level, or model boundaries. Waves were generated by a plunger-type wave maker that reproduced long-crested, irregular waves scaled to match wave spectra typical of those generated by storms in the Gulf of Alaska to the west and southwest of Sitka. Wave approach direction was fixed by the orientation of the wave machine within the basin. The use of long-crested waves to represent multidirectional wave conditions in the prototype was a reasonable compromise at Sitka, where incident storm waves are channeled by the surrounding land masses, and wave approach directions are somewhat limited. Water level, identified as an important factor in harbor wave agitation at Eliason Harbor, in the physical model was kept static at the level corresponding to maximum water level for much of the testing. This assured the maximum transmission of wave energy over and through the breakwaters into the protected harbor area. Model boundaries are responsible for two laboratory effects: unwanted reflections and unwanted current patterns. Reflections from vertical walls in the model basin were kept to a minimum by placement of rubberized "horsehair" mats to absorb incident wave energy. Wave guides (vertical walls) were used at the ends of the wavemaker to prevent immediate diffraction of waves before they entered into the modeled region, which would reduce wave height along the crest.

6.1.8.2 Wave Climate

As previously stated, the wave climate associated with the exciting mechanism at Eliason Harbor was never defined. The deficiency correction study began with the premise that the harbor would be instrumented and the harbor exciting mechanism would be identified using the instrument data and local observation. The instrumentation was deployed for two seasons, but both seasons experienced a mild wave climate, so no exciting mechanism was identified. In the absence of measured data, the original design wave height was used as the exciting wave height, and a range of periods was tested, bracketing the period noted as the problem by the harbormaster's office. Local knowledge was used to determine the wave directions for the study.

Even if the refinement of wave environment by hindcast had helped define the wave dynamics, the interaction between the floats and the waves would continue to have been a partially unknown factor in the problem definition. A site visit to Sitka Harbor during a moderate offshore event on December 4, 2009, identified a definite relationship between harbor and dock motion and energy entering the gaps between breakwaters. The float motion related to storms in the Gulf of Alaska was confirmed by the local users to some extent by this event. Although wave activity entering the harbor was modest, float motion was extensive, but modest in displacement. Using this information, the deficiency correction study proceeded based on the assumption that any reduction in wave energy entering through the Channel Rock Breakwaters would result in decreased movement of the floats. However, the amount of decreased motion in the floats resulting from the decreased energy transmission and the sensitivity of the motion to wave period cannot be determined by the studies performed to date. A similar problem at Crescent Harbor was resolved by reducing the entrance channel width, which reduced wave energy entering the harbor and dampened float motion.

6.1.8.3 Tsunamis

Sitka has experienced tsunamis and other earthquake-induced waves. The maximum wave, crest-to-trough of 14.3 feet high, following the Alaska earthquake of March 27, 1964 produced a maximum runup of 7.8 feet. Sitka was the only Southeast Alaska port to report significant damage from that event. One dock was destroyed with damage to floats and vessels. All other known seismic waves at Sitka have been below 2 feet in height with less than 3-foot of runup. The 100-year frequency runup at Sitka has been estimated at 7.9 feet in the vicinity of West Anchorage at Sitka. Damage to Sitka from tsunamis, possibly reinforced by seiching, is one of the most likely consequences of earthquakes. No underwater or above-water landslides associated with waves attributable to earthquakes have been recorded in the Sitka area. However, wave heights, and particularly damages, cannot be predicted with confidence. The risk of damage to the breakwater and harbor facilities based on historical information is minimal.

6.1.8.4 Seismicity and Seismic Subsidence

Sitka lies in a region of high earthquake activity. Nine earthquakes of 7.0 or greater on the Richter scale have occurred near the coastline of Southeast Alaska since 1899, with three within 100 miles of Sitka. Many lesser magnitude earthquakes frequently occur in the area. Some microearthquakes may be caused by a rebound of land due to the retreat of large glaciers that were present in the region several hundred years ago. Potential damage to breakwaters and harbor facilities from earthquakes would be seen in ground shaking and compaction. The foundation conditions in the Channel Rock area are primarily bedrock, rock, gravel, and sand deposits, with some surface layers of marine sediments. For earthquakes less than 7.0 on the Richter scale, it is assumed no damage would occur to the breakwater. For greater than 7.0 earthquakes, damage should be relatively minor, consisting of subsidence and/or consolidation of the breakwater foundation of up to 3 to 5 feet. Following such an event, the condition of the project will need to be assessed and any need for remediation determined. It is likely that damages to other public and private facilities in Sitka would be more extensive.

6.1.8.5 Relative Sea Level Rise

Relative sea level is generally falling near geological plate boundaries and in formerly glaciated areas such as Southeast Alaska. Based on tide gage data for the last century from Juneau, about 100 miles northeast of Sitka, the approximate recorded relative rate of sea level rise is -1.38 inches/century, which is due to isostatic rebound. For the next century, the sea level at Sitka is likely to remain relatively constant or fall somewhat.

6.2 Environmental Effects of Recommended Corrective Action and Impacts on Prior Environmental Concerns or Commitments

The following is a summary of the pertinent issues associated with the potential effects of the recommended plan on the project area’s environment. A more-detailed description is provided in the environmental assessment (Appendix A). The primary environmental issues associated with the proposed corrective action are essentially identical to those issues expressed by State and Federal agencies about the original Channel Rock Breakwaters project, that is, the project's potential impacts on Pacific herring, water quality and circulation, marine mammals, and Endangered Species Act species. More recent coordination with NMFS revealed concerns about the impacts of the recommended action on essential fish habitat.

6.2.1 Pacific Herring

For the original project, the USFWS, ADF&G and NMFS believed that together, the changes in wave action and circulation and the potentially poorer water quality that might result from altered circulation and wave conditions and from increased boating use could cause herring to use their spawning habitat less and/or to produce fewer viable offspring. As a result, a 5-year monitoring program was implemented to compare pre-project and post-project herring spawning activity and egg/fry survival in the 20 acres of core herring spawning habitat that might be affected by the Channel Rock Breakwaters. If monitoring indicated a significant loss of spawning or egg/fry viability, in-kind mitigation measures would be implemented, that is, appropriate sized rock would be placed in soft-bottom habitat to provide attachment substrate for enough kelp to replace adversely impacted herring spawning habitat.

The final 1993-1998 monitoring report indicated herring spawn had decreased within the harbor basin created by the Channel Rock Breakwaters as compared with areas surveyed outside the harbor during the same timeframe. However, the report also noted that the breakwaters had become colonized with algae species suitable for herring spawning. The ADF&G and USFWS concluded that the algae growth on the breakwaters was compensating, at least in part, for habitat degraded by the harbor project, and no further mitigation was recommended at that time.

In 2005, the Corps and USFWS entered into an agreement to conduct a biological evaluation of the new Channel Rock Breakwaters with emphasis on their habitat value as Pacific herring spawning substrate. It was found that after 10 years, the subtidal surface (between -30 feet MLLW and the surface) of all three breakwaters, both seaward and harbor side, supported robust stands of algae (e.g. sugar kelp and fringed sieve kelp). The primary difference between the outside and inside surfaces of the breakwater appeared to be the presence of perennial kelp (<u>Macrocystis</u> <u>pyrifera</u>) outside the harbor and its near absence inside. However, the USFWS concluded that an abundance of suitable herring spawning habitat was available on the harbor side of the breakwaters.

The Corps believes that the corrective action would have a net beneficial environmental effect on Pacific herring and their spawning habitat as well as essential fish habitat. Constructing the breakwater to fill in the gap between the south and main breakwaters would eliminate approximately 38,000 square feet of established Pacific herring spawning habitat. However, after construction, approximately 58,000 square feet of suitable rocky substrate would be available for kelp and other marine algae species to become established and support spawning Pacific herring.

6.2.2 Water Quality and Circulation

Prior to the Channel Rock Breakwaters being constructed, the Corps collected water and sediment samples in 1996 in areas that might be affected by the harbor expansion. The samples were collected to determine baseline water and sediment quality and to give a basis of comparison for future sampling. No water quality or sediment quality criteria were exceeded in the collected samples. PCB's were not found in marine sediments, and petroleum hydrocarbons and oil/grease levels were below detection limits of 3 milligrams per liter. The purpose of the Corps' 1997 sampling effort was to determine whether there was an effect on water and sediment quality that could adversely impact the herring fishery in the vicinity of Thomsen Harbor. None of the 1997 samples were found to exceed water quality or sediment quality criteria; therefore, it was inferred that the herring fishery in the Sitka Harbor area had not been adversely impacted. Except for the short-term, localized turbidity associated with the placement of breakwater material into the marine environment, no adverse impacts to water or sediment quality is expected to occur as a result of the corrective action.

To address concerns about the corrective action's potential effect on harbor circulation, the Corps constructed a physical model of Sitka Harbor at the Corps' Hydraulics and Coastal Laboratory at the Waterways Experiment Station. Eighteen breakwater configurations were constructed and tested to determine the amount of wave energy reaching the inner harbor and to aid development of alternatives. Time lapse video of the circulation model runs were viewed together with biologists from USFWS, NMFS, and ADF&G, and the general consensus was that circulation behind each of the project alternatives was at least the same as, or in most cases, better than the circulation modeled for the existing Channel Rock Breakwaters configuration. No alternative appeared to produce "dead zones" where the water did not circulate. It appeared that closing off or constricting some of the gaps in the breakwater improved circulation since the same volume of water was forced through smaller or fewer openings.

6.2.3 Marine Mammals

The placement of fill material in the gap between the south and main breakwaters would result in some temporary disturbance of ambient noise and suspended sediment conditions. These changes would likely cause marine mammals that would otherwise be present in the vicinity of construction to move away from the area temporarily during construction but would not likely produce significant long-term harm to any species.

6.2.4 Endangered Species Act Species

Because ESA-listed species may be affected by the Corps' proposed project, the Corps was required to prepare a biological assessment to determine whether NMFS-related listed species (humpback whale - endangered and Steller sea lion - threatened eastern population and endangered western population), special status species (Pacific herring Southeast Alaska distinct population segment – candidate), or designated critical habitat are likely to be adversely affected. No USFWS- listed species exist in the project area.

Project construction activities and the newly constructed breakwater segment would result in short-term alterations to habitat used by Steller sea lions and Pacific herring.

However, the results of Corps field studies indicate that within a few years following completion of the breakwater segment, the breakwater armor rock would recolonize itself with productive populations of invertebrates and algae that would support spawning Pacific herring. In time, the revegetated breakwater segment would function ecologically similarly to the Sitka Harbor shoreline and other already revegetated Channel Rock Breakwater segments.

Vessel noise and transit associated with construction activities have the potential to cause avoidance, disturbance, or displacement of Steller sea lions and humpback whales from the Sitka Harbor area during peak Pacific herring spawning activities when Steller sea lions and humpback whales feed on staging and spawning adult herring. Therefore, the Corps has proposed to cease in-water construction during peak Pacific herring spawning activities (between March 15 and June 1). Construction activities outside this period coincide with periods when a minimum number of marine mammals are present. Additionally, speed limits would be imposed on construction vessels moving between the project area and material suppliers to mitigate the danger of collisions between vessels and marine mammals.

The Corps believes that its proposed action: (1) would not modify or adversely affect designated critical habitat; and (2) may affect, but is not likely to adversely affect, humpback whales, Steller sea lions (eastern and western distinct population segment) or Pacific herring (Southeast Alaska distinct population segment).

6.2.5 Essential Fish Habitat

EFH is defined as those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity. The types of impacts that would possibly affect EFH species/species complexes (five Pacific salmon species, the sculpin complex, and several species of flatfish, rockfish, and forage fish) known or highly likely to occur within the project area are separated into short-term and long-term impacts.

Short-term impacts include: (1) water quality impacts in the form of increased levels of turbidity resulting from fill and rock placement and oil/grease releases from work vessels and equipment; (2) noise disturbance from operation of heavy equipment, cranes, or barges and from rock or pile installation; and (3) disturbance from increased construction-related work boat traffic in the project area and along supply routes.

Long-term impacts include: (1) the loss and conversion of marine habitat (mixed soft bottom to rocky subtidal habitat) resulting from the placement of rock and fill into the marine environment, and (2) water quality impacts from altering harbor circulation and flushing patterns.

Except for the short term, localized turbidity associated with the placement of breakwater material into the marine environment, no adverse impacts to water or sediment quality, EFH, and EFH-related species/species complexes are expected to occur as a result of the recommended corrective action.

6.2.6 Mitigation Requirements Resulting from Implementing Corrective Action

Incorporating the following mitigation measures and Endangered Species Act-related terms and conditions/conservation measures into the recommended plan is expected to ensure that no significant adverse impacts would occur.

- The proposed action shall cease in-water construction between March 15 and June 1 during peak herring spawning activities, juvenile salmon outmigration, and rearing activities, and when Steller sea lion and humpback whale feeding and abundance is expected to be greatest in the project area.
- To minimize the danger to marine mammals from project-related vessels, speed limits (e.g. less than 8 knots) shall be imposed on vessels moving in and around the project area.
- Project-related vessels and barges shall not be permitted to ground themselves on the bottom during low tide periods, unless there is a human safety issue requiring it.
- A construction oil spill prevention plan shall be prepared.
- Breakwater construction shall use core, B rock, and armor stone clean of organic debris and invasive species.
- To accelerate recolonization of the new breakwater segment, all armor rock removed from the existing breakwaters with sessile or attached adapted marine organisms and sea algae shall be reused in constructing the new breakwater segment.
- Project-related vessels shall not travel within 3,000 feet of designated Steller sea lion critical habitat (haulouts or rookeries).

6.3 Implementation of Corrective Action

6.3.1 Construction

Major harbor construction for the design deficiency correction is confined to filling the gap between the southwestern and middle Channel Rock Breakwater segments. Construction time is estimated to involve only a single construction season. Any environmental construction restrictions would be specified in the project's plans and specifications.

6.3.2 Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R)

The Alaska District would continue to periodically visit the site following completion of the deficiency correction element to inspect the breakwaters and accomplish hydrographic surveys of portions of the harbor. Inspections and surveys provide information to determine if maintenance of the breakwater or dredging of the basin is required. Operation and maintenance of local service facilities, including the mooring basin and float system, will continue to be accomplished by the CBS. The Federal government would be responsible for the breakwaters and the navigation aids. The existing channels between the breakwaters have not required any dredging since their completion more than a decade ago. Based on past experience with the existing harbor, it is assumed that the modified breakwaters would not require maintenance dredging. However, 2008 condition surveys of the breakwater features have indicated that some maintenance of the rock armor on the existing breakwaters will be required in the next 5 to 10 years. This work is in accord with the potential project maintenance identified in the feasibility report. The new rock work also will require relatively minor maintenance over its project life amounting to replacement of 10 to 15 percent of the initial rock volumes.

6.3.3 Cost Apportionment for Modified Channel Rock Breakwaters Element of Sitka Harbor Project

Construction of the deficiency correction measure for the Channel Rock Breakwaters element of the Sitka Harbor project would be undertaken at full Federal expense, except for any LERRD associated with the correction, as stated in section 1.2 and in table 9, as follows. The Federal government would continue to assume 100 percent of the operation and maintenance costs for the breakwaters and the navigation aids.

Table 8. Cost Apportionment

Item	Federal	Non-federal
Design Deficiency Correction Element		
General Navigation Features (breakwater gap fill)	100%	0%
Lands, Easements, Rights-of-Way, Relocations (GNF)	0%	100%
Navigation Aids (US Coast Guard)	100%	0%

[a] Cost sharing reflects provisions of Water Resources Development Act of 1986. Non-Federal original cost share includes 10% of original GNF plus additional 10% original GNF minus LERRD credit

The Federal government would continue to assume 100 percent of the operation and maintenance costs for the breakwaters and the navigation aids. The non-Federal sponsor would continue to assume all other operation and maintenance costs. The sponsor would remain responsible for providing LERRD, if any, required for construction and maintenance of the inner harbor facilities.

6.3.4 Existing Project Cooperation Agreement

The project's existing Project Cooperation Agreement (PCA) was signed by the Acting Assistant Secretary of Army for Civil Works on 7 December 1993 and is provided in Appendix E. Its provisions generally reflected the provisions for local cooperation requirements recommended by the District Engineer in his 1992 report. Headquarters guidance, discussed in section 1.2, requires the District, following approval of the DCER, approval of the plans and specifications, and appropriation of construction funds for the corrective action to amend the description of the general navigation features (GNF) in the existing PCA to include the approved corrective action, and to separate the prior (cost shared) work and the new (Federal expense) work. The construction of the corrective action will be at Federal expense, except for any LERRD, which will be provided by the sponsor.

6.4 Views of Local Sponsor

The local sponsor is very supportive of this project to correct the design deficiency in the Channel Rock Breakwaters element of the Sitka Harbor, Alaska project. Since soon after construction was originally completed for the project's general navigation features and local service facilities, the sponsor has reported excessive swell and wave conditions in the harbor and has worked diligently to have the problem resolved. The sponsor has provided a letter of intent, dated 12 August 2011, which is provided in Appendix E. The sponsor has also provided a Statement of Financial Capability, which is included in Appendix E.

7.0 PUBLIC INVOLVEMENT AND AGENCY COORDINATION

7.1 Public Involvement Activities

The original Channel Rock Breakwaters project went through an extensive public involvement and review process: (1) the Sitka community was polled and their needs assessed; (2) local informal meetings were conducted to determine public concerns and presentations were made at Sitka assembly meetings; and (3) a Draft Interim Feasibility Report and Environmental Impact Statement was distributed for a 45-day public review period, followed by a public meeting. The Final Feasibility Report and Environmental Impact Statement for the original project were submitted to Congress on November 13, 1992.

Following completion of project construction, public concerns were raised about whether the project was functioning as intended. Because of expressed public concerns and after preliminary Corps study, Congress directed the Secretary of the Army acting through the Chief of Engineers to design and construct modifications to the Channel Rock Breakwaters navigation project at Sitka Harbor, Alaska to correct design deficiencies by adding to, or extending, the existing breakwaters to reduce wave and swell motion. After extensive coordination with representatives from Sitka, the Corps prepared the DCER.

An environmental assessment (EA) and unsigned Finding of No Significant Impact (FONSI) (Appendix A) was prepared, which relied extensively on previous National Environmental Policy Act-related scoping efforts and public input associated with the original Channel Rock Breakwaters project. The EA/unsigned FONSI for the Sitka Harbor, Alaska, Corrective Navigation Improvements was distributed for a 30-day public review on 5 April 2011. Public comments were received only from the City and Borough of Sitka and the Sitka Tribe of Alaska, both of which commented on issues, subsequently resolved, surrounding potential quarry sites. The FONSI was revised based on comments received and signed on June 23, 2011.

7.2 Coordination of Corrective Action with Federal and State Agencies

The development and preparation of the EA and FONSI was coordinated with a variety of State and Federal agencies. Both the USFWS and NMFS have provided input under authority of the Endangered Species Act, Marine Mammal Protection Act, and Fish and Wildlife Coordination Act. The NMFS also provided essential fish habitat information under the authority of the Magnuson-Stevens Fishery Conservation & Management Act.

Harbor water quality and circulation issues were coordinated with staff biologists from the USFWS, NMFS and ADF&G. An evaluation to determine consistency with Section 404(b)(1) of the Clean Water Act, which governs discharge of dredged or fill material, has been completed.

Both the Corps and the Alaska State Historical Preservation Officer (ASHPO) determined that the original, larger-scaled navigation project would have no effect on known historical or prehistoric resources. The same determination is applicable for the proposed corrective action and has been coordinated with the ASHPO.

The Alaska Division of Coastal and Ocean Management coordinated the State's review of the Corps' proposed action for consistency with the Alaska Coastal Management Program (ACMP). Based on an evaluation by the Alaska Departments of Environmental Conservation, Fish and Game, Natural Resources and the Sitka Coastal District, the State concurs with the Corps' determination that its proposed activities are consistent with the ACMP to the maximum extent practicable.

A checklist of project compliance with relevant Federal, State, and local statutes and regulations is shown in table 9.

Table 9. Environmental Compliance Checklist

FEDERAL	Compliance
Archeological & Historical Preservation Act of 1974	FC
Clean Air Act	FC
Clean Water Act	FC
Coastal Zone Management Act of 1972 *	FC
Endangered Species Act of 1973	FC
Estuary Protection Act	FC
Federal Water Project Recreation Act	FC
Fish and Wildlife Coordination Act	FC
National Environmental Policy Act *	FC
Land and Water Conservation Fund Act	FC
Marine Protection, Research & Sanctuaries Act of 1972	FC
National Historic Preservation Act of 1972	FC
River and Harbors Act of 1899	FC
Magnuson-Stevens Fishery Conservation & Management Act *	FC
Marine Mammal Protection Act	FC
Bald Eagle Protection Act	FC
Watershed Protection and Flood Preservation Act	FC
Wild & Scenic Rivers Act	N/A
Executive Order 11593, Protection of Cultural Environment	FC
Executive Order 11988, Flood Plain Management	FC
Executive Order 11990, Protection of Wetlands	FC
Executive Order 12898, Environmental Justice	FC
Executive Order 13045, Protection of Children	FC
STATE AND LOCAL	
State Water Quality Certification *	FC
Alaska Coastal Management Program *	FC

PC = Partial compliance, FC = Full compliance

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Conclusions

The recommended plan for corrective action meets the planning objectives by reducing wave energy entering Sitka Harbor through the gaps between breakwaters in a cost effective manner, providing significant energy decrease with no significant impact to harbor circulation or herring spawning grounds. The studies documented in this report indicate that construction of modifications to the Channel Rock Breakwaters feature of the Sitka Harbor, Alaska, project, as described in this report, is technically feasible and environmentally and socially acceptable. Construction of the recommended plan should provide an immediate decrease in energy entering the harbor, thereby reducing the risk of damage to vessels and moorage facilities within the harbor. The City and Borough of Sitka has indicated its willingness to act as a local sponsor for the project and fulfill all the necessary local cooperation requirements. Thus, it is concluded that the deficiency correction action that should be implemented at this time consists of closing the gap between the existing main and south breakwaters of the Channel Rock Breakwaters feature of the Sitka Harbor project.

8.2 Recommendations

I hereby recommend construction of the Alternative 4 modification to the Channel Rock Breakwaters element of the Sitka, Alaska, navigation project in accordance with Section 3005 of the Water Resources Development Act of 2007, as generally described in this report. The action involves closing the existing opening between the main and south breakwaters at an estimated initial planning, design, and construction cost of $10.6 million (1 October 2011 price level). Prior to the start of construction, the existing 1992 Project Cooperation Agreement (PCA) must be amended and the non-Federal sponsor must agree to changed provisions. The suggested revisions to the 1993 PCA are provided in Appendix E, Pertinent Documents. Other PCA changes may be appropriate as determined by the Chief of Engineers to be necessary due to changes in law.

The recommendations contained herein reflect the information available at this time, current Departmental policies, and interpretation of applicable legislation. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified prior to implementation and before they are transmitted to the Congress as proposals for implementation funding in a Corps appropriations bill or other suitable legislation. However, prior to transmittal to the Congress, the sponsor, the State, interested Federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

Reinhard W. Koenig — 19 Mar 2012

Reinhard W. Koenig
Colonel, Corps of Engineers
District Commander

Date