US Army Corps of Engineers®
Seattle District

Long-Term Management Strategy for the South Jetty

Grays Harbor, Washington

Draft Letter Report and Integrated Environmental Assessment

March 2012

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List of Abbreviations and Acronyms

µg	microgram
BA	Biological Assessment
BCR	benefit-to-cost ratio
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
CAA	Clean Air Act
CDIP	Coastal Data Information Program
CERB	Coastal Engineering Research Board
CERC	Coastal Engineering Research Center
CHL	Coastal and Hydraulics Laboratory
CTH	Committee on Tidal Hydraulics
Corps	U.S. Army Corps of Engineers, Seattle District
cy	cubic yard
CZMA	Coastal Zone Management Act
DAHP	Department of Archaeology and Historic Preservation
dBA	A weighted decibel
DO	dissolved oxygen
DPS	Distinct Population Segment
EA	Environmental Assessment
Ecology	Washington State Department of Ecology
EFH	Essential Fish Habitat
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
EPA	see USEPA
FMP	Fishery Management Plan
FONSI	Finding of No Significant Impact
ITR	Independent Technical Review
kg	kilogram
LR	Letter Report
LTMS	Long-Term Management Strategy
MBTA	Migratory Bird Treaty Act
MCDA	Multi-Criteria Decision Analysis
MHHW	mean higher high water
MLLW	mean lower low water
MMPA	Marine Mammal Protection Act
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MSL	mean sea level

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NEPA	National Environmental Policy Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NRHP	National Register of Historic Places
O&M	operations and maintenance
ORCAA	Olympic Regional Clean Air Agency
PDT	Project Delivery Team
SHPO	State Historic Preservation Officer
SLR	sea level rise
SPCC	Spill Prevention, Control, and Countermeasures
TBT	tributylin
U&A	Usual and Accustomed
USC	United States Code
USCG	U.S. Coast Guard
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
VLM	vertical land movement
WDFW	Washington State Department of Fish and Wildlife
WDNR	Washington State Department of Natural Resources
WES	Waterway Experiment Station
WQC	Water Quality Certification

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ABSTRACT

Responsible Agency: U.S. Army Corps of Engineers, Seattle District (Corps)

This environmental assessment (EA), prepared pursuant to National Environmental Policy Act (NEPA) requirements, and letter report (LR) evaluates impacts on the Grays Harbor South Jetty and Half Moon Bay resources that would be expected if the Corps were to implement its preferred long-term strategy for continued maintenance of authorized federal Navigation Project features in the project vicinity, primarily at the South Jetty. Based on the analyses described in this EA, Alternative 1B, Modified Current Practice with Modified Diffraction Structure, is recommended as the preferred alternative. The Draft Letter Report and EA also discusses the "future without project condition." Alternative 1B was selected using an evaluative tool, the Multi-Criteria Decision Analysis (MCDA) and Corps' engineering, environmental, and economic expertise.

This alternative would include: 1) initial placement of sediment between Half Moon Bay and South Beach to reduce risk of breaching; 2) A 500 foot extension of the existing diffraction mound to dissipate wave energy and reduce erosion rates in western shoreline of Half Moon Bay thereby minimizing future nourishment requirements and 3) periodic (approximately every 10 years) placement of sand in supratidal and intertidal (dune and beach) areas of the bay when a risk based erosion trigger is reached.

Expected environmental impacts of this alternative are both positive and negative. The modification to the diffraction structure would elevate the existing structure over a 2-acre subtidal area footprint. The structure would be placed over relic jetty riprap and sand generating a loss of benthic habitat, however would minimize erosion to the western dune and beach of Half Moon Bay thereby requiring less frequent beach fill placements and providing habitat for benthic organisms including barnacles and macroalgae. The loss of two acres of subtidal sandy habitat is considered insignificant when compared with the hundreds of acres undisturbed sandy subtidal area throughout the outer Grays Harbor. However, some juvenile salmon that migrate along the outer bay shorelines to the Pacific Ocean may opt to pass along the approximately 1,000 linear feet of riprap that would comprise the border of the modified diffraction structure and be subject to predation by ling cod and rockfish that routinely inhabit such areas. As mitigation for construction impacts, rock riprap from the west and east ends of the remnant north jetty, located across Grays Harbor, between Ocean Shores and Damon Point, would be removed, thereby providing juvenile salmon and other fish access to over 2 miles of intertidal and shallow subtidal rearing and feeding habitat. Other mitigation would involve placement of angular quarry spalls along the modified diffraction structure to fill in interstices that could be occupied by predator fish mentioned above. Sand placement in bay intertidal areas would fill in the beach scarp but cover benthic resources; however, migration of species from adjacent areas would result in repopulation of the newly created sloping beach. Dune grass could be damaged due to construction activities but if so, it would be replanted by the

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Corps in the spring following construction activities. Construction would occur only during approved Federal fishery agencies' work "windows" for juvenile emigrating salmonids (times of the year when various juvenile species in Grays Harbor are lowest in number).

In addition to the fisheries and benthic resources evaluated above, the following resources, and potential impacts to these, were evaluated: bathymetry, hydrology and hydraulics, water quality, sediment quality, shorebirds, aesthetics, air quality, noise, cultural and historic resources, Tribal Usual and Accustomed Fishing Areas, commercial fisheries, crab culture, land use, navigation, recreation, and socioeconomics. Risks associated with sea level rise were also evaluated. Based on the information contained in this letter report/EA, it is concluded that none of these resources would be significantly affected by the preferred alternative.

Implementation of the recommended plan, including design and construction considerations, operation and maintenance considerations, cost estimates, and real estate requirements are well described in this letter report/EA. The preferred alternative is not expected to contribute significantly to cumulative impacts on project area resources and will be consistent with applicable local, state, and federal regulations.

The Corps has determined that the proposed action is not a major federal action significantly affecting the quality of the human or natural environment, and therefore does not require preparation of an environmental impact statement.

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PUBLIC COMMENT OPPORTUNITIES FOR GRAYS HARBOR LONG TERM MAINTENANCE STRATEGY

The public is invited to comment on the content of and recommended alternative in the Army Corps of Engineers' Draft Letter Report/EA, including draft Environmental Assessment. The document is available on-line at:

http://www.nws.usace.army.mil/ers/index.cfm

Public Meeting
A public meeting will be held in Aberdeen, Washington, as follows:

Date: Thursday, May 3, 2012
Time: 4:30-7:00 PM
Location: Port of Grays Harbor Port Office, 111 S. Wooding Street, Aberdeen, WA 98520

Directions are online at:
Written Comments
Written comments also may be submitted to: CJ Klocow, U.S. Army Corps of Engineers, Seattle District, Environmental Resources Section, P.O. Box 3755, Seattle, WA 98124-3755 or cj.klocow@usace.army.mil

All comments on the draft letter report/EA must be received by May 16, 2012.

For more information on the project visit www.nws.usace.army.mil

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1 SUMMARY

Grays Harbor is located on the southwest Washington coast on the Pacific Ocean approximately 45 miles north of the mouth of the Columbia River and 110 miles south of the entrance to the Strait of Juan de Fuca. The project area, picture in Figure 1, is located on the south side of the entrance to Grays Harbor, adjacent to the South Jetty.

The harbor is 15 miles long and 11 miles wide and enclosed by two long spits, Point Brown to the north and Point Chehalis to the south. The Grays Harbor federally authorized navigation project consists of a deep-draft channel with a width ranging from 350 to 1,000 feet and a depth of 32 to 46 feet, and two jetties. The two jetties are 17,200 feet and 13,734 feet long (north and south, respectively) and are constructed of large armor rock. The jetties extend seaward from Point Brown (north) and Point Chehalis (south), constricting the harbor entrance width to about 6,500 feet. A vicinity map (Figure 1) shows the Federal Navigation Channel features (i.e., the South Jetty and Federal Navigation Channel) in the harbor entrance.

The shoreline to the west and south of Point Chehalis has undergone major changes since the U.S. Army Corps of Engineers ("Corps") constructed the jetties between 1898 and 1916. The south jetty is a barrier to northerly long shore drift, and by 1904 South Beach had advanced 3,000feet to the west, as illustrated in Figure 4 (page 9). During much of the 20th century, the shoreline advanced or retreated depending on the condition of the jetty structure. However, since the 1960s, an erosion trend has been apparent along the South Beach shoreline. South Beach recession rates since 1967 have ranged from 2 to 62 feet per year. One of the consequences of this erosional trend was the formation of a breach during a December 1993 storm event when the South Beach shoreline outflanked the east end of the jetty. Numerous actions and investigations have been undertaken between 1994 and the present, including closure of the 1993 breach and other measures to alleviate risk to the navigation project features.

This persistent loss of sediment from the entrance to Grays Harbor (including North Beach and South Beach) is expected to continue indefinitely. The Corps has identified a problem of shoreline erosion in the vicinity of the South Jetty which could again result in the breaching of the landmass adjacent to the jetty, adversely impacting critical elements of the federal navigation project.

The purpose of the long-term management strategy (LTMS) study is (1) to assess the risk that such a breach may occur, (2) to evaluate the threat of adverse impact to the Grays Harbor Navigation Project resulting from a breach, and—if action is determined to be warranted—(3) assess alternatives and recommend the most appropriate long-term strategy for continued maintenance of the authorized Federal Navigation Project features. The objective of any recommended project would be to minimize the risk of adverse impact to navigation features over the next 50 years due to a breach between the Pacific Ocean and Half Moon Bay.

SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers, April 2011.

Figure 1. Vicinity and project area map

This LTMS study is being conducted under the Corps' authority to operate and maintain the completed federal navigation project in the most efficient and effective manner. The cost of the current investigation is being borne entirely by federal entities. The study area under consideration includes those project features and adjacent environment affected by the erosion. The area includes the South Jetty, North Jetty, Point Chehalis revetment, navigation channel, South Beach, Half Moon Bay, and east to Whitcomb Flats.

While an LTMS plan is being selected and implemented, the Corps has maintained the land connection between the shoreline and the South Jetty through periodic sand placement. The current practice requires sand placement when monitoring data show pre-determined triggering criteria are met.

The planning process initially identified several potential LTMS alternatives. Input from stakeholders was used to screen out some alternatives from further consideration, and multi-criteria decision analysis (MCDA) was used to evaluate each alternative on the basis of how they performed against thirteen criteria in the categories of environmental, engineering, cost, and public/social acceptance. High-performing alternatives were determined using dominance analysis. The alternatives development, screening and evaluation process is described in Chapter 6 of this draft letter report/EA.

Based on these analyses, the LTMS team identified Alternative 1B as the recommended plan[1.] Alternative 1B was chosen because the recommended action, including proposed mitigation measures, best achieves the project purpose while minimizing impacts to the environment. This alternative would entail placement of sand on the dune area between Half Moon Bay and South Beach, based on triggering criteria similar to the methodology used in the current practice, along with construction of a modified diffraction structure at the eastern terminus of the South Jetty. When compared to the current practice, the proposed modified diffraction structure is expected to reduce the amount of sand needed to be placed at Half Moon Bay. The modified diffraction structure will impact aquatic habitat, primarily juvenile salmonid habitat. To offset this impact, riprap from the relic North Jetty will be removed near the land connection at Point Brown and Damon Point. This removal is expected to promote better water movement through the Oyhut Wildlife Recreation Area and provide access to excellent shallow water habitat for fish, including Endangered Species Act (ESA) listed salmonid species, at all tidal levels.

This *Long-Term Management Strategy for the South Jetty: Draft Letter Report and Integrated Environmental Assessment (EA),* along with the appended Clean Water Act Section 404(b)(1) evaluation, documents the process of determining a recommended plan and the basis for this recommendation. As required by the National Environmental Policy Act

[1] For the purposes of this document, which is a letter report and integrated environmental assessment (EA), the alternative termed "recommended plan" serves as the preferred alternative under NEPA.

(NEPA), the Corps prepared the draft EA to document the potential effects on the environment of any proposed action. The draft EA is integrated into this letter report.

Please direct questions or requests for additional information to:

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2 INTRODUCTION

This section includes information on the authority for the proposed work, purpose and need for the proposed project, the project area and some of its history, previous study of the erosion starting in the 1960s and resulting recommendations, details of the 1993 breach and actions taken to respond to the breach, and a summary of prior studies and reports.

2.1 AUTHORITY

The Grays Harbor Navigation Channel Project, including maintenance of the Federal Navigation Channel and South Jetty, is authorized principally by the River and Harbor Act of 3 June 1896 (29 Stat. 202, Ch. 314), and by the River and Harbor Act of 30 August 1935 (49 Stat. 409, Ch. 831, House Document 53, 73rd Congress, 1st Session), as further amended, among others, by the Water Resources Development Act of November 17, 1986 (Public Law 99-662). The proposed work is within the Grays Harbor Navigation Channel Project operations and maintenance (O&M) authority, as the intent of the work is to maintain Federal Navigation Channel features, including the South Jetty and Federal Navigation Channel. Activities that maintain the functionality of, and protect from damage, the features of an authorized navigation project are a proper use of O&M funds because of the reasonable relationship between those actions and perpetuating the purpose for which the navigation project and its features were legislatively authorized in the first instance.

2.2 PROJECT LOCATION AND BACKGROUND

Grays Harbor is located in Grays Harbor County, Washington at the mouth of the Chehalis River on the Washington coast, about 45 miles north of the Columbia River and 110 miles south of the entrance to the Strait of Juan de Fuca. The cities of Ocean Shores, Hoquiam, Aberdeen, Markham, Bay City, and Westport are situated along the Grays Harbor shoreline. A 23.5-mile Federal Navigation Channel is maintained from the entrance to Aberdeen, Washington. A vicinity map showing the Federal Navigation Channel features (i.e., the South Jetty and Federal Navigation Channel) in the harbor entrance is provided on Figure 1.

Grays Harbor broadens from the river channel at the city of Aberdeen to a large, pear-shaped estuary encompassing bays to the north and south. On the ocean side, two long spits enclose the estuary, Point Brown to the north and Point Chehalis to the south. Two rubble mound jetties (North Jetty and South Jetty) extend seaward from Point Brown and Point Chehalis, respectively, constricting the harbor entrance width to about 6,500 feet. The U.S. Army Corps of Engineers, Seattle District (USACE), constructed the North and South Jetties between 1898 and 1916. The jetty system has been very effective in maintaining water depths in the entrance to Grays Harbor that allow for reliable transit of ships. Though the jetties have performed their originally designed function of maintaining a navigation channel

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at the mouth of Grays Harbor, they have interrupted and redirected the littoral transport of sand.

On the south side of the entrance, Half Moon Bay is located on the harbor side of South Beach immediately south of the South Jetty. On the north side of the entrance, Oyhut Wildlife Recreation Area is fronted by the submerged North Jetty, which connects Point Brown to Damon Point. The project setting is shown on Figure 2.

The harbor and coastline are used for migration, spawning, feeding, and rearing of a broad range of fish, shellfish, and marine-dependent wildlife. Grays Harbor is considered a major waterfowl area and is part of the Pacific flyway. Wide varieties of birds use the region during their migration, while several species are permanent residents. Some species of terrestrial mammals occur in the vicinity of the project, and marine mammals frequent these waters. The area immediately offshore of Half Moon Bay and South Beach is used by surfers, and the beaches are used by fishermen, campers, and other recreational users. See Figure 3 for an image of the immediate project area.

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SOURCE: Image from Google Earth Pro, 2011.

Figure 2. Project setting

Figure 3. Project area, including Half Moon Bay and South Beach (2009)

2.3 HISTORICAL EVENTS

The shoreline on both the north and south sides of the entrance to Grays Harbor has undergone major changes since the Corps constructed the North and South Jetties between 1898 and 1916 in an effort to minimize dredging requirements for the deep-draft Federal Navigation Channel. Construction of the jetties constricted the inlet to Grays Harbor, which led to flushing of inner harbor sediments offshore and increased tidal currents in the entrance channel that moved the ebb-tidal delta further offshore (Buijsman et al. 2003). As shown in Figure 4, by 1909 the South Beach spit had witnessed 3,000 feet (0.57 mile) of accretion oceanward as a result of entrance materials introduced into the nearshore system.

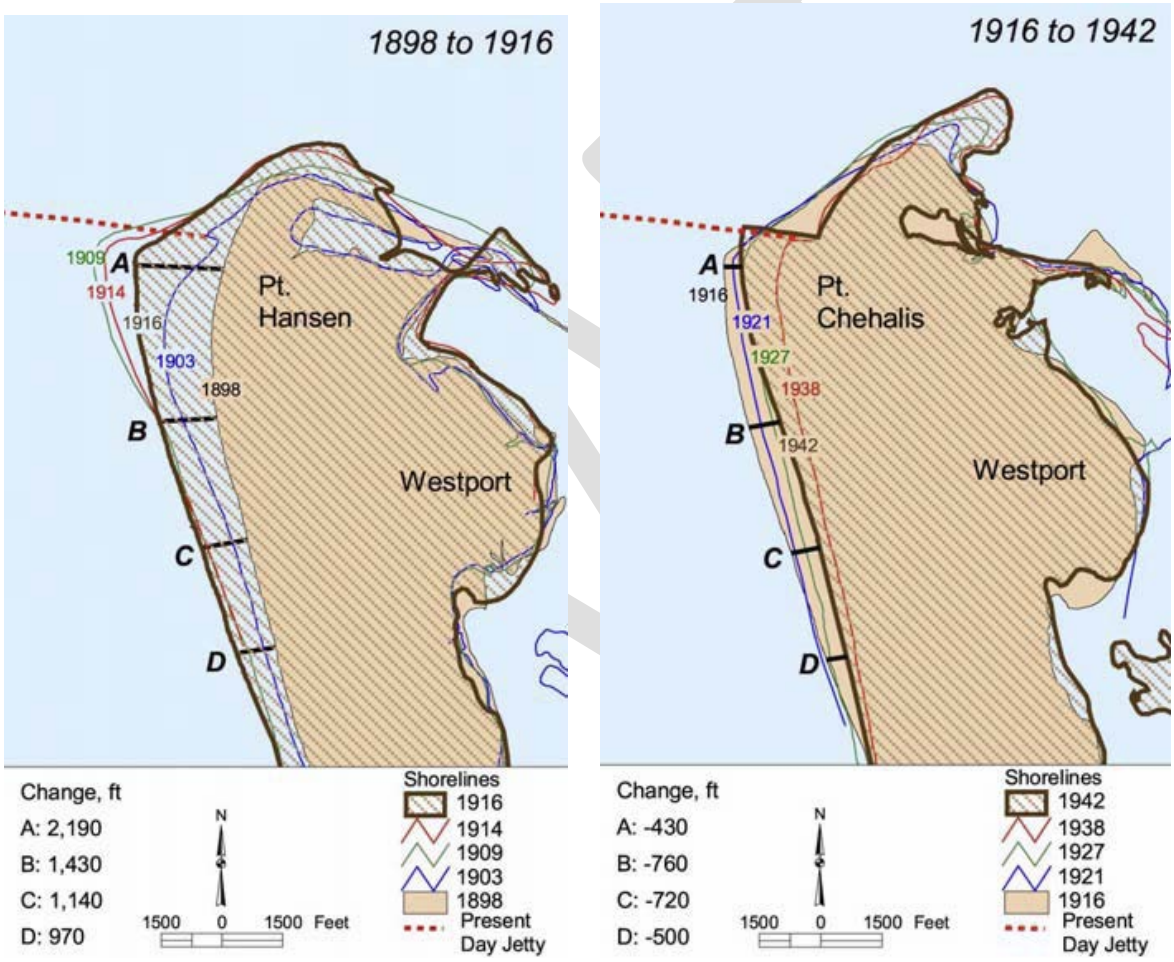

Figure 4. Shoreline change from 1898 to 1916 and 1916 to 1942, initial shoreline advancement during jetty construction and equilibrium period immediately following, respectively (from Kraus and Arden 2003)

Major rehabilitation of the South Jetty occurred between 1935 and 1939 and again in 1966. Following the South Jetty rehabilitation in 1939, scour potential through the entrance channel increased and began to erode the Point Chehalis shoreline at Westport. The main thalweg through the entrance was located only 2,000 feet north of Point Chehalis and erosive forces began eroding the shoreline and resulted in formation of present-day Half

Moon Bay. By 1952, erosion of Point Chehalis slowed as the outer 6,000 feet of the South Jetty deteriorated and the Point Chehalis revetment and groins were constructed to stabilize the shoreline. However, the landward root of the South Jetty became exposed and resulted in continued erosion within Half Moon Bay.

During the first half of the twentieth century, the shoreline advanced and retreated as the system moved toward equilibrium following the large pulse of sediment into the nearshore system; however, since the 1960s, a long-term trend of erosion along the South Beach spit shoreline has been apparent. Erosion of South Beach is attributed to changes in littoral drift patterns and offshore steepening of the shoreline, while Half Moon Bay erosion is a result of the flow confinement and wave refraction induced by the jetties. Sustained erosion of South Beach combined with erosion in Half Moon Bay culminated in a breach severing the land connection to the South Jetty in December 1993.

2.4 1993 Breach History and Expected Future Impacts of South Jetty Breach on Federal Navigation Project

This section contains information on erosion concerns and studies conducted before the 1993 breach, detailed information on the 1993 breach and immediate response actions, and information about investigations and actions that have taken place since then.

2.4.1 Erosion Concerns and Studies Conducted Before the 1993 Breach

In the mid 1980s, the South Beach erosion rate increased and the Corps requested assistance from the Waterways Experiment Station (WES), Coastal Engineering Research Center (CERC). Coastal engineers from CERC made a site visit in August 1990 (USACE 1990) to assess the situation. CERC determined a breach "could occur in the next 5 to 10 years," but the effect on Grays Harbor itself was "difficult to estimate." The CERC assessment also stated "should a breach open, it would widen through erosion by waves and tidal currents . . ." and "[t]he impact of such an event to the channel, project maintenance, navigation, and local lands could be significant."

In 1992, the Corps requested that Battelle/Marine Sciences Laboratory conduct a detailed study to evaluate the long-term trends in erosion near the entrance to Grays Harbor. The report (Battelle 1992) concluded ". . . the long-term loss of this sediment from the region off South Beach reduces the likelihood that the observed shoreline retreat is a short-term phenomenon that may soon reverse . . .."

2.4.2 Details of the 1993 Breach and Immediate Response Actions

One year after the Battelle study was completed, the persistent erosion of the shoreline at the landward end of the South Jetty resulted in the formation of a breach between the jetty and the adjacent South Beach during a moderate winter storm on December 10, 1993. The

breach widened rapidly, exposing the landward end of the jetty and eroding portions of Westhaven State Park, threatening park facilities and access to the park; within a week, the breach was approximately 200 feet wide (Figure 5). At the end of six weeks, the breach was about 500 feet wide, and the elevation of the deepest portion of the breach (immediately south of the jetty) was estimated at approximately 5 feet above the mean lower low water (+5 MLLW).

Figure 5. Photograph of the 1993 breach at Point Chehalis between Half Moon Bay and the South Jetty, taken December 17, 1993

The non-Federal sponsor (Port of Grays Harbor) and the City of Westport were alarmed by the formation of the breach and expressed concern about further loss of land and possible adverse impacts to navigation. The local interests contended that significant shoaling in the Federal Navigation Channel and instability of the South Jetty foundation could occur if the breach were to capture a significant portion of the ebb flow. In this scenario, Port operations could be slowed or halted resulting in significant economic impact. Additional concerns included impacts to local infrastructure such as the City of Westport's sewer outfall, municipal well field, and wastewater treatment plant. Hosey and Associates (1994) prepared a Congressional briefing document for the City of Westport suggesting the Corps could have

avoided the breach from occurring and chose a delayed response versus an immediate response resulting in greater costs. The report listed the following consequences from failure to repair the breach:

- Escalating costs of repair at the expense of the federal government
- Development of a wide and deep channel behind the South Jetty
- Increased filling of the existing navigation channel with sediment, causing increased need for channel maintenance
- Constant intense erosion eliminating a State park and as much as 3000 feet of Washington beaches, with erosion continuing more than 5 miles south of the jetty
- Incapacitation of the Westport wastewater treatment facility from destruction of the outfall, and eventual loss of the facility itself
- Salt water intrusion into the Westport domestic drinking water aquifer.
- Loss of State park, homes, and infrastructure along the coast.

In a memorandum dated March 10, 1994 (USACE 1994a), coastal engineers at the Corps' Northwestern Division responded to the concerns raised by the City of Westport's consultant. The report stated the consultant's report represents the "worst case scenario when either forecasting potential outcomes or recommending alternative solutions and attempts to present solutions where the federal Government funds all studies and solutions." The memorandum also states that "The material that is being eroded did not exist prior to construction of the South Jetty" and that "the situation is not an emergency and that damage to the jetty is not probable within the near term. Seattle District is presently evaluating various solutions and believes that the best technical solution is a fix that will resolve long term erosion."

In January 1994, a team of coastal engineers from WES made a site visit to inspect the breach. The team consisted of technical experts in coastal structures and tidal hydraulics from the CERC and Hydraulics Laboratory (HL). In a memorandum dated March 17, 1994 (USACE 1994b), the technical team concluded that:

- ". . . the breach may 'heal' during the summer months, diminishing the impact on the erosion to South Beach."
- "It is highly likely that the breach will reappear the following winter."
- "Impacts on inlet navigation are likely to be minor for the foreseeable, short-term future, the next 1-2 years."
- "The potential for recurrence and enlargement of the breach at the South Jetty area is very high."
- "There is potential for an impact to the navigation project to develop in the long-term."

The team concluded the report suggesting the Corps:

- Develop a 2-D numerical hydrodynamic model for the Grays Harbor Entrance

- Continue bathymetric and topographic monitoring of the breach
- Conduct a quantitative morphodynamic study to formulate scenarios of potential future breach and inlet dimensions
- Reevaluate dredge material disposal practices to optimize the quantities of material available for placement in critical areas
- Conduct a design analysis to optimize locations of dredge material placement
- Conduct a sediment budget analysis for updrift and downdrift coasts of the Grays Harbor Inlet and develop erosion mitigation measures for the South Beach

The concern regarding adverse long-term effects to the Federal Navigation Project was shared widely between the local sponsor and the Corps' technical experts. However, there was a difference of opinion regarding the time frame for a threat to the federal navigation channel to develop.

Uncertainty and lack of consensus regarding the level of threat posed by the breach were temporarily rendered moot on March 23, 1994, when the Assistant Secretary of the Army for Civil Works directed the Corps to fill the breach and to "conduct a comprehensive study to determine the most appropriate long-term solution." In late fall 1994, the breach was filled with approximately 600,000 cubic yard (cy) of material dredged from the Federal Navigation Channel (Figure 6).

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Figure 6. Photograph of South Beach, South Jetty, and Half Moon Bay after breach was filled at Point Chehalis in 1994, taken February 1, 1996

2.4.3 Studies Conducted Regarding Erosion and Related Concerns Since the 1993 Breach and 1994 Breach Fill

2.4.3.1 Search for a Long-Term Solution

The search for consensus resurfaced when the Corps began to develop alternatives for a "long-term solution." As part of the study process, the Corps requested that a Special Subcommittee of the Committee on Tidal Hydraulics (CTH) and the Coastal Engineering Research Board (CERB) evaluate the breach problem. In June 1995, a report by the Special Subcommittee concluded that "[w]ithout intervention the breach would be a threat to the jetty and to the entrance channel" and that "[a]n eastern extension of the South Jetty to a southern extension of the Point Chehalis revetment . . . appears to be the most viable alternative for protecting the jetty, navigation channel, and west shore of Point Chehalis" (USACE 1995). The committee also concluded that "[a]nalysis of existing data, acquisition of additional data, and modeling are needed to evaluate long-term maintenance alternatives."

In August 1995, the Corps completed a "Section 111" construction project to add 300,000 cy of beach nourishment at Point Chehalis in an effort to help provide protection to City of

Westport infrastructure. At the time, the continuing authority program (CAP) required local sponsor cost sharing, required a positive benefit-to-cost ratio (BCR), and limited federal cost to not more than $2 million. In feasibility stage, the BCR was computed as 1.09 to 1 over a 10 year project life. However, within a year of completing construction, two-thirds of the material eroded and it became clear the BCR assumed in feasibility would not be met and the federal cost limit would be reached. The project was terminated in July 1996.

In June 1997, the Corps completed an Evaluation Report (USACE 1997) that recommended construction of a project similar to that proposed by the Special Subcommittee, CTH. The study concluded that extending the South Jetty to meet the existing Point Chehalis revetment and conducting beach nourishment was the most appropriate solution. Drawings illustrating this plan are shown in Figure 7.

The planned solution consisted of:

1. Extending the existing South Jetty in an eastward alignment for a total of 4,300 feet, constructed in two phases. The first phase would include a 1,000 foot extension to the existing South Jetty (Eastward extension – Segment 1) and a 2,300 foot long segment northward to the existing Point Chehalis revetment (Northward extension – Segment 2). The second phase would connect Segment 1 and 2 at project year 25 with the remaining 1,000 foot section of jetty.
2. Direct beach nourishment for toe protection to the South Jetty extension. Beach nourishment was estimated to occur at four-year intervals.

2.4.3.2 Eastward Extension of the South Jetty Planned and Deferred

The report was approved and the Point Chehalis revetment was extended by 1,900 feet during the period November 1998 to March 1999. Plans for the eastward extension of the south jetty were finalized. However, the jetty extension was deferred as a result of change in key non-Federal sponsor and other local officials, resulting in revived technical and political objections, renewed analysis of environmental concerns, and rekindled local community opposition, all of which collectively affected the regulatory climate to the extent it appeared impossible to conclude the necessary interagency coordination – particularly 401 Water Quality Certification from the State of Washington – as had previously been expected.

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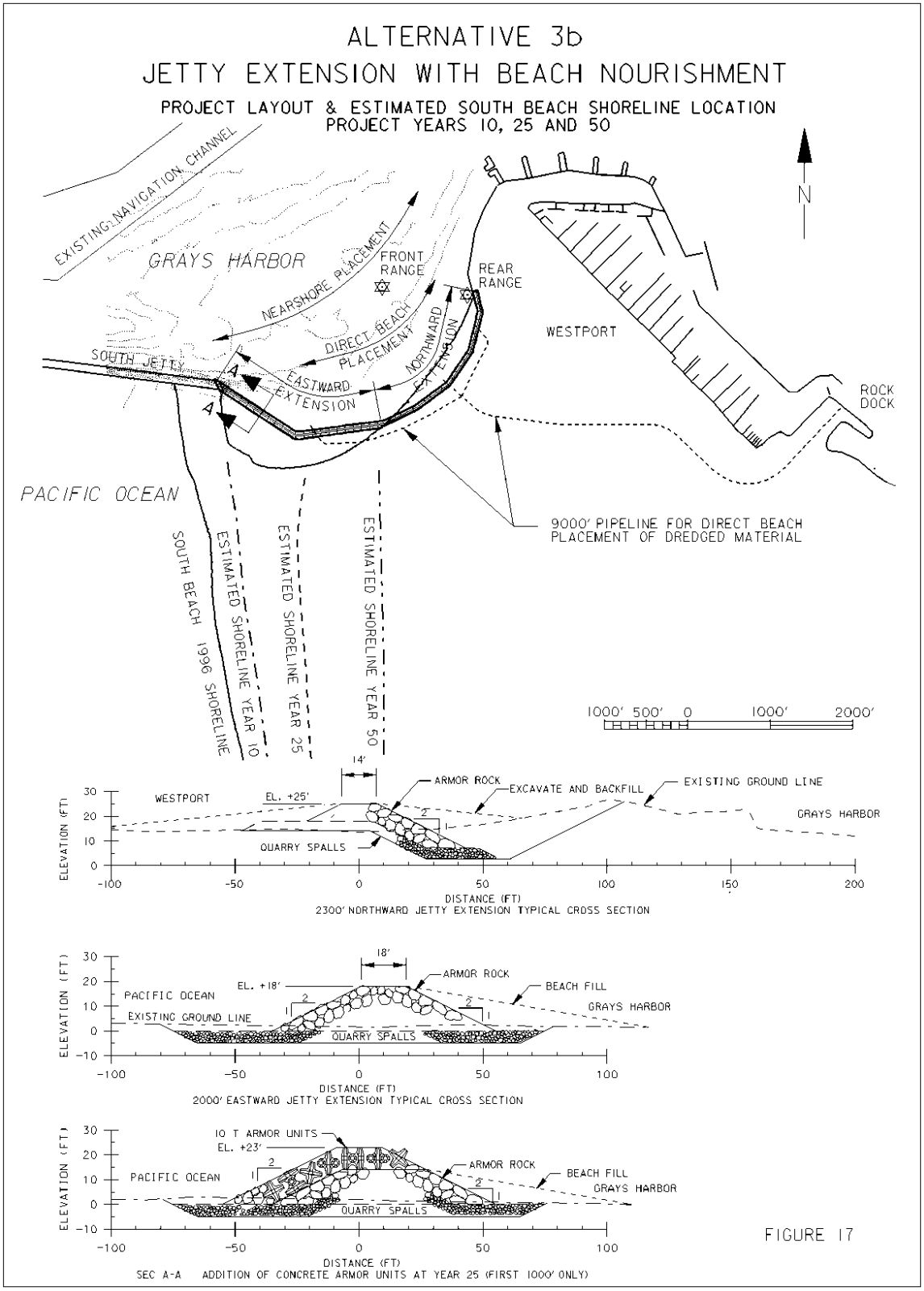

Figure 7. Drawings from the plan recommended in the 1997 Evaluation Report

2.4.3.3 Modified Plan for Eastward Extension of the South Jetty and Related Evaluation Initiated in 1999-2000

During the same time, the City of Westport continued to assert that the Half Moon Bay shoreline adjacent to the Westhaven State Park access road would nevertheless continue to erode and threaten the road, as a consequence of the deferral of the eastward extension of the South Jetty. Eventually, the first and second phase of the South Jetty extension was modified to incorporate a less extensive and less intrusive design, to minimize environmental impacts. The modified plan consisted of:

1. Construction of a wave diffraction structure at the east end of the South Jetty, to reduce wave-induced erosion of Half Moon Bay,
2. Creation of a cobble transition beach designed to slow Half Moon Bay beach erosion directly adjacent to the jetty, and
3. Repair work to strengthen the landward end of the South Jetty at the breach fill.

In November 1998, the Seattle District requested investigators at CHL to conduct "fast-track" physical model tests of a proposed wave diffraction mound and modifications to the south jetty. The diffraction mound concept was being investigated by the Coastal Inlets Research Program (CIRP) as a means of reducing bank erosion that commonly occurs at the landward ends of jetties (Seabergh 2001). Between December 1999 and February 2000, a wave diffraction structure was constructed and 11,600 cy of rounded cobble and gravel were placed on the Half Moon Bay shoreline.

2.4.3.4 Continuing Erosion after 2000, 2001 Overtopping of the Breach Fill, and Related Repairs

In 2000, the retreat of the South Beach shoreline had exposed the root of the South Jetty. The South Jetty Repair Project was undertaken from 2000 to 2001 to reinforce the inner (landward) root of the jetty to withstand the undermining effects of a future breach and construction of a diffraction mound as investigated by CHL to help alleviate bank erosion. Approximately 120,000 tons of jetty stone were placed to reinforce the South Jetty root and 30,000 tons of new rock was placed to construct the wave diffraction structure.

In November 2001, waves overtopped the breach fill. The haul road, used to transport armor rock as part of the South Jetty Repair Project (1999–2000), was breached by severe end-cutting erosion and storm-wave overtopping. In addition, three large rainwater runoff gullies, each about 5 feet deep, cut through the narrow strip of remaining land. In January 2002, urgent repairs to relocate the haul road were made to ensure access to the jetty for future rehabilitation was maintained. Furthermore, an additional 16,100 cy of 12-inch-minus cobble and gravel[2] were placed along the western shore of Half Moon Bay to slow erosion of the South Jetty breach fill and maintain access to the jetty via the relocated haul road. In April 2002, approximately 125,000 cy of sand from an upland stockpile was placed at the breach site to resupply sediment to the dune. Periodic measures have been taken since

[2] Cobble and gravel with individual particle sizes less than 12 inches in diameter.

then to extend the life of the breach fill until a long-term solution is developed and implemented, as further described below.

In November 2002, the Corps placed an additional 135,000 cy of sandy dredged material at the breach fill. Approximately 50,000 sprigs of native American dune grass (*Leymus mollis*) were planted on 3 acres of the breach fill to improve resistance to wind and rain erosion (Arden 2003).

2.4.3.5 Physical and Numerical Model Studies Initiated in 2003 and Internal Technical Review of Study Results

In 2003, the Corps initiated two studies with ERDC-CHL:

1. Half Moon Bay, Grays Harbor, WA: Movable-Bed Physical Model Study
2. Breach History and Susceptibility Study (numerical modeling study)

The physical model study (Hughes and Cohen 2006) was conducted at ERDC-CHL in Vicksburg, Mississippi. The purpose of the model was to investigate sediment transport within Half Moon Bay and evaluate various alternatives including beach nourishment, gravel protection, rubble mound structures, and dredged sand placement in the nearshore. The report concluded that:

- Over time, additional erosion of the gravel material and subsequent redistribution of the gravel along the Half Moon Bay Beach should be anticipated. With the loss of gravel material presently protecting the western shoreline of the bay, additional erosion of the breach fill from the bay side would increase breaching potential.
- If periodic nourishment of dredged material to the nearshore region in Half Moon Bay from bottom-dump barge decreases in the future, the first effect would likely be sediment loss from the beach profiles closest to Point Chehalis.

The numerical modeling study (Wamsley et al. 2006) was initiated to determine if a breach at the South Jetty would pose a threat to the Federal Navigation Channel or to the associated project features, particularly to the South Jetty and the Point Chehalis revetment.

The technical report concluded that:

- The 1993 breach would have continued to grow in depth and width had it not been mechanically closed in August 1994.
- Winter storms of 1994/1995 would have opened the breach significantly.
- The report projected that, by April 1995, the width and depth of the breach would have extended approximately 755 feet and to -10 feet MLLW, respectively.
- Hydrodynamic modeling of a "worst case simulation" show
    - Exposure of the South Jetty terminus to strong currents associated with a breach has the scour potential for destabilization of the jetty foundation.
    - There is "an increased potential for erosion in the revetment area."

- "With west-southwest storm waves, flow through the breach is continuously flooding. The strong flood flow through the breach during ebb tide in the inlet pushes the ebb jet to the north, reducing the ebb current in the navigation channel . . . This significant change would likely alter the potential for scour and deposition in the navigation channel."
- A permanent breach holds potential regional implications for the flow distribution and sedimentation pattern at Grays Harbor . . . The breach would transport sediment into Half Moon Bay and reduce sediment transport to the north, which is the direct and natural mechanism for sediment bypassing."

Pursuant to Corps policy, and mirroring the request of many members of the public, an independent technical review (ITR) of the report was conducted between May and September 2005. The ITR was chaired by a special sub-committee to the USACE Committee on Tidal Hydraulics. The review team consisted of the following leading scientists and engineers in the fields of coastal and geomorphic processes from across the country.

- Arthur T. Shak, U.S. Army Corps of Engineers, Los Angeles District (Chair)
- Dr. William H. McAnally, Mississippi State University
- Dr. Joan Oltman Shay, Northwest Research Associates
- Dr. Jim Phipps, Grays Harbor College, Professor Emeritus
- Dr. Robert G. Dean, University of Florida, Professor Emeritus

The team provided a rigorous review of the two ERDC-CHL reports. The ITR concluded:

- The selected hydrodynamic and wave transformation models are appropriate for the study.
- The breach morphological model appears to be appropriate for the problem considered; however, the large adjustments in model parameters that were required to calibrate the model are a concern.
- The uncertainty in any breach morphological model results is high enough that another model, independently developed, should be implemented before statements about breach growth or recovery can be made with a modicum of confidence.
- Although the model conclusions are supported by model results, there is a large uncertainty in morphological results and therefore in the concomitant conclusions of the report.
- Due to the uncertainty that remains about the evolution of the breach, the goal of confidently assessing the threat to the Grays Harbor Federal Navigation Project was not achieved.
- The hydrodynamic conditions associated with the worst-case large breach, as modeled, may not approximate reality and the prediction of an increasing breach depth by the morphological model may overstate the risk to the Grays Harbor Federal Navigation Project.

- Without intervention, the width of the 1993 breach would have continued to increase, albeit at a slow enough time-scale that would have permitted a measured, physical closure response if deemed necessary.

The ITR report reflects that definitive quantitative conclusions could not be drawn from the model study, that would either confirm or refute the original conclusions, delineated by WES (USACE 1994b) and the CTH Special Subcommittee (USACE 1995), that a breach would eventually become a threat to the federal project. The conclusions indicate that the time frame for, and severity of, breach evolution remain unresolved. The questions that were raised emphasize the complexity and uncertainty in estimating the consequences of a breach. However, the ITR recommendation for independently developing another numerical model to more confidently quantify breach growth and recovery was not pursued, because land access to the jetty to carry out both routine and emergency repairs became a pivotal consideration in the cost-effectiveness of long-term maintenance of the South Jetty. This was demonstrated during an emergency repair by the Portland District to the Coos Bay, Oregon North Jetty in December 2002 where, if land access had not been previously established, emergency repairs to the jetty would have been delayed to the summer months and would likely have resulted in much greater repair costs (Hays et al. 2003). Given the proximity of the navigation channel to the outer reach of the Grays Harbor South Jetty, it is likely that damage to this reach of jetty could have significant impacts on navigation if the jetty were damaged in this area and repairs could not be performed in a timely manner.

2.4.3.6 Interim Action Plan

This led to the development of the an Interim Action plan which calls for periodic placement of sand on the South Beach and Half Moon Bay shorelines when pre-defined erosion triggers are met — specified amounts of erosion, each of which triggers a pre-defined action for placement of sand. In February 2004, 29,000 cy of sand was placed in the southwest corner of Half Moon Bay to protect eroding breach fill material.

Sand placement was also conducted in December 2004 (20,000 cy), and in October 2010 the Corps placed an additional 20,000 cy of sand on the South Beach shoreline and 10,000 cy of sand on the Half Moon Bay shoreline as an interim measure to reduce the potential for a breach to occur. This placement was required due to erosion of the South Beach and Half Moon Bay shorelines that had occurred since the previous sand placement activities.

2.4.3.7 Complete History of Construction and Maintenance Events in the South Jetty Vicinity

The complete history of construction and maintenance events at the South Jetty and adjacent shorelines is shown in Table 1.

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Table 1. History of Construction and Maintenance Events at the South Jetty and Adjacent Shorelines

Period	Event
1898 to 1902	Initial construction of the South Jetty. Constructed to 13,734 feet with a top elevation of +8 feet mean lower low water (MLLW).
1907 to 1916	Initial construction of the North Jetty. Elevation of 17,204 feet with a top elevation of +8 feet MLLW.
1935 to 1939	South Jetty reconstruction. Station 80+00 to 210+00 with a top elevation of +20 feet MLLW. Erosion of Point Chehalis begins on north side of the South Jetty.
1935 to 1940	North Jetty reconstruction. Outer 7,000 feet with a top elevation of +20 feet MLLW.
1942	Maintenance dredging of the bar and entrance channel no longer required due to scouring effect of jetty system.
1946	Half Moon Bay begins to form.
1950 to 1956	Construction of Point Chehalis shoreline protection (revetment and groins).
1966	South Jetty reconstruction. Station 110+00 to 150+00 with a top elevation of +20 feet MLLW.
1970 to 1973	Extensive groin replacement and revetment repair along Point Chehalis.
1975	North Jetty reconstruction. Outer 6,000 feet with a top elevation of +20 feet MLLW.
1990	Construction of outer harbor Federal Navigation Channel improvements.
1991	Re-institution of maintenance dredging of bar and entrance channel.
1992 to present	Nearshore placement of maintenance-dredged material south of the South Jetty in Half Moon Bay and at South Beach.
Fall 1993	Rehabilitate southern portion (800 feet) of the Point Chehalis revetment.
December 1993	Breach occurs between Half Moon Bay and the South Jetty.
August 1994	South Jetty Breach Fill Project. Corps places 600,000 cy of dredged material to close the South Jetty breach.
July 1995	Breach Fill Relocation Project. Corps relocates 150,000 cy of breach fill material from western Half Moon Bay shoreline to South Beach.
1995	City of Westport places 82,000 cy of sand on the east shore of Half Moon Bay to protect their sewer outfall line.
1995	The Corps places 300,000 cy of dredged material to nourish the Half Moon Bay eastern shoreline (Section 111 Project).
February 1997	The Corps places two upland berms (10,000 and 5,000 cy) at the Section 111 project site.
December 1998 to March 1999	Point Chehalis Revetment Extension Project. Corps extends the Point Chehalis revetment 1,900 feet.
2000 to 2002	North Jetty Major Maintenance Project.
December 1999 to February 2000	South Jetty Repair Project (diffraction mound and transition beach).
September 1999 to May 2002	South Jetty Rehabilitation Project:: Station 87+00 to 120+00, with a top elevation of +23 feet MLLW
January 2002	The Corps places 16,100 cy of 12-inch-minus cobble and gravel along the western shore of Half Moon Bay to slow erosion of the South Jetty breach fill and maintain access to the jetty via the relocated haul road.
May 2002	The Corps relocates 135,000 cy of sand from the Point Chehalis revetment stockpile site to the breach fill.
February 2004	South Jetty Breach Fill Maintenance Project, fiscal year 2004. The Corps places 25,000 cy sand on the Half Moon Bay shoreline as an interim measure.
December 2004	South Jetty Breach Fill Maintenance Project, fiscal year 2005. The Corps places 20,000 cy sand on the Half Moon Bay shoreline as an interim measure.
December 2005	The Corps removes 1,000 cy of sand that was mis-placed between December 2004 and January 2005, and relocates sand to within footprint of December 2004 design.

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Period	Event
October 2010	South Jetty Breach Fill Maintenance Project, fiscal year 2010. The Corps places 20,000 cy sand on the South Beach shoreline and 10,000 cy sand on the Half Moon Bay shoreline as an interim measure.
October-November 2010	300 feet of Point Chehalis revetment repaired in 2 locations. 1120 tons of 2-4 ton rock was placed to repair 100 feet of revetment between Groin C and D during an emergency repair during a 23 October 2010 storm. 200 feet of revetment west of Groin A was repaired in November 2010 with 2800 tons of 9-17 ton rock.

2.5 PRIOR STUDIES AND REPORTS

The studies and reports listed in section 2.4 and other historic reports pertaining to the Grays Harbor South Jetty and the Long-Term Management Strategy are listed in Table 2.

Table 2. Previous Grays Harbor Studies and Reports

Year	Study/Report
1955	Plans for Improvement of Grays Harbor and Point Chehalis, Washington; Hydraulic Model Investigation (TM No. 2-417)
1963	Review of Improvements Recommended at Grays Harbor, Washington
1965	General Design Memorandum, South Jetty Rehabilitation
1967	Report on Grays Harbor, Washington
1972	Report 4, South Jetty Study (TR H-72-2)
1992	Historical Bathymetric Changes Near the Entrance to Grays Harbor, Washington (Contract DE-AC06-76RLO 1830)
1994	Report to CTH and CERB Consultants on Long-Term Maintenance of the South Jetty at Grays Harbor, Washington
1995	Review of Long-Term Maintenance Plans for the South Jetty, Grays Harbor, Washington
1997	Long-Term Maintenance of the South Jetty at Grays Harbor, Washington
1999	South Jetty Repair Final Environmental Assessment
2000	Programmatic Biological Evaluation: Fiscal Years 2001-2006 Maintenance Dredging and Disposal, Grays Harbor and Chehalis River Navigation Project, Grays Harbor County, Washington
2002	South Jetty Breach Fill Final Environmental Assessment
2003	South Jetty Sediment Processes Study, Grays Harbor, Washington: Evaluation of Engineering Structures and Maintenance Measures (ERDC/CHL TR-03-4)
2004	Final Environmental Assessment, South Jetty Breach Fill Maintenance; Final Supplemental Environmental Assessment, South Jetty Breach Fill Maintenance
2005	Final Supplement to the Final Supplemental Environmental Assessment for the South Jetty Breach Fill Maintenance
2006	Breach History and Susceptibility Study, South Jetty and Navigation Project, Grays Harbor, Washington (Wamsley et al. 2006; ERDC/CHL TR-06-22)
2006	Half Moon Bay, Grays Harbor, Washington Movable-Bed Physical Model Study (Hughes and Cohen 2006; ERDC/CHL TR-06-15)
2007	Environmental Assessment – Grays Harbor Test Dredge for Potential Entrance Channel Realignment Grays Harbor Navigation Project Grays Harbor County, Washington
2010	Final Supplemental Environmental Assessment for the South Jetty Breach Fill Maintenance

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2.6 PROJECT PURPOSE AND NEED

Jetty construction originally resulted in large accretion of sediments on the outer shorelines of the jetties, which has been eroding since the 1960s. These accretion and erosion processes, coupled with channel morphology, resulted in erosion to South Beach shoreline and formation of present-day Half Moon Bay. In 1993, erosion of both South Beach and Half Moon Bay shorelines resulted in a breach of the South Beach spit severing the connection of the South Jetty to land. While periodic measures have since been taken to manage risk, continued erosion could again result in breaching of the landmass adjacent to the jetty, which could potentially have adverse effects on operations and maintenance (O&M) of the federal navigation project. The potential adverse effects include:

- Shoaling in the navigation channel
- Structural damage to the South Jetty
- Damage and increased O&M to Point Chehalis revetment and groins
- Damage and increased O&M to Westport marina features, and
- Adverse impacts to the North Jetty resulting from changes littoral drift.

The purpose of the LTMS study is (1) to assess the risk that such a breach may occur, (2) to evaluate the threat of adverse impact to the Grays Harbor Navigation Project resulting from any breach, and—if action is determined to be warranted—(3) assess and recommend the most appropriate long-term strategy for continued maintenance of the authorized Federal Navigation Project features.

There is universal agreement among the numerous scientific experts who have studied this complex system over the last 20 years that, without affirmative action to protect against erosion, a breach across the South Beach spit will occur. There is less than complete agreement as to the imminence of such a breach occurring, and the physical dimensions of breach that will develop before there is an opportunity to close it once again. Consequently, there is less than full agreement as to the exact nature and degree of adverse impacts on the various features of the navigation project. However, there is ample evidence that adverse impacts on effective O&M of the navigation features will occur; likewise, the magnitude of those adverse consequences is substantial, as indicated above, Thus, the risk, calculated by multiplying the probability of consequences by the magnitude of consequences, is sufficiently elevated to render it both prudent and justified to take action under the navigation project's O&M authority to address the threat of a breach, through either preventive or responsive action. This elevated degree of risk is adequately substantiated, notwithstanding the lingering scientific uncertainty regarding the precise nature and extent of the threat posed by a breach.

The objective of the study is to determine a technically feasible, cost effective, environmentally sound, and publicly acceptable solution that minimizes risk to the federal navigation project O&M over the next 50 years.

3 EXISTING ENVIRONMENT OF THE STUDY AREA

This section describes the physical and biological characteristics of the study area and discusses concerns related to the Magnuson-Stevens Fishery Conservation and Management Act. It also describes the area's human use characteristics.

3.1 PHYSICAL CHARACTERISTICS

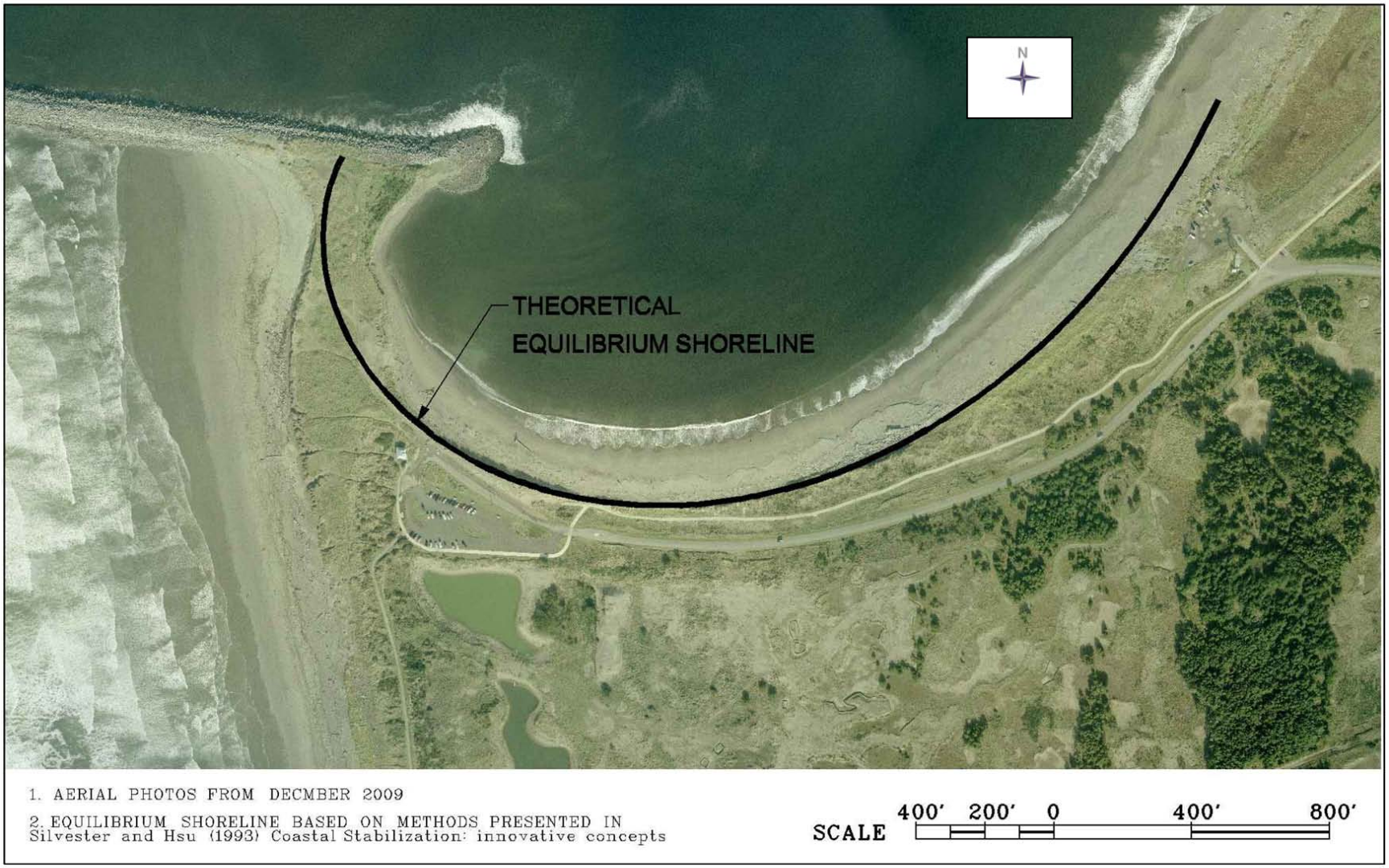
Physical characteristics are described in terms of bathymetry and geology and in terms of hydrology and hydraulics. In addition, risk and uncertainties associated with sea level rise and the possibility of earthquake and tsunami are discussed.

3.1.1 BATHYMETRY AND GEOLOGY

The narrow neck of land that connects the South Jetty to South Beach is a high-energy area subject to direct tidal, wave, and wind action. The shoreline is composed of fine- to medium-grained sands and some gravel, common to the Columbia River littoral cell (USGS 2004). The wave energy results in shifting substrate that lacks organic material. This area has undergone major changes during the life of the South Jetty. South Beach has accreted and retreated several times from the early 1900s until about 1967, when the shoreline began its constant retreat (Kraus and Arden 2003, ERDC/CHL TR-03-12).

Half Moon Bay is a type of coastal feature common at the landward end of jetties. The bay formed in 1945, 6 years after the South Jetty was reconstructed and the height of the jetty was raised by 12 feet (USACE 2004). The Point Chehalis revetment was constructed between 1950 and 1956 to combat the rapid retreat of the Half Moon Bay shoreline. Between 1957 and 1993, the unarmored portion of the shoreline retreated at an average annual rate of 5 to 10 feet per year. Between May 1993 and December 1994, localized areas retreated up to 150 feet. A 1,900-foot-long revetment extension was constructed in 1998/1999 to protect the Westport wastewater treatment plant and sewer outfall. Since 1994, 225,000 cubic yards (cy) of dredged material from the O&M of the Entrance Channel are placed offshore (below -10 ft MLLW) of the eroding shoreline in Half Moon Bay each year. Additionally, dredged material from the outer navigation channel (Outer Crossover through the Entrance Channel Reach) are used to nourish the Half Moon Bay shoreline directly. Wave action then transports the material through the nearshore area, which helps to maintain a gently sloping shallow bay.

Geometric relations between the primary wave direction and the jetty orientation can be used to predict equilibrium shoreline positions of crenulated bays such as Half Moon Bay. (see Figure 8; Hsu et al. 1987). Although the shoreline of Half Moon Bay seems to be approaching equilibrium (Figure 8), it is anticipated that the shoreline will continue to adapt to wave conditions and changes in water level. In particular, increased erosion occurs during storms with prolonged elevated water levels. The shoreline can be expected to erode in the northwest corner of Half Moon Bay unless this control point is moved eastward or a less erodible substrate, such as cobble, is placed to mitigate erosion (Komar 1998).



SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers, April 2011.

Figure 8. Theoretical equilibrium shoreline for Half Moon Bay

Portions of the 23.5-mile Federal Navigation Channel are periodically dredged to remove accumulated sediment, and potential deepening of the channel is the subject of ongoing studies. In the seaward portion of the harbor, sediment accumulates primarily by redistribution of estuary silt by wind and waves and deposition of ocean sands by tidal action. In the interior harbor, discharges from the Chehalis, Elk, Humptulips, Hoquiam, Johns, and Wishkah rivers contribute to sediment accumulation (USACE 2007a).

From South Beach, the continental shelf extends seaward for 30 to 36 miles and then drops off into deep water (USACE 2007a). The coastal currents and wave climate contribute to a net regional sediment transport to the north along the continental shelf in Washington. In the winter, the longshore transport (littoral drift) is directed toward the north, and sand is eroded from beaches due to a net cross-shore transport of sand offshore induced by winter storm waves. In the summer, the littoral drift generally shifts to the south due to swell waves predominantly from the northwest, which tend to move sand onto the beach. Although the wave climate and coastal currents along the Washington shelf result in dominance of the northern component of longshore transport on a regional scale, local wave refraction and shoreline reorientation have led to a reversal of net sediment transport and a southward net littoral drift on the beaches south of Grays Harbor (Kaminsky et al. 2000). This localized reversal of the longshore transport may be a factor in the persistent erosion at South Beach. Figure 9 shows the South Beach and Half Moon Bay shoreline positions since 1942.

Between 1957 and 1993, prior to the breach, the average annual long-term shoreline recession rate of Half Moon Bay—determined by estimating the change in position of shoreline contours—was 5 to 10 feet per year (USACE 1997). Sediment transport studies in Half Moon Bay indicate that sediment is eroded from the west end (estuary side) of the beach and transported via a longshore current east along the shoreline until it is eventually delivered to the tidal stream in the main channel (Osborne 2003a).

Based on a review of aerial photographs of the beach scarp, the average South Beach shoreline recession rate from 1990 to 1996 was approximately 36 feet per year (USACE 1997). Observations in the vicinity of the South Jetty indicate that the greatest amount of erosion occurs near the jetty and decreases with distance to the south (Wamsley et al. 2006).

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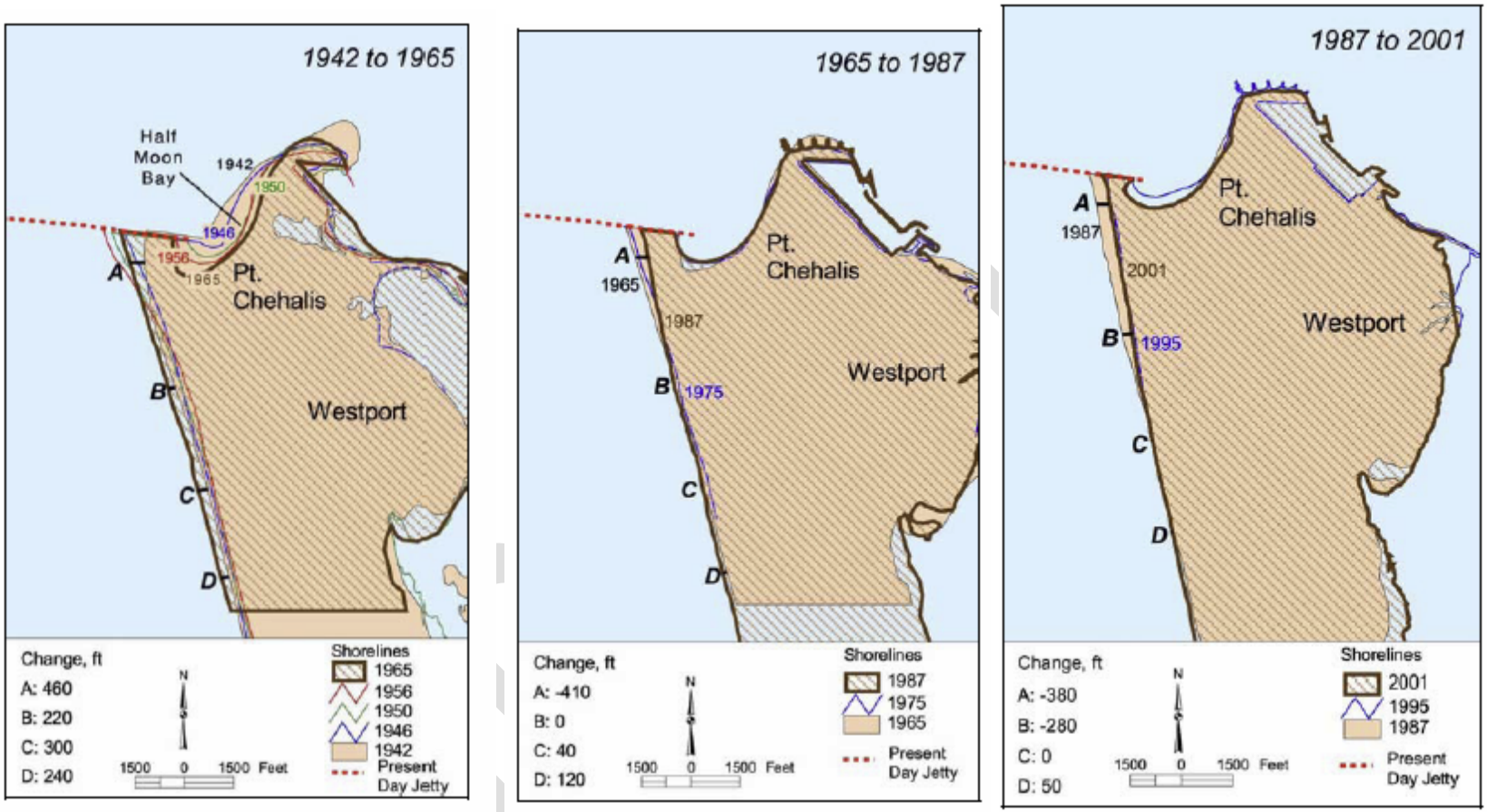

Figure 9. South Beach and Half Moon Bay shoreline positions since 1942 (from USACE 2003, ERDC/CHL TR-03-12)

After formation of the breach in 1993, material has been periodically placed along the Half Moon Bay and South Beach shorelines and the crest of the South Beach spit dune to slow shoreline recession and protect the South Jetty, Westhaven Park, and Westport facilities. Cobble and gravel placement, construction projects, and erosion events altered the shoreline from 1994 to 2004 (USACE 2004). Specific events are discussed in section 2.4 and Appendix D. Construction and material placement activities conducted in October 2010 in the vicinity of Half Moon Bay and South Beach are summarized on Figure 10.

In 2005, surface sediment samples were collected from the project area. Sampling results indicated that the sediment at South Beach was generally less than 1 percent fines and more than 99 percent sand. The sediment at the Half Moon Bay shoreline consisted of primarily sand (averaging 95.8 percent sand in subtidal stations) and gravel with 0.1 to 2.4 percent fines (SAIC and CEA 2005). In areas where material was placed to fill the breach, cobbles are generally present in intertidal areas (USACE 2004).

3.1.2 HYDROLOGY AND HYDRAULICS

The hydrology and hydraulics within Grays Harbor and the project area are governed by interactions between tides, currents and waves. The following subsections discuss these phenomena in greater detail.

3.1.2.1 Tides and Currents

Grays Harbor experiences relatively large semi-diurnal tides. The mean tidal range varies from 7 feet at the harbor entrance in the city of Westport to 7.9 feet in the city of Aberdeen. Relative to MLLW, mean sea level (MSL) is 4.8 feet and mean higher high water (MHHW) is 9.1 feet (NOAA 2011). At MHHW, the water surface within Grays Harbor covers approximately 94 square miles, while at MLLW the water surface area within Grays Harbor is approximately 38 square miles and approximately 63 percent of the harbor's surface area is covered mudflats (USACE 2007a).

During the summer season, mean water levels can be as much as 1 foot lower than during the winter season (Wamsley et al. 2006). Additionally, El Niño winters typically bring higher than normal water levels. Strong offshore or onshore wind events throughout the year can affect the magnitude and duration of tidal stages.

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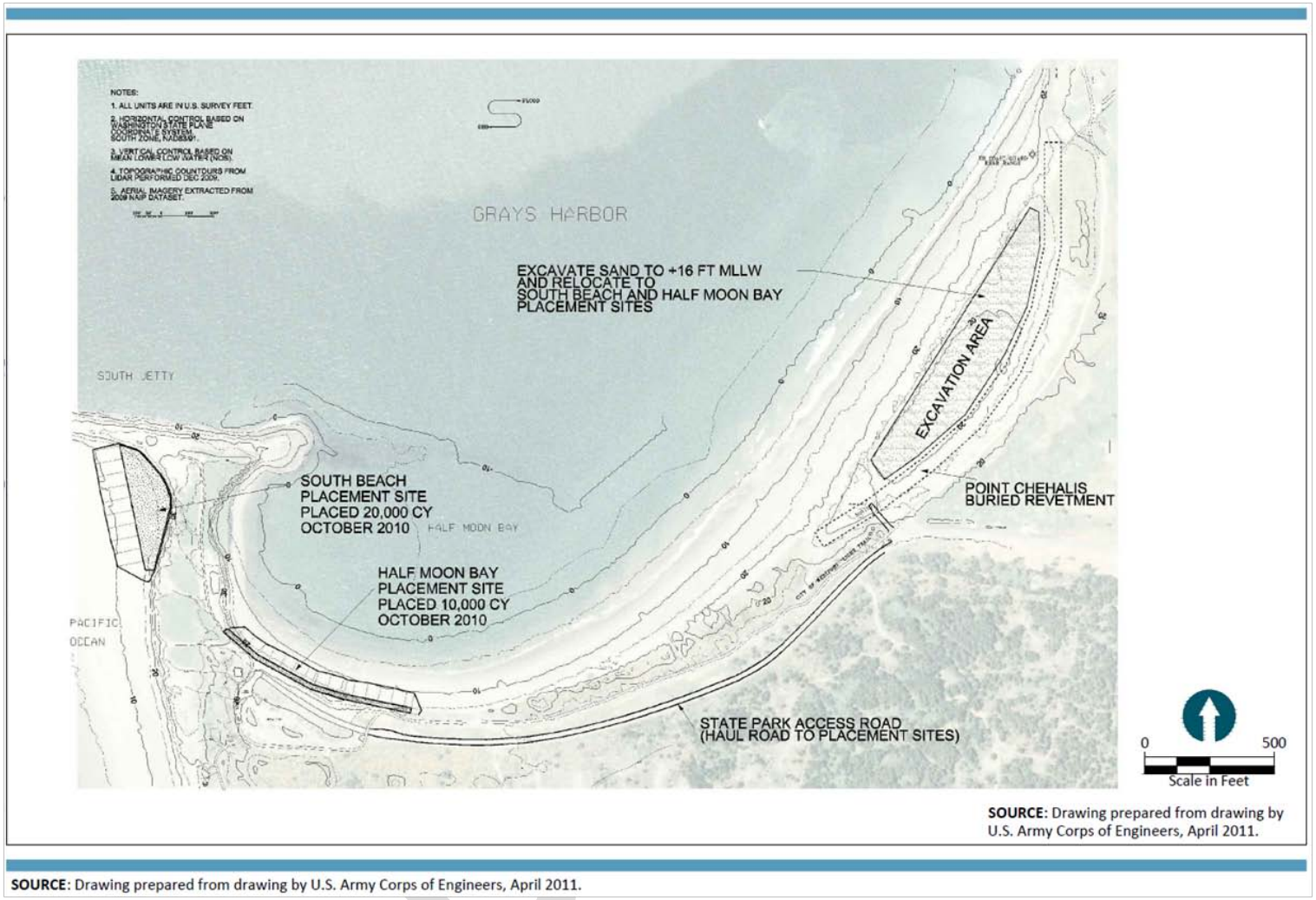

SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers, April 2011.

Figure 10. Construction activities during 2010

The Grays Harbor current regime is generally dominated by tidal currents; however, during high flows of the Chehalis River, currents in the upper estuary are impacted by the river flow. The North and South Jetties have altered the current patterns in and around the harbor mouth, as compared with the current patterns of pre-construction conditions. By design, the jetties constrict tidal flow by confining tidal currents within the harbor inlet. The objective of the North and South jetties is to produce scouring velocities within the harbor inlet to maintain the Federal Navigation Channel depth and reduce the need for dredging (USACE 1997).

Ebb currents are stronger along the South Jetty, whereas flood currents are stronger along the North Jetty (USACE 2000). Seaward movement of sediment is created in the southern half of the entrance channel, and a landward movement of sediment is created in the northern half of the entrance channel (USACE 2007b). In Half Moon Bay, fine- and medium-grained sands are transported out of the project area by strong ebb currents (Osborne 2003a). Additionally, tidal flows in and out of the estuary strongly influence nearshore ocean currents and waves along the Washington coast in the vicinity of Grays Harbor.

3.1.2.2 Waves

Along the Washington coast and in the northeastern Pacific Ocean, strong seasonal variations occur in wave climate. Information about the wave climate in the vicinity of the entrance to Grays Harbor (such as significant wave height, peak wave period, and wave direction) is recorded by a Coastal Data Information Program (CDIP) buoy (No. 036), located in approximately 130 feet of water and 5.9 miles southwest of the harbor entrance. Significant wave height is a measure of the highest waves within a given set (specifically, it is the average height of the top third highest waves of a set). Wave period is a description of the amount of time it takes for two sequential wave crests to pass a fixed point (the peak wave period is a more sophisticated calculation based on maximum wave energy and frequencies). Wave direction is the direction from which waves approach (USACE 2009a). In the summer, waves originate primarily from the west-northwest, and the average deep-water significant wave height is less than 6.6 feet, with a peak wave period of less than 10 seconds. In contrast, waves in the winter generally come from the west-southwest, with a wave height of approximately 12 feet and a peak wave period of more than 12 seconds (Wamsley et al. 2006). Typically, deep-water waves are refracted towards the harbor's mouth by the bathymetry offshore of Grays Harbor, which concentrates wave energy in the harbor entrance. Waves at the harbor entrance are also significantly influenced by tidal currents. During ebb tide, waves steepen and peak, whereas the opposite occurs during flood tide (USACE 2000).

This seasonal variability in wave height and direction generally results in northerly offshore sediment transport in the winter (beach erosion) and southerly onshore transport in the

summer (beach accretion). From 1997 to 2000, the Washington State Department of Ecology (Ecology) and the U.S. Geological Survey conducted a regional monitoring program to quantify the short- to medium-term beach change rates and morphologic variability in the study area. The seasonal pattern was evident in data collected near the South Jetty, and the magnitude of seasonal shoreline change was as much as 100 feet (Ruggiero and Voigt 2000).

Extreme waves, defined as those with a wave height greater than 16.4 feet as classified by Wamsley et al. (2006), generally originate from the west-southwest. Based on information collected from CDIP Buoy No. 036 between 1985 and 2009, waves at the buoy with a height of 27 feet have an average period of 2 years between occurrences (return period), while waves with a height of 40 feet have a period of 50 years between occurrences (Appendix D-Figure 1.4). Several storms with similar directionality and larger deep-water wave heights have impacted the area since the December 1993 storm event without inducing a breach into Half Moon Bay. The storm that breached the project area in December 1993 featured maximum offshore wave heights of 24.6 feet from the south-southwest to west, which corresponds to approximately a 1-year return period event for the Grays Harbor area. It is hypothesized that the duration of the December 1993 storm event, which was approximately 8 days in length, contributed to the breach.

Results from a field experiment conducted in September and October 1999 indicated that the significant wave height in outer Half Moon Bay is approximately 57 percent lower on average than at the CDIP Buoy No. 036 (Osborne 2003a). In general, the significant wave height and direction of deep-water waves propagating from the CDIP buoy towards Half Moon Bay could be affected and potentially attenuated by several processes, such as refraction (due to changes in bathymetry along the direction of propagation); dispersion; dissipation due to breaking (diffraction around structures and other obstacles); reflection from structures and beaches; and/or wave-current interaction due to tidal currents.

Physical model tests conducted by ERDC-CHL (Seabergh 2001) indicated that a wave diffraction mound would be effective in protecting the breach fill adjacent to the South Jetty. From December 1999 to February 2000, a wave diffraction mound and gravel transition beach were constructed at the western edge of Half Moon Bay. The diffraction mound did alter the wave climate of Half Moon Bay (R2 Resource Consultants, Inc. 2005). Specifically, the wave direction within Half Moon Bay was altered by wave refraction and diffraction around the constructed mound (Osborne 2003a). Although the wave diffraction mound was in place, storms in November and December 2001 overtopped the breach fill (USACE 2004).

Locally generated wind waves are common within Grays Harbor. Prevailing winds from the west and south occur particularly during the winter, and northerly winds of less intensity generally occur during the summer. In the outer areas of the harbor, where long fetches exist, waves of 1 to 3 feet are common. At high tide when wind conditions are favorable,

waves greater than 5 feet can occur. Farther inland, where fetches are limited, wind-generated waves are generally less than 2 feet (USACE 2000). Locally generated waves within Grays Harbor, in addition to waves propagating into the harbor from the ocean, can contribute to sediment movement within the harbor, especially in shallow areas.

3.1.3 Risk and Uncertainties Associated with Sea Level Rise

Many factors affect local sea level rise (SLR). These factors include the rise in global sea level combined with local factors, such as vertical land movement (VLM) and seasonal elevation changes due to atmospheric circulation effects (Mote et al. 2008). The Corps acknowledges the potential for localized SLR effects on its projects and issued Engineer Circular (EC) 1165-2-211 (USACE 2009b) as guidance to address the effects of future SLR on projects within its Civil Works Program.

Global SLR has been associated with effects of global climate change. A rise in the global temperature has caused oceans to warm, which has led to thermal expansion. The rise in global temperatures has also resulted in the melting of global ice and contributed to the additional volume of water added to the oceans.

Locally along the Washington coast, there are two additional features that affect local SLR: atmospheric circulation and local tectonic movement. As described by Mote et al. (2008), wind plays a part in sea elevation. SLR is more pronounced in winter months when the prevailing northward wind combined with the Earth's rotation (Coriolis Effect) produces an elevated sea level by as much as 20 inches when compared to summer elevations. During an El Niño year, the winter elevation could increase by an additional 12 inches.

According to Mote et al. (2008), western Washington sits in an area were the Juan de Fuca oceanic plate is subducting under the North American continental plate. This area of subduction is causing the land along the Washington coast to rise vertically, causing tectonic uplift. This VLM is more pronounced along the northwestern tip of the coast and becomes less pronounced farther south. The VLM along the central Washington coast within the project area is estimated to be 1.5 to 2 millimeters per year with a total estimated uplift of 3 to 4 inches over the project life of 50 years (Mote et al. 2008).

Using the methods described in the Corps EC 1165-2-211 (USACE 2009b), the Corps has estimated that local SLR for the project area would range from a medium estimate of 0.7 feet to a high estimate of 1.9 feet by the year 2060. These methods take into account local sea level trend data as well as VLM to predict future sea levels for the study area.

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3.1.4 Risk and Uncertainties Associated with Cascadia subduction zone earthquake and tsunami

The morphological effects associated with a Cascadia Subduction Zone earthquake and tsunami are not included within the scope of this study. Additionally, the alternatives presented will not mitigate the risks associated with such an event. Frankel and Petersen (2008) estimate that the probability of a Magnitude Mw = 8.8 – 9.2 event in the next 50 years is approximately 14%. The expected consequences of such an event are twofold:

1. Co-seismic land level change usually accompanies such an earthquake. In the case of the 2011 Japan earthquake, the subsidence was as much as 3.4 feet. In the 2010 Chile earthquake, coastal areas were uplifted by as much as 10 feet.
2. If a significant tsunami is generated during a Cascadia rupture, the potential for large morphological change from coastal currents and waves is significant.

3.1.5 Water Quality

Waters in the vicinity of Half Moon Bay and the South Jetty have been classified as AA (extraordinary) by Ecology (USACE 2004). The water quality of Grays Harbor has been influenced by historic and current land uses near the harbor. Historically, both the inner and outer portions of Grays Harbor were on Washington State's 303(d) list[3] for fecal coliform; however, Grays Harbor is no longer 303(d)-listed (USACE 2007a) for fecal coliform. Currently, the only Grays Harbor 303(d) listing is for low dissolved oxygen (DO) in the outer harbor (Ecology 2008).

Water quality may be impacted by suspended sediments from rivers discharging into the harbor. During certain tidal stages in the upper estuary, the water column is strongly stratified. Freshwater with low salinity and density is discharged into the inner harbor by local rivers, creating a surface layer that flows seaward on top of highly saline and dense seawater moving inland during flood tide. In the outer harbor and in the vicinity of Half Moon Bay, the water column is generally well mixed (USACE 2000). Water temperature, DO, and pH level fluctuations in Grays Harbor can generally be attributed to natural processes, such as nutrient enrichment from wastewater treatment plant effluent or solar heating of shallow water (USACE 2000).

Periodic dredging of the Federal Navigation Channel also affects water quality. Maintenance dredging is conducted by clamshell and hopper dredges to remove accumulated sediment. Dredged material may be placed at several authorized locations: Point Chehalis revetment stockpile site, South Jetty open water disposal site, Point Chehalis open water disposal site, South Beach shoreline, or Half Moon Bay shoreline (USACE 2006a). Suspended sediments

3 Under section 303(d) of the 1972 Clean Water Act, states, territories, and authorized tribes are required to develop lists of impaired waters, which have come to be known as "303(d) lists." For any water body listed as impaired, all identified causes of impairment, such as fecal coliform contamination, must also be identified.

caused by dredging and disposal operations generally cause a temporary, localized increase in total suspended solids and a decrease in DO levels. However, observations indicate that these events are localized and do not impact the project area for an extended amount of time (USACE 2000).

3.1.6 SEDIMENT QUALITY

Sediment quality issues are related to water quality in that sediment within Grays Harbor may also have been impacted by historic and current land uses near the harbor. Potential sediment contaminants include antifoulants (i.e., tributyltin [TBT]), paints, petroleum products, metals, and sandblast grit from boat yards and marinas; dioxins from pulp mill processing; pesticides from oyster aquaculture activities; and guaiacol and resin acids from the handling of wood products and raw logs. In 1998, Ecology noted that although a few localized problem areas were present within Grays Harbor, chemical concentrations in the sediment were low (Norton 1999).

The *Dredged Material Evaluation and Disposal Procedures* (USACE 2008a) details the sampling plan and requirements for determining whether dredged material from the Federal Navigation Channel is acceptable for unconfined, open-water disposal. Historically, contaminants such as metals, sevin, dioxin, resin acids, guaiacol, and tributylin (on a case-by-case basis) have been included in the testing. Currently, some of these contaminants are excluded from testing because of they were not detected in earlier samples. Existing sediment data from the Federal Navigation Channel indicate low or non-detect levels of chemicals of concern and no significant toxic responses in agency-mandated biological testing (USACE 2000). Some dredged material from the Federal Navigation Channel that meets criteria for unconfined, open-water disposal is often placed at the Half Moon Bay shoreline. While there is evidence that some native sediment from the inner harbor has historically contained dioxin, material that would be used as a source for beach nourishment would be coarse, clean sand from the outer harbor. In September 2008, 12 samples were collected by the Corps near the entrance to Grays Harbor to evaluate background dioxin levels in the vicinity of the Grays Harbor; the dioxin toxic equivalents concentrations of these samples ranged from 0.26 to 0.29 micrograms per kilogram (µg/kg; parts per trillion; Fox 2009), which are extremely low concentrations, far below agency concern levels.

3.2 BIOLOGICAL CHARACTERISTICS

Grays Harbor is a biologically diverse and productive ecosystem. The harbor itself consists of a large estuary of various habitat types that support a diverse assemblage of species. As the receiving point for the Chehalis, Elk, Humptulips, Hoquiam, Johns, and Wishkah rivers, Grays Harbor is the fourth largest estuarine environment in the western United States (Seiler 1989; Corps 1997). A subset of these habitat types and associated species are present in and around the project area, which includes Half Moon Bay, South Beach, and the South Jetty.

3.2.1 HABITAT AND VEGETATION

The project area consists of a rocky jetty (South Jetty), sandy beaches (Half Moon Bay and South Beach), and sand dunes. The shoreline at Half Moon Bay is a mix of gravel, rock, and sand, while the shoreline at South Beach is primarily sand. Freshwater wetlands are located in the vicinity of the project but are not located in the project area.

3.2.1.1 Rock Jetty and Remnants

Although the South Jetty is not naturally occurring, it does provide habitat for benthic species that are adapted to rocky environments. It is constructed of large boulders that provide underwater crevasses that can be used by marine fish species. Modest populations of marine algae, primarily sea lettuce (*Ulva* spp.) and rockweed (*Fucus* spp.), are found attached to remnant intertidal rock riprap directly east of the present jetty. The rock riprap also provides substrate for various sessile invertebrates, e.g. isopod and amphipod species. In addition, various bird species may use the jetty for roosting and/or foraging for small fishes.

3.2.1.2 Subtidal Sandflats and Sandy Beach

Subtidal sandflats and sandy beach habitat are found within Half Moon Bay and along South Beach. No marine algae are presently found in these areas. This area has good tidal flushing and could be used by a variety of marine species, e.g. flatfishes, mole crabs, small polychaetes and isopods, and soft-shell clams that inhabit intertidal and subtidal sandy beach habitats.

3.2.1.3 Sand Dunes

Sand dunes present within Half Moon Bay and at South Beach have both native and non-native vegetation present. Plantings of native dune wild rye (*Elymus mollis*) occurred directly south of the jetty and on top of the breach fill placed in 2002. This planting had a 91 percent plant survival rate; thus, much of the dunes have native dune wild rye. Adjacent dune areas have invasive, non-native vegetation, including European beach grass (*Ammophila arenaria*), Scot's broom (*Cytisus scoparius*), and Himalayan blackberry (*Rubus armeniacus*).

As part of the Corps' 2002 effort to plant American dune grass on the breach fill, experimental plots were created to evaluate different methods for establishing vegetation. The 50,000 grass culms of native wild rye were planted on the 3-acre breach fill and have been monitored since 2002 (USACE 2005b). Plant survival rates on the experimental plots were highest when the dune grass was planted in clusters. Sand deposition was also accelerated under the clustered planting treatment. Plant survival rates for the larger planting area are comparable to the survival rates on the experimental plots.

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3.2.1.4 Wetlands

An extensive, large deflation plain wetland is present along the entire south side of the state park access road and will not be affected by this project. Vegetation in the wetland includes shore pine (*Pinus contorta*), Hooker's willow (*Salix hookerana*), California wax myrtle (*Myrica californica*), slough sedge (*Carex obnupta*), common rush (*Juncus effusus*), and silverweed (*Potentilla anserina*).

3.2.2 Organisms Present in the Area and Their Status

Grays Harbor is biologically a very productive estuary. Several species that could be affected by project activities can be expected to be present within or to transit the project area.

3.2.2.1 Zooplankton

Studies conducted by Kinney et al. (1981) found that Grays Harbor's predominant taxa, based on numerical frequency of occurrence in sampled collections, included barnacle larvae (nauplii and cyprides), calanoid copepods (*Eurytemora americana, Acartia clause,* and *Calanus* spp.), and crangonid shrimp larvae (*Centropages abdominalis*). Juvenile and adult sand shrimp (*Crangon francisscorum*), and mysid shrimp (*Americamysis bahia*) composed the majority of the total standing crop (biomass).

3.2.2.2 Benthic Invertebrates

Benthic invertebrates known to be present within Half Moon Bay (see 4.2.1.2.) include mole crabs (*Emerita analoga*), small polychaetes, nematodes and amphipods (several species of each) and heart cockles (*Clinocardium nuttallii*; USACE 2004). In addition, the amphipod Jassa (*Jassa marmorata*) is another notable invertebrate found throughout Grays Harbor. This species has been found to be a significant food source for multiple marine species, notably outmigrating juvenile salmon. Although abundant in Grays Harbor among the piles and other in-water structures, it is not found in great numbers in the project area.

Of special economic and ecological importance in Grays Harbor is the Dungeness crab (*Cancer magister;* Antrim et al. 2007). The Dungeness crab is the only commercially important crab in the state of Washington's territorial waters, and it is also an important prey for several species of fish. Dungeness crab habitat preferences include eelgrass and mudflats, making Grays Harbor a prime habitat. This species has been noted to be present in the project area, and numbers of Dungeness crab are monitored by the Corps in conjunction with nearshore disposal of dredged material in Half Moon Bay.

The Pacific razor clam (*Siliqua patula*) is also found in Grays Harbor and inhabits intertidal coastal beaches along the Pacific coast (Antrim et al. 2007). Razor clams prefer gently sloping beaches with fine-grained sand that are fully exposed to the surf of the open ocean (Lassuy and Simons 1989). This species is important forage for Dungeness crab, birds, and

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several fish species. Humans also harvest this species when regulations allow. Surveys for the Pacific razor clam within the project area indicate that populations are very low from the South Jetty to a point approximately 3 miles to the south (Ayers 2009). No Pacific razor clams have been recorded in Half Moon Bay or at the South Jetty. Pacific razor clams may be present at South Beach; however, their numbers are likely very low, as indicated by a lack of sport fishing for them along South Beach (Burkle 2005).

No observations of either Pacific Oyster (*Crassostrea gigas*) or native Olympia oyster (*Ostrea conchaphila)* have been made either in Half Moon Bay or at South Beach. Neither location provides the type of habitat required by oysters. Oysters are commercially grown in Grays Harbor but outside of the project area southeast of Westport.

3.2.2.3 Fish

Grays Harbor provides habitat for a variety of fish species, including six documented species of salmonids: Chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho salmon (*O. kisutch*), steelhead (*O. mykiss*), coastal cutthroat trout (*O. clarki clarki*), and native char (*Salvelinus spp.*; R2 Resource Consultants, Inc. 2005). A survey documented more than 91,000 individual fish, representing 32 fish species, including three species of salmonids (Chinook, cutthroat, and rainbow/steelhead), during beach seining activities conducted in 2004 in Half Moon Bay (Table 3; R2 Resource Consultants, Inc. 2005). Forage fish dominated the species collected in the beach seining activities, comprising 86 percent of the overall catch. Chinook made up the majority of the salmonids captured, representing 2 percent of the total fish captured, while only one cutthroat and one steelhead trout were captured.

Bull trout (*Salvelinus confluentus*) have been documented in Grays Harbor but do not spawn in the Chehalis River basin and probably originate from spawning populations of native char in the Quinault or Queets rivers, both located more than 60 miles north of the Grays Harbor (Jeanes et al. 2003).

Table 3 lists the species of fish whose presence in Grays Harbor has been documented.

Table 3. Common and Scientific Names of Fish Species Documented in Grays Harbor (R2 Resource Consultants, Inc.)

Common Name	Scientific Name	Common Name	Scientific Name
Steelhead	*Oncorhynchus mykiss*	Shiner perch	*Cymatogaster aggregate*
Coastal cutthroat trout	*0. clarki clarki*	Redtail surfperch	*Amphistichus rhodoterus*
Chinook salmon	*0. tshawytscha*	Striped seaperch	*Embiotoca lateralis*
Coho salmon	*0. kisutch*	Pile perch	*Rhacochilus vacca*
Chum salmon	*0. keta*	Silver surfperch	*Hyperprosopon ellipticum*
Bull trout	*Salvelinus confluentus*	Bay pipefish	*Syngnathus leptorhynchus*
White sturgeon	*Acipenser transmontanus*	Black rockfish	*Sebastes melanops*
Saddleback gunnel	*Pholis ornata*	Pacific staghorn sculpin	*Leptocottus armatus*
Snake prickleback	*Lumpenus sagitta*	Buffalo sculpin	*Enopihrys bison*

Common Name	Scientific Name	Common Name	Scientific Name
Rock greenling	*Hexagrammos lagocephalus*	Prickly sculpin	*Cottus asper*
Kelp greenling	*H. decagrammus*	Cabezon	*Scorpaenichthys marmoratus*
Lingcod	*Ophiodon elongatus*	Eulachon	*Thaleichthys pacificus*
American shad	*Alosa sapidissima*	Speckled sanddab	*Citharichthys stigmaeus*
Pacific sandfish	*Trichodon trichodon*	Sand sole	*Psettichthys melanostictus*
Pacific tomcod	*Microgadus proximus*	Rock sole	*Lepidopsetta bilineata*
White seaperch	*Phanerodon furcatus*	English sole	*Parophrys vetulus*
Starry flounder	*Platichtys stellatus*		

Notes: Table originally printed in *2004 Half Moon Bay Fish Survey* (R2 Resource Consultants, Inc. 2005).

Studies on forage fish in Grays Harbor have also been conducted. Forage fish are significant due to the critical part they play as the prey base for a large variety of other marine organisms. Simenstad (1981) found seven species of forage fish occurring in Grays Harbor: Pacific herring (*Clupea harengus pallasi*), Pacific sand lance (*Ammodytes hexapterus*), northern anchovy (*Engraulis mordax*), surf smelt (*Hypomesus pretiosus*), longfin smelt (*Spirinchus thaleichthys*), whitebait smelt (*Allosmerus elongates*), and American shad (*Alosa sapidissima*). Northern anchovy were the most ubiquitously distributed species and were represented in all life history stages. Surf smelt were the most common species in the lower estuary, while longfin smelt appeared to be restricted to the inner reaches of the estuary. Juvenile Pacific herring were also abundant. These species are all likely to be found within or transiting the project area.

The Pacific sand lance is present in the project area, and this species is of particular importance as a food source for green sturgeon (*Acipenser medirostris)*. Although sand lance spawn at beaches close to the project area, it is unlikely that the project area would be used as spawning habitat. Sand lance have been noted to prefer gravel beaches for spawning rather than cobble beaches, such as at Half Moon Bay, and sandy beach habitats, such as those present at South Beach (Brunner 2009).

The surf smelt also has specific spawning habitat requirements, including substrate type and size and a specific tidal elevation for successful spawning. Penttila (2007) found surf smelt eggs in Puget Sound in gravel ranging in size from 1 to 7 millimeters in diameter (i.e., "pea gravel"). Sediments present at Half Moon Bay and South Beach are not suitable for surf smelt spawning, as the gravel size in the upper intertidal area is composed primarily of larger gravel (wave energy has sorted the transition material so that larger cobble are generally present in upper intertidal areas where spawning would occur). A study conducted in Half Moon Bay also found no evidence of surf smelt spawning (R2 Resources, Inc. 2005). Herring spawning is not known to occur within the project area but has been noted approximately 1 mile east of the project area in Westport (WDFW 2008).

3.2.2.4 Birds

Varying bird species use the different habitats within the project area, as documented by the Corps (USACE 2006b). Because of the rocky habitat provided by the South Jetty, it would be expected to host black oystercatchers (*Haematopus bachmani*), ruddy and black turnstones (*Arenaria interpres* and *A. melanocephala*), surfbirds (*Aphriza virgata*), rock sandpipers (*Calidris ptilocnemis*), and wandering tattlers (*Heteroscelus incanus*). Half Moon Bay, with its protected shoreline, is likely to be attractive habitat to killdeers (*Charadrius vociferous*), semipalmated plovers (*C. semipalmatus*), and western sandpipers (*C. mauri*). South Beach, with its high-energy beach, is likely to be habitat used by sanderlings (*Caldris alba*) and larger shorebird, such as whimbrels (*Numenius phaeopus*), dunlins (*Calidris alpina*), and godwits (*Limosa* spp.). The open-water areas of Grays Harbor are also known to be used by marbled murrelet (*Brachyramphus marmoratus*) during various times of the year (Speich and Wahl 1995). Marbled murrelets are relatively opportunistic foragers; they have flexibility in prey choices, which likely enables them to respond to changes in prey abundance and location (USFWS 1996).

During nesting season, western snowy plovers (*Charadrius alexandrinus nivosus*) in the area generally forage on natural dunes along the ocean beaches and on ephemeral sand spits within the Oyhut Wildlife Recreation Area. Plovers are not known to over-winter on Damon Point or within the Oyhut Wildlife Recreation Area (USFWS 1999).

During a 13-day shorebird survey of the project study area in 2006, the highest numbers of species and numbers of birds (94 percent of the total number of birds sighted) were seen at South Beach (USACE 2006b). The remaining 6 percent of sightings were divided evenly between Half Moon Bay and the South Jetty. Dunlins made up the majority of all sightings. Therefore, shorebirds observed during the Corps' survey preferred South Beach to Half Moon Bay and the South Jetty. The project area is used by shorebirds as roosting habitat during very high tides.

3.2.2.5 Turtles

Four species of sea turtles could occasionally swim in the project vicinity, usually outside of the project area; however, nesting by any sea turtles within or near the project area is highly unlikely. These species include leatherback sea turtles (*Dermochelys coriacea*), loggerhead sea turtles (*Caretta caretta*), green sea turtles (*Chelonia mydas),* and Olive Ridley sea turtles (*Lepidochelys olivacea*). Nesting for these species occurs in the subtropics or tropics. Although these species may pass by the project area in coastal waters, it is likely that they would be much farther offshore than the project area.

Leatherback sea turtles may use oceanic areas off the Washington coast as foraging grounds during the summer and fall months. Aerial surveys indicate that leatherback sea turtles usually occur in continental slope waters (NMFS and USFWS 1998a). Eastern Pacific waters

may be used as foraging grounds and migratory corridors for loggerhead sea turtles; however, sightings in the eastern Pacific Ocean are generally confined to the summer months off Southern California (NMFS and USFWS 1998b). Beach strandings and gillnet captures of green sea turtles have been reported off the Washington coast, but it has been suggested that these individuals were vagrants that strayed northward with El Niño currents (NMFS and USFWS 1998c). No regular occurrences of green sea turtles off the Washington coast were noted in the 1998 draft recovery plan for this species. Olive Ridley sea turtles may undergo regular migrations from breeding areas to feeding areas in the south; however, El Niño events may cause this species to migrate northward, where they may "cold stun" once they encounter colder water (NMFS and USFWS 1998d). Thus, Olive Ridley sea turtles are unlikely in the project area.

3.2.2.6 Marine Mammals

As with turtles, several species of marine mammals may occasionally be found in the project vicinity; however, these species are more likely to be found offshore of the project area. Blue whales (*Balaenoptera musculus*) may feed on the continental shelf off the Washington and Oregon coast during the summer months (Reeves et al. 1998a). North Pacific fin whale (*B. physalus*) concentrations generally form along frontal boundaries or mixing zones between coastal and oceanic waters; no regular occurrences off the Washington coast were noted in a 1998 draft recovery plan for this species (Reeves et al. 1998b). Sei whales (*B. borealis)* inhabit areas along the continental slope; however, they rarely enter semi-enclosed marginal seas or gulfs (Reeves et al. 1998b). Sperm whales (*Physeter macrocephalus* or *P. catodon*), while more frequently present off the Washington coast, typically inhabit deep waters and seldom venture close to coastal areas (Barlow et al. 1997). The preferred habitat for these whale species is the open ocean, not coastal waters.

Stellar sea lions (*Eumetopias jubatus*), California sea lions (*Zalophus californianus*), and harbor seals (*Phoca vitulina*) haul out on coastal locations throughout Washington state. While harbor seals regularly use several haul-out areas within Grays Harbor, there is no indication that these sites are used regularly by Stellar sea lions (Jeffries et al 2000).

3.2.3 Endangered Species Act, Marine Mammal Protection Act, Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act and Essential Fish Habitat

Some species likely to be present within the project area are listed and/or protected under the Endangered Species Act (ESA), Marine Mammal Protection Act (MMPA), Bald and Golden Eagle Protection Act (BGEPA), and/or the Migratory Bird Treaty Act (MBTA). In addition, the project area is considered Essential Fish Habitat (EFH) under three Fishery Management Plans (FMPs) designated under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA).

ESA. Federal action agencies that fund, permit, or carry out activities that may affect a species listed as threatened or endangered under the ESA are required to consult with the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS) under Section 7 of the ESA. The goal of the consultation process is to ensure a federal action does not jeopardize the continued existence of an ESA-listed species. In accordance with Section 7(a)(2) of the ESA of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed and proposed threatened or endangered species. A biological evaluation is in preparation and informal consultation will be initiated with NMFS and the USFWS at the appropriate time.

Table 4 lists ESA-listed species in the project vicinity and their critical habitat

Table 4. ESA-listed species and their critical habitat within the action area

Species	Listing Status	Critical Habitat Status	Critical Habitat in Action Area
Coastal/Puget Sound Bull Trout *Salvelinus confluentus*	Threatened	Designated	Yes
Lower Columbia River Chinook salmon *Onchorhynchus tshawytscha*	Threatened	Designated	No
Upper Willamette River Chinook salmon *Onchorhynchus tshawytscha*	Threatened	Designated	No
Columbia River chum salmon *Onchorhynchus keta*	Threatened	Designated	No
Western Snowy Plover *Charadrius alexandrius nivosus*	Threatened	Designated	Yes
Eulachon *Thaleichthys pacificus*	Threatened	Designated	No
Marbled Murrelet *Brachyramphus marmoratus*	Threatened	Designated	No
Southern Green Sturgeon *Acipenser medirostris*	Threatened	Designated	Yes
Eastern Stock Steller Sea Lion *Eumetopias jubatus*	Threatened	Designated	No
Southern Resident Killer Whale *Orcinus orca*	Endangered	Designated	No
Humpback Whale *Megaptera novaeangliae*	Endangered	None	—
Blue Whale *Balaenoptera musculus*	Endangered	None	—
Fin Whale *Balaenoptera physalus*	Endangered	None	—
Sei Whale *Balaenoptera borealis*	Endangered	None	—
Sperm Whale *Physeter macrocephalus*	Endangered	None	—
Leatherback Sea Turtle *Dermochelys coriacea*	Endangered	Designated	Proposed

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Species	Listing Status	Critical Habitat Status	Critical Habitat in Action Area
Loggerhead Sea Turtle *Caretta caretta*	Threatened (proposed as endangered)	Designated	No
Nesting Green Sea Turtle *Chelonia mydas*	Endangered	Designated	No
Nesting Olive Ridley Sea Turtle *Lepidochelys olivacea*	Endangered	Designated	No

MMPA. All species of marine mammals are protected under MMPA, regardless of their population status. Some species of marine mammals not listed under the ESA but protected under MMPA may be present in the project area. These species include the California sea lion and harbor seal, which may use the South Jetty as a resting location or haul-out site.
BGEPA. Although the bald eagle (*Haliaeetus leucocephalus*) has been removed from listing under the ESA effective August 8, 2007 (USFWS 2007), it is protected under the BGEPA. Bald eagle sightings near the project area are most frequent during winter months, because Grays Harbor provides important bald eagle winter-feeding habitat. Anadromous fish returning to spawn, waterfowl, and shorebirds are the primary eagle prey found in the estuary. Bald eagles tend to congregate near the mouths of the Chehalis, Elk, Humptulips, Hoquiam, Johns, and Wishkah rivers and near Newskah and Charley creeks. There is no known roosting habitat for bald eagles in the project area. Therefore, it is unlikely that bald eagles would be found roosting in the project area. However, they may transit through the project area.

MBTA. The MBTA protects numerous species of migratory birds. The list of species protected under the MBTA is maintained by the USFWS (2008). Migratory bird species protected under the MBTA may transit the project area, but the project area does not contain nesting habitat or primary foraging habitat for MBTA species. Minor construction related impacts to migratory birds may occur; however, the breach fill habitat is largely disturbed due to the high-energy environment present and the heavy use by humans and their pets. Truck traffic and related noise would be restricted as much as possible to existing roadways and access to the site would be only via the existing access road on the breach dune. Impacts to area dune grass would be minimized, as fill areas are largely restricted to unvegetated, eroded areas. No significant impacts to migratory birds are expected.

MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT .Federal action agencies that fund, permit, or carry out activities that may adversely impact EFH are required to consult with NMFS regarding the potential effects of their actions on EFH and are required to respond in writing to NMFS' recommendations. The proposed project is located within areas designated as EFH for three FMPs: the Pacific Coast Groundfish FMP,

the Coastal Pelagic Species FMP, and the Salmonid FMP (PFMC 1998a, 1998b, and 2000). The EFH of the species listed in Table 1 can be found in the project area.

Table 5. Essential Fish Habitat Species and Their Life Stages That Occur Within the Project Area

Common Name	Scientific Name	Adult	Juvenile	Larvae	Egg
Groundfish Species					
Pacific sanddab	*Citharichthys sordidus*	—	—	X	—
Petrale sole	*Eopsetta jordani*	—	—	X	X
Pacific cod	*Gadus macrocephalus*	—	—	X	—
Soupfin shark	*Galeorhinus galeus*	X	X	—	—
Flathead sole	*Hippoglossoides elassodon*	—	X	X	X
Spotted ratfish	*Hydrolagus colliei*	X	X	—	—
Rock sole	*Lepidopsetta bilineata*	—	—	X	X
Dover sole	*Microstomus pacificus*	—	—	—	X
Lingcod	*Ophiodon elongatus*	—	X	—	X
English sole	*Parophrys vetulus*	X	X	—	X
Starry flounder	*Platichthys stellatus*	X	X	X	X
Sand sole	*Psettichthys melanostictus*	—	—	—	X
California skate	*Raja inornata*	X	—	—	X
Brown rockfish	*Sebastes auriculatus*	—	—	X	—
Copper rockfish	*Sebastes caurinus*	—	—	X	—
Black rockfish	*Sebastes melanops*	—	X	—	—
Redstripe rockfish	*Sebastes proriger*	—	—	X	—
Spiny dogfish	*Squalus acanthias*	X	X	—	—
Coastal Pelagic Species					
Northern anchovy	*Engaulis mordax*	X	X	X	X
Market Squid	*Loligo opalescens*	X	X	X	X
Pacific sardine	*Sardinops sagax*	X	X	X	X
Pacific (chub) mackerel	*Scomber japonicas*	X	X	X	X
Pacific Salmon					
Coho salmon	*Oncorhynchus kisutch*	X	X	—	—
Chinook salmon	*Oncorhynchus tshawytscha*	X	X	—	—

3.3 HUMAN USE CHARACTERISTICS

For human use, the characteristics considered are aesthetics, air quality and noise, cultural and historic resources, Tribal usual and accustomed areas, commercial fisheries and aquaculture, land use, navigation, recreation, and socioeconomics.

3.3.1 AESTHETICS

Aesthetics relate to a viewshed from which humans derive value for preservation or protection. Generally, these areas have significant historic or scenic values that may become diminished if developed or altered. Aesthetics at the existing area include a coastal marine environment within the Pacific Ocean to the west and Grays Harbor inlet to the east. The South Jetty, included in the project area, is part of the entrance to Grays Harbor, which is a

popular destination for commercial and transient vessels. Westport Marina is immediately east of the project area, adding to marine vessel traffic in the area.

Land surrounding the project area includes a mix of natural and built environments. Westport is located to the southeast and Westhaven State Park is adjacent to the project area. Westport attributes much of its activity to the marine environment, as it is a popular tourist destination for surfing, whale watching, and other marine-related activities. Land and beach use in the area is comprised of year-round recreational activity (see section 3.4.8).

3.3.2 Air Quality and Noise

Air quality is typically assessed by local, state, and federal agencies in relation to ambient air quality standards set to protect human and environmental health. Three agencies currently monitor air quality in Grays Harbor County: the Environmental Protection Agency (USEPA), Ecology, and the Olympic Region Clean Air Agency (ORCAA).

The USEPA has set National Ambient Air Quality Standards for six common air pollutants under the Clean Air Act (CAA): ozone, particulate matter, carbon monoxide, nitrogen oxides, sulfur dioxide, and lead (USEPA 2009). Grays Harbor County meets USEPA National Ambient Air Quality Standards for the six common air pollutants and those set by Washington State for particulate matter and sulfur dioxide. The project area is not located in a CAA non-attainment area, because concentrations of pollutants are below the standards enforced by the USEPA. Air quality in the area is exceptional, primarily due to the westerly wind off the Pacific Ocean (GHEDC 2008). Wind, wave, and shorebird noise all occur naturally within the vicinity of the project area. Marine vessel traffic and commercial and recreational uses in Grays Harbor are anthropogenic sources of noise within the vicinity of the project.

3.3.3 Cultural and Historic Resources

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires that the effects on potential sites, structures, or objects included or qualified for the National Register of Historic Places (NRHP) be considered prior to proposed actions. The project area is located in an estuarine area, in a region that is generally of cultural significance due to Native American usage and early European settlement (USACE 2007a).

For decades, the project area has been primarily composed of fill material and wind-blown and current transported sand deposits. Several archaeological sites have been recorded within the vicinity of the project area and include the remains of a disturbed shell midden and pestle, and a shell midden and possible village site. Both sites are located within less than 0.50 miles of the project area. Several cultural resources surveys have been conducted for previous Corps projects within the vicinity of Gray's Harbor. In 1986, Shapiro and

Associates conducted a survey for historic sunken shipwrecks. Based on the information they compiled there are no shipwrecks within the vicinity of Half Moon Bay and South Jetty (Shapiro and Associates 1986). In 2002, the Corps conducted a cultural resource survey for the Half Moon Bay transition gravel and cobble placement project located within the current Grays Harbor LTMS project area. The 2002 report determined that the Half Moon Bay portion of the project area is composed of recent dredge spoil fill and twentieth-century sand dune deposits (Kent 2003). The remaining portion of the Grays Harbor LTMS project has not yet been surveyed for this project nor has Section 106 consultation began for this project. As the North and South jetties are over fifty years old they will need to be recorded and evaluated for inclusion on the National Register of Historic Places (NRHP). Section 106 consultation and evaluation of the North and South jetties will occur prior to the draft EA being finalized.

3.3.4 Tribal Usual and Accustomed Areas

Tribal Usual and Accustomed (U&A) areas are locations where tribes retain the right to fish or harvest other species (including both plants and animals) as defined by treaty rights. The Tribal U&A areas in proximity to the proposed project area are those of the Quinault Tribe (Preston et al. 2004). Typically the Quinault tribe harvests spring and summer fish stock from April to July. In the winter season, a small Tribal steelhead fishery is in operation at the beginning of each week when fishing is allowed. Tribal fisheries, including salmon, steelhead, marine fishes, and Dungeness crab, are typically conducted farther east in Grays Harbor and generally not in Half Moon Bay. The Corps will coordinate with the Quinault Tribe prior to project construction activities to avoid any conflict with Tribal fisheries operations.

3.3.5 Commercial Fisheries/Aquaculture

More than 2,000 acres of state-owned aquatic land is leased out by the Washington State Department of Natural Resources (WDNR) to be used for oyster culture related activities in Grays Harbor County (USACE 2006a). Whitcomb Flats is a flood shoal located east of the Grays Harbor entrance (see Figure 2), approximately 3 miles east of Westport Marina, and is a productive area for commercially grown Pacific oysters. These beds are being threatened by sand migration and high-energy waves occurring during storm events. Throughout the past 34 years, the beds have continually shifted eastward (USACE 2006a). Many highly productive oyster lands in the southern portion of Grays Harbor have been lost due to geomorphic changes and inlet processes that have resulted in the migration and erosion of Whitcomb Flats (Osborne (2003b)). Shifting sands bury oyster beds and/or change the substrate from more productive mud to compacted sand. Exposure to higher wave energy interferes with harrowing (harvest) operations, further affecting production. Several oyster growers have been forced to shift production to marginal areas where growth rates are not as high and oyster quality is low.

In response to concerns voiced by WDNR and oyster growers in 2001, the Port of Grays Harbor commissioned a report to provide additional information on the erosion/migration of Whitcomb Flats and its possible causes. A "Section 905(b)" reconnaissance study[4], completed by the Corps and WDNR in 2009, investigated potential measures to improve conditions for oyster aquaculture at Whitcomb Flats. The above-mentioned reports and studies did not indicate any direct relationship between erosional processes at Half Moon Bay and migration of sand at Whitcomb Flats.

Other commercial fisheries in or offshore of Grays Harbor mainly harvest Dungeness crab, pink shrimp (*Farfantepenaeus duorarum*), and various migrating fish species, such as albacore tuna (*Thunnus alalunga*), steelhead, and other salmon and groundfish species (GHEDC 2008).

3.3.6 Land Use

Land uses in Grays Harbor County range from residential, commercial, municipal, and industrial (paper mill, timber- and forestry-related industries, and marine vessel moorage and repair) to maricultural (oyster beds), agricultural (cranberry bogs), and recreational uses (USACE 2007a). The current land use designation at Half Moon Bay and South Beach is Recreation and Parks (City of Westport 2007). The designation under the City of Westport's Shoreline Master Plan is primarily Urban; a portion of the project area is within an area designated as Conservancy with a Dune Protection Zone overlay.

3.3.7 Navigation

The Port of Grays Harbor includes a deep-water, full-service port incorporated within the U.S. Foreign Trade Zone (GHEDC 2008). The port is accessible by the Federal Navigation Channel, which is maintained by the Corps through annual maintenance dredging. The North and South Jetties make up the entrance to the bay, extending seaward from Point Brown and Point Chehalis, respectively. The jetties create an access area approximately 6,500 feet wide (USACE 2007b).

The Westport Marina, located east of the South Jetty, is one of the largest coastal marinas in the Pacific Northwest and provides moorage to approximately 650 mooring and transient vessels up to 200 feet in length. The U.S. Coast Guard (USCG) Station, also located and operating in Westport, serves the Grays Harbor coastal region with both sea and land services (GHEDC 2008).

[4] A Section 905(b) reconnaissance study refers to Section 905(b) of the WRDA of 1986. The reconnaissance study report documents the results of the analyses conducted during the reconnaissance phase and includes a preliminary analysis of federal interest, costs, benefits, environmental impacts, and an estimate of the costs of preparing a feasibility report. The analyses conducted are based on existing, readily available data and professional and technical judgment. The 905(b) Analysis Report is prepared by the district and approved by Army Corps of Engineers Headquarters.

3.3.8 RECREATION

Recreational use in the area occurs year-round, and marine-related leisure and recreation are a primary tourist attraction in Grays Harbor County. Surf riding (surf boarding, body boarding, knee boarding, and wind surfing), hiking, biking, kayaking, recreational fishing, diving, bird watching, horseback riding, and park-related activities (e.g., picnicking and leisure sports) are all recreational activities occurring in the project area (USACE 2004). Westport has charter boat services for whale watching and deep-sea fishing and is also home to the Westport Aquarium and Westport Maritime Museum, which are popular tourist sites.

Surf riding in the Westhaven State Park and Half Moon Bay area is a popular year-round activity. Three locations in the area are candidates for prime surfing: South Beach near the South Jetty, Half Moon Bay, and the Point Chehalis revetment (USACE 2004). Surfers report that one of the three spots is usually producing a rideable wave. Unlike open-ocean beaches, Half Moon Bay is sheltered from wind and direct swell conditions. Deeper water in the harbor entrance allows swells to gain momentum before shoaling up offshore to produce smoothly breaking waves, which are sought after by surfers.

No National Park Service land exists in the vicinity of the project area (NPS 2009).

3.3.9 SOCIOECONOMICS

Socioeconomics includes the economic and social characteristics of a given area, such as its industry and employment, property, taxes, population characteristics, community stakeholders, community resources, and land use. Updated facts and figures describing the demographic profile of Grays Harbor County, school districts, and industry and employment can be found at the Grays Harbor Council of Governments website. The community of Westport and its surrounding municipalities (adjacent to Grays Harbor) are popular tourist destinations due to recreational opportunities (see section 3.4.8) and commercial and recreational fisheries (see section 3.4.5). Socioeconomic stakeholders within the project vicinity include, among others, the City of Westport, Port of Grays Harbor, Washington Dungeness Fisherman's Association, USCG, Westport Marina, Lanco, International Longshore and Warehouse Union, Friends of Grays Harbor, and the Surfrider Foundation (ECO 2005).

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4 FUTURE WITHOUT PROJECT CONDITIONS

This section describes the most likely future without-project conditions, which are the conditions likely to occur if no federal action is taken to solve the problems identified above, along with the potential impact on the federal navigation project.

The purpose of establishing current and expected future conditions is to provide a baseline to be used for comparison with different alternative actions. An evaluation and understanding of the current and future conditions is also used to further define and characterize the problem and is the basis for forming alternatives. The product resulting from this step of the planning process is the documentation of without-project conditions, summarizing the inventoried conditions in the current scenario and in a future scenario without a Corps LTMS project to address impacts related to erosion. An underlying assumption of the LTMS investigation is that the Corps is obligated to maintain the authorized navigation channel and navigation project features.

When determining the without-project conditions under the Corps planning process and as defined by NEPA, the Corps looks at current conditions. If a structure is in place, its existence will be factored into the assessment. For Grays Harbor, the team will evaluate existing conditions including existing structures and known natural conditions, such as tide, current, winds, waves, and sediment transport. The Corps must also consider future conditions and more specifically the future without-project conditions. Existing conditions and future conditions were assessed and taken into account to the extent practicable, as determined by the Corps with input from stakeholders, and alternative strategies were compared to the without-project conditions to help assess effectiveness of the alternatives. Two critical parameters related to without-project conditions on the Grays Harbor project are:

- Erosion rates on South Beach and Half Moon Bay
- Consequences associated with a breach

The “no response” alternative (i.e., allowing a breach to form) was used as the future without-project conditions for the purposes of evaluating and comparing alternatives. The “no response alternative” assumes no further action will be taken to prevent a breach, and response will be evaluated at such time that it is determined that the South Jetty is in need of major repair or rehabilitation and access becomes necessary.

For this study, the future without-project conditions are different than the “no action” alternative described in the NEPA regulations. Where ongoing programs initiated under existing legislation and regulations would continue, no action may be defined as no change

from current management direction or level of management intensity (Council on Environmental Quality 1981). Therefore, the No Action alternative may be thought of in terms of continuing with the present course of action until that action is changed. Accordingly, projected impacts of the alternatives would be compared to those impacts anticipated for the current practices; reasonable alternatives would include management strategies of both greater and lesser intensity, especially greater and lesser levels of resource development. For this LTMS study, Alternative 1A is the No Action alternative. Alternative 1A would continue the present course of action until that action is changed, while the future without-project condition would *not* include the current practice. No Action is an alternative that was evaluated along with other alternatives.

The forecast of the future without-project conditions reflects the conditions expected during the same period of analysis as the analyses conducted on the alternatives for this study. The future without-project conditions provides the basis from which alternative plans are formulated and impacts are assessed.

The future without-project conditions are assumed to involve the following:

- No action is taken to prevent the anticipated breach.
- O&M navigation channel dredging continues with disposal in existing disposal sites.
- The anticipated breach is allowed to form.
- The South Jetty toe is undermined, resulting in increased frequency of maintenance and repairs.
- There is increased shoaling in the navigation channel, resulting in increased O&M dredging.
- There is increased O&M of the Point Chehalis revetment and groins.
- There are large scale changes in littoral drift at the Grays Harbor entrance.

4.1 EXPECTED FUTURE IMPACTS OF SOUTH JETTY BREACH ON FEDERAL NAVIGATION PROJECT

The erosion of sediment from the harbor entrance area between the two jetties, almost certainly, is a direct result of the jetties themselves. The jetty system was designed to concentrate the tidal flow through the entrance, in an effort to minimize maintenance dredging requirements.

In the present entrance configuration, sediment is transported from the mouth of the harbor by the ebb tide and carried seaward until the ebb flow jet loses its energy and deposits the material seaward of the jetties in 45 to 125 feet of water (the blue-colored area in Figure 11).

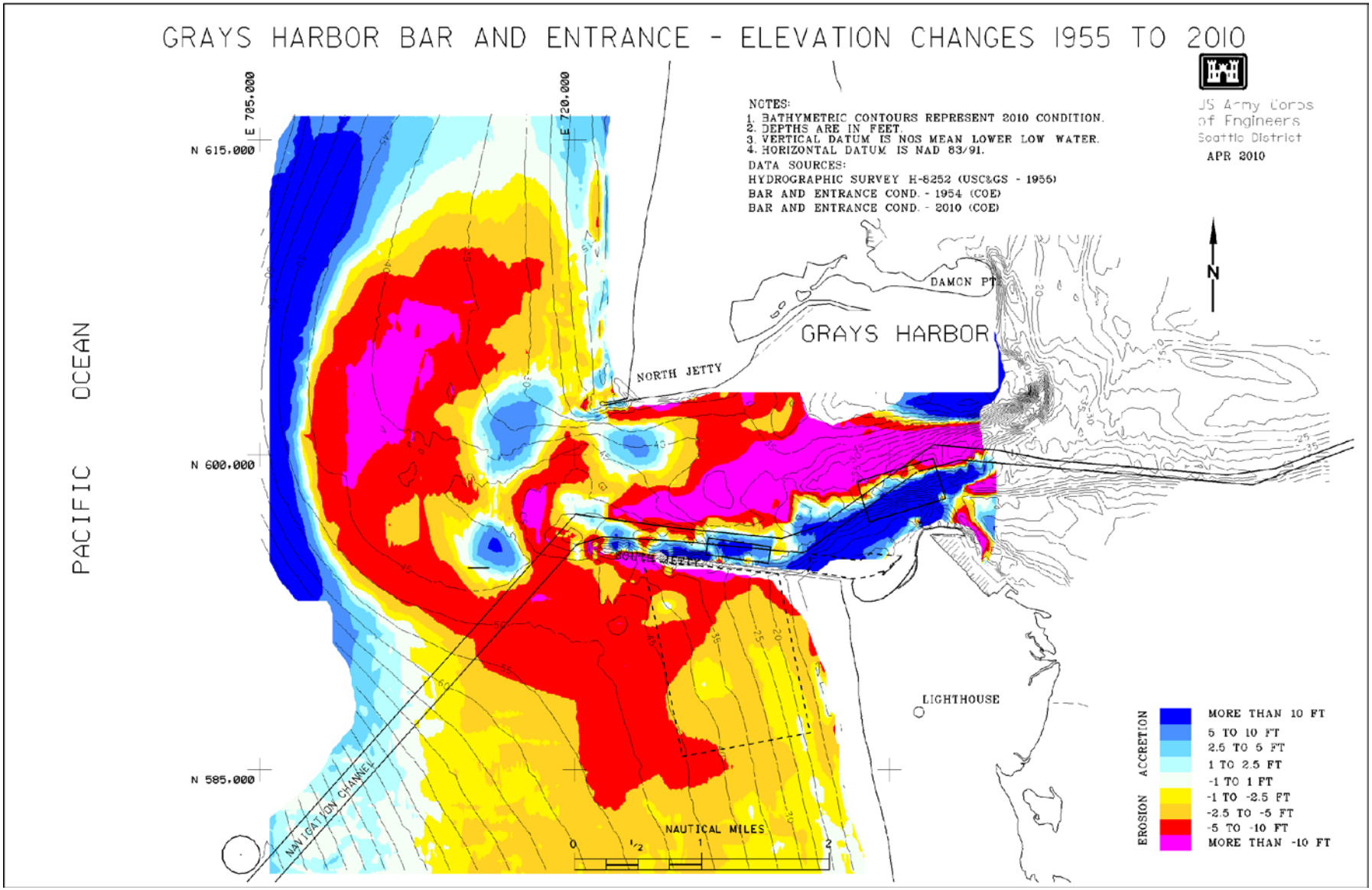

Figure 11. Elevation Changes, 1955-2010

Additionally, sediment captured by the flood tide re-enters the harbor on the north side of the harbor and contributes to deposition near Damon Point. Figure 11 (above) and Figure 12 illustrate that significant deposits have occurred in only three areas, deep-water seaward of the entrance, immediately north of Half Moon Bay, and south of Damon Point. This same trend is expected to continue into the future. A sediment budget analysis from 1955 to 2010 reveals that the region offshore of South Beach (from the South Jetty 10,000 feet south and seaward between depths of -20 feet to -55 feet MLLW) has lost nearly 31 million cy since 1955. In the same interval the Entrance and the Bar have lost another 30 and 33 million cy respectively. The nearshore area offshore of North Beach has lost approximately 5 million cy. These have all been long-term trends it is therefore probable that they will continue in the future.

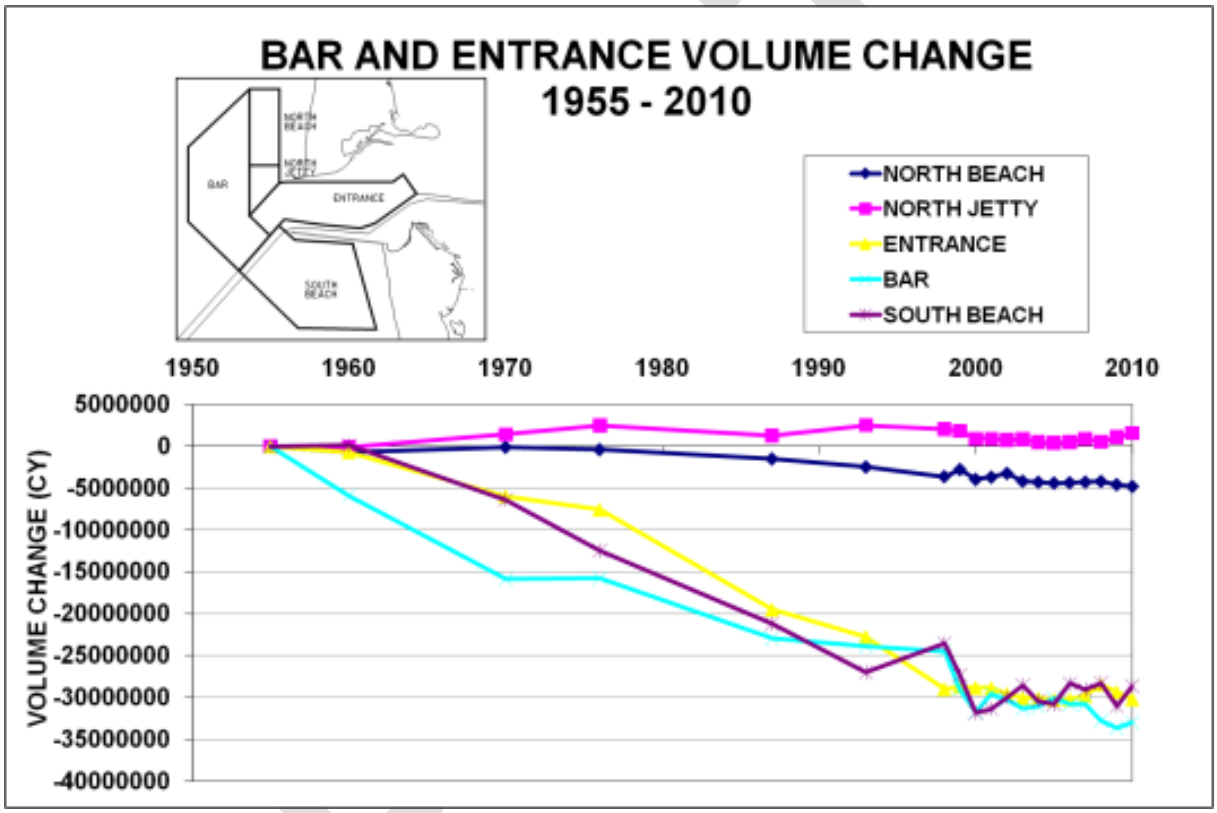

Figure 12. Bar and Entrance Volume Changes, 1955-2010

If water depths in the central portion of the harbor entrance continue to increase at the present rate, a new channel alignment may be advantageous, with depths at or below the project depth, in the northeast-southwest alignment (red area in Figure 11). In this scenario, requirements for maintenance dredging in the Entrance Reach might be reduced in some areas; however, maintenance dredging will likely be required where the Entrance Reach meets the Bar Channel as discussed in section 2.3.10 of Appendix D. Thus, it is appropriate to assume that maintenance dredging will still continue to supply material suitable for beneficial use.

If the South Beach and Half Moon Bay shorelines continue to recede at the historic rates, a breach will eventually reform. Assuming the 1993-1994 breach scenario is repeated, sand carried through the breach will fill most of Half Moon Bay, and for a period of time will reduce, if not eliminate, erosion along the Half Moon Bay shoreline. Continued erosion of the breach area will widen the gap between the South Jetty and the shoreline, and a permanent secondary channel to the ocean may be created through the remains of Half Moon Bay. (Such a channel, 1,000 feet wide with a bottom elevation at -10 feet MLLW, existed 100 years ago as Canoe Channel, prior to the construction of South Jetty – see Appendix D – Figure 3.19).

The lack of a quantitative assessment regarding the growth and evolution of a breach limits precise determination of the degree of risk a breach may have on the federal navigation features. These questions have not been definitively resolved, and there may very well never be sufficiently authoritative answers to substantiate a consensus viewpoint among all interested and informed parties that implementing affirmative action is reasonably necessary. However, a combination of historic knowledge of the breaching process, numerical modeling studies, and professional judgment has produced a significant body of work which indicates there is reasonable probability that adverse consequences to cost-effective navigation project operation and maintenance would be generated by a breach. Therefore, in light of the these consequences to the integrity and operability of the South Jetty and the navigation channel, and recognizing the advisability of maintaining land access to the South Jetty structure for maintenance purposes, the Corps has determined that it is prudent and justifiable to proceed with LTMS action on the expectation that a breach would eventually pose an unacceptable threat to the navigation project and its facilities. The anticipated long-term consequences of a breach include:

- Shoaling in the navigation channel
- Structural damage to the South Jetty
- Increased O&M of Point Chehalis revetment and groins
- Increased O&M of Westport marina features, and
- Adverse impacts to the North Jetty resulting from changes littoral drift.

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5 PLAN FORMULATION

The Corps planning process begins with specifying the problems and opportunities to be addressed in the study. This step is followed by an inventory of existing conditions and a forecast of future without-project conditions. Formulation of alternatives then begins with the largest possible selection of alternatives and screens them through a series of increasingly focused analyses and comparisons. The NEPA requires consideration of a reasonable range of alternatives, and a preliminary screening of the alternatives narrows the field by eliminating alternatives that prove unacceptable or infeasible. Alternatives passing this initial screening are developed and screened further until a final array of alternatives is selected. Any implementable combination of measures may be considered a separate alternative. Each final alternative receives equal development, analysis, and comparison.

5.1 PROBLEMS AND OPPORTUNITIES

Water and related land resources project plans are formulated to alleviate problems and take advantage of opportunities in ways that contribute to study-planning objectives. The beach and dune area connecting South Beach with Half Moon Bay has been impacted by erosion, resulting in a breach in December 1993, and consequently has received sand nourishment from the Corps to address ongoing erosion in recent years. The Corps has performed a number of studies and interim management actions near the South Jetty to manage the risk to the federal navigation project since the December 1993 breach. The Corps has obtained a comprehensive dataset on erosion rates and a general sense of how a breach forms and evolves. The Corps has been able to observe the performance of engineered structures and refine their design to achieve greater effectiveness. Finally, the Corps has received extensive feedback from local stakeholders on what measures are environmentally and publicly acceptable.

5.2 PURPOSE AND OBJECTIVE

5.2.1 STUDY PURPOSE

The purpose of the long-term management strategy (LTMS) study is (1) to assess the risk that such a breach may occur, (2) to evaluate the threat of adverse impact to the Grays Harbor Navigation Project resulting from any breach, and—if action is determined to be warranted—(3) assess and recommend the most appropriate long-term strategy for continued maintenance of the authorized federal navigation project features.

5.2.2 PROJECT OBJECTIVE

The objective of any recommended project would be to minimize the risk to operation and maintenance of the Federal navigation features over the next 50 years, as a result of a breach between the Pacific Ocean and Half Moon Bay.

5.3 ASSUMPTIONS

Alternatives were developed based on the following assumptions:

- The design life will be 50 years.
- The loss of material from the area offshore of South Beach will continue at historic rates.
- The recession rate of the area offshore of the South Beach shoreline will continue at the 1976-to-2011 average rate of 10 feet per year.
- With Half Moon Bay shoreline not in equilibrium, the recession rate in the northwest corner of Half Moon Bay will continue to erode at the 2005-to-2011 average rate of 30 feet per year.
- A breach would form, and eventually create unacceptable risk of adverse effect on the Federal navigation features.
- The South Jetty requires routine rehabilitation at 25-year intervals, at which points in time adequate and cost-effective construction access is required.
- Emergency repairs to the South Jetty during the winter season would require land access. If land access is not present, repairs would not occur until the following summer.

5.4 PLANNING CONSTRAINTS

The formulation of alternatives to address the study purpose is limited by planning constraints. Planning constraints are resource, legal, and policy issues that limit the planning process. General constraints on USACE plans are that they must conform to USACE policies for the project purpose, as well as all federal laws, regulations, and Executive Orders, and that they are within the geographic limits of the study authority. Another general constraint is the current limits of knowledge, information, and predictive ability. An additional constraint that has been identified that is specific to this study is:

> The Corps will continue to maintain and protect the Federal Navigation Channel features in a technically feasible, cost-effective, environmentally acceptable, and publicly acceptable manner.

These assumptions and constraints have guided the development of the full range of alternatives for the LTMS.

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6 ALTERNATIVES DEVELOPMENT AND SCREENING

The LTMS PDT developed alternatives by gathering information from previous studies and EAs, and conducting public and stakeholder meetings. Because of the diverse nature of the user groups at Grays Harbor and the complicated nature of the LTMS, the PDT sought extensive public involvement and internal Corps analyses to develop the potential list of alternatives during this study.

6.1 INITIAL ALTERNATIVES IDENTIFICATION

The Corps and stakeholders identified 22 alternatives in 2005: 15 from previous Corps studies and seven suggested by stakeholders based on other studies and stakeholder preferences. The Corps addressed these 22 alternatives in 2009 based on screening criteria (discussed at the 2005 and 2009 stakeholder meetings described and summarized in Appendix A). Below are the 22 alternatives:

- Nearshore Berms
- Revetment and Jetty Extension
- South Jetty Reinforcement
- Direct Beach Nourishment
- Relocation of Bar Channel
- Current Breach Maintenance Project
- Beach Nourishment
- Jetty Extension without Beach Nourishment
- South Jetty Spur Groin
- South Beach Revetment
- South Jetty Reconstruction
- Straighten Channel (Segment Parallel to South Jetty; Eliminate Dog-Leg)
- Jetty Extension with Beach Nourishment
- Implementation Plan from 1997
- Buried Revetment between South Beach and Half Moon Bay
- Gravel Cobble Transition Beach
- Point Chehalis Control Point
- Modification of the East End of the South Jetty
- Weir Jetty
- Construction of Submerged Berm or Breakwater
- Allow Breach to Form
- Terraced Revetment

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6.2 INITIAL ALTERNATIVES SCREENING

The LTMS study process addressed the identified problems associated with a breach by assessing a range of alternatives. The LTMS study team developed screening criteria to establish a common framework of important factors to evaluate all of the alternatives (Table 6). The team developed a primary list of threshold criteria that any alternative carried forward for consideration within this study must meet. The team also developed additional comparative evaluation criteria that focused on Engineering, Biological/Environmental considerations, Economic considerations, and Other considerations, based on stakeholder input during a public workshop in 2005.

Table 6. Initial Screening Criteria, 2005

Criteria The Corps must apply the following **threshold criteria** when evaluating potential government actions: • The project must accomplish the project purpose • The plan must be feasible from an engineering standpoint • The plan must be economically viable (cost-effective) • The plan must be environmentally acceptable (receive approval and concurrence from resource agencies) • The plan must be within the Corps' O&M authority for the Grays Harbor Navigation Project • The plan must comply with existing state and federal laws • The plan must maintain the Corps' obligations related to the existing revetment • The design must anticipate a decreasing availability of maintenance dredged material that is suitable for beach nourishment
Evaluation Criteria - Through collaborative meetings, the following **evaluation criteria** were proposed:
Engineering: • Meets existing navigational needs • Accounts for long term "erosional trend" throughout the study area • Considers the sediment budget for ecological beneficial use • Considers the sediment budget for project cost savings • Considers sediment budget for protection of navigational features • Considers the extent of impacts to navigation features • Maintains navigational safety
Biological/Environmental: • Are there impacts to benthic resources • Are there potential impacts on sediment quality • Are there potential impacts on water quality • Are there impacts on shellfish aquaculture • Are there impacts on vegetation (land and water) • Is it environmentally sustainable? • Are there impacts on salmon, bull trout, and forage fish? • Are there impacts on shorebirds • Are there impacts on crabs? • Does it provide for no net loss of fish and shellfish habitat (productive capacity)?
Economic: • Considers capital costs and compare all alternatives

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- Compares annual maintenance costs
- Considers navigation uses and impacts (all classes/types of vessels)
- Are there aquaculture industry impacts?

Other:

- Maintains public safety
- Maintains Coast Guard accessibility
- Meets seismic design criteria
- Are there sea level rise impacts over the course of the strategy
- Is the system-wide functionality of the preferred alternative defined well enough to determine impacts of choices
- Are there recreational impacts
- Are there incidental consequences of implementation
- Is it locally acceptable
- Does it protect infrastructure from erosion

The team consolidated the Engineering, Environmental/Biological, Economic, and Other categories into initial screening criteria prior to the 2009 workshop, as shown in Table 7.

Table 7. Consolidated Initial Screening Criteria, by Category, Winter 2009

Category	Criterion	Definition
Engineering	Navigation function	The alternative provides a functional navigation channel. For example, the alternative minimizes incremental shoaling (increased dredging costs)
	Navigation safety	The alternative provides a safe channel.
	Navigation reliability	The alternative provides a reliable channel.
	Sediment budget for protection of navigational features	There is an adequate sediment supply for the alternative to maintain the structural integrity of the navigation features
	Impacts to surrounding projects	Does the alternative result in adverse impacts to the South Jetty, North Jetty, Point Chehalis Revetment & Groins, Section 111 project, Westport marina breakwaters ?
Biological/ Environmental	Impacts to dune grass	Alternative has a low risk of adverse impacts to dune grasses
	Impacts to benthic food resources	Alternative minimizes adverse impacts to benthic resources [smothering/burying fish food organisms, benthic invertebrates]
	Impacts to forage fish	Alternative minimizes adverse impacts to sand lance, surf smelt, Pacific herring, anchovies
	Impacts to juvenile ESA-listed salmonids	Alternative minimizes adverse impacts to Chinook salmon, coho salmon, chum salmon, bull trout
	Impacts to ground fishes	Alternative does not increase habitat for predator species, e.g. rockfish, ling cod; flatfishes
	Impacts to essential fish habitat (EFH)	Alternative minimizes adverse impacts to EFH, green sturgeon (green sturgeons are an ESA-listed species that could be present in the summer)

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Economic/ Cost	Capital Costs	Present value of the life-cycle costs.
	Annual Maintenance Costs	Annual cost to maintain the elements proposed in the alternative
	Infrastructure Impacts	Construction of the alternative does not degrade local infrastructure - for example trucking borrowed sand over local roads
Social	Impacts to recreation	Alternative minimizes impacts to uses and views of the ocean; surfing; beachcombing, etc.
	Public safety	Alternative increases or does not negatively affect safety of access and use of those areas that are open to the public (safe foot and vehicle access, slope stability, etc.)

Table 8 shows the results of the initial screening from September 2005 and winter 2009 based on the criteria discussed above. Through this process, the team screened out nine alternatives and carried 15 alternatives forward. In Table 8, the initial alternatives are listed in the left column; the center column shows an arrow for alternatives that passed the screening and were carried forward and gives reasons that other alternatives did not pass the screening; and the right column shows the remaining alternatives, with assigned alternative numbers. The titles of some alternatives were refined during the process to better reflect the alternative.

Table 8. Results of Initial Alternatives Screening, September 2005 and Winter 2009

September 2005 Alternatives from "Scoping" Efforts ***(From Sept 2005 Workshop)***	**Result of Screening**	**Alternatives Carried Forward Following Initial Screening2005-2008** ***(From Winter 2008-09 EA)***
Current Practice		**Current Practice**
• Current breach maintenance project[j]	→	1. Current Practice/Interim Action (2005 Supplement to SEA) NEPA No Action Alternative
Beach Nourishment		**Beach Nourishment**
• Direct beach nourishment[a] • Beach nourishment[c]	→	2a. Sand on South Beach and Half Moon Bay
• Direct beach nourishment[a] • Beach nourishment[c] • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	2b. Sand on South Beach (5-year interval) and Half Moon Bay (10-year interval) with modified diffraction/sand retention structure
• Direct beach nourishment[a] • Beach nourishment[c] • Gravel cobble transition beach • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	2c. Sand on South Beach (5-year interval) and gravel on Half Moon Bay (25-year interval) with diffraction structure
• Direct beach nourishment[a] • Beach nourishment[c] • Gravel cobble transition beach • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	2d. Dune construction and modified diffraction structure with a sand and gravel mix on Half Moon Bay (10-year interval)

September 2005 Alternatives from "Scoping" Efforts ***(From Sept 2005 Workshop)***	**Result of Screening**	**Alternatives Carried Forward Following Initial Screening2005-2008** ***(From Winter 2008-09 EA)***
• Direct Beach Nourishment[a] • Beach Nourishment[c] • Gravel Cobble Transition Beach • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	2e. Dune construction and diffraction structure with gravel on Half Moon Bay (25-year interval)
Jetty Extension		**Revised Jetty Extension**
• Revetment and jetty extension[a]	Did not meet environmental screening criteria	
• Jetty extension with beach nourishment[i] (Implemented plan from 1997) • Buried revetment between South Beach and Half Moon Bay • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	3a. Jetty extension with beach nourishment and modified diffraction structure
• Jetty extension with beach nourishment[i] (Implemented plan from 1997) • Buried revetment between South Beach and Half Moon Bay • Gravel cobble transition beach • Pt. Chehalis Control Point (Modification of the east end of the South Jetty)	→	3b. Jetty extension with gravel (25-year interval) beach nourishment on Half Moon Bay and modified diffraction structure
• Jetty extension without beach nourishment[4] • Pt. Chehalis Control Point (Modification of the east end of the South Jetty) • Weir jetty	→	3c. Jetty extension with weir and modified diffraction structure
• Terraced revetment	Did not meet engineering feasibility screening criteria	
Jetty Rehabilitation		
• South Jetty reinforcement[a]	→	Construction completed 2002
• South Jetty spur groin[e]	Did not meet environmental screening criteria	
• South Beach revetment[f]	Did not meet economic/cost screening criteria	
• South Jetty reconstruction[g]	Did not meet engineering feasibility and economic/cost screening criteria	
Deferred Action[b]		**Deferred Action**
• Allow breach to form	→	4a. New trestle construction
• Direct beach nourishment • Allow breach to form		4b1. Close breach with sand 6 months after established trigger
• Direct beach nourishment • Allow breach to form		4b2. Close breach with sand 2 years after trigger
• Direct beach nourishment • Allow breach to form		4b3. Close breach with sand when next jetty maintenance is required (approximately 25-year interval)
• Direct beach nourishment • Allow breach to form		4c. Emergency closure of breach with sand
No Response		**No Response**
• Allow breach to form	→	Allow breach to form
Berms		
• Nearshore berms[a]	Incorporated into DMMP for HMB[k]	
• Construction of submerged berm or breakwater	Did not meet environmental screening criteria	

September 2005 Alternatives from "Scoping" Efforts *(From Sept 2005 Workshop)*	Result of Screening	Alternatives Carried Forward Following Initial Screening2005-2008 *(From Winter 2008-09 EA)*
Navigation Channel Modifications		
• Realignment of navigation channel (Entrance Reach)[h]	*Separate project*[5]	
• Relocation of bar channel[h]	*Considered only if Entrance Reach realigned*	

[a] From 1995 Committee on Tidal Hydraulics (CTH)
[b] 1997 Alternative 1
[c] 1997 Alternative 2
[d] 1997 Alternative 3a
[e] 1995 CTH & 1997 Alternative 5
[f] 1995 CTH & 1997 Alternative 6
[g] 1997 Alternative 7
[h] 1997 Alternative 4
[i] 1997 Alternative 3b
j 2005 Interim Action
[k] DMMP for HMB– Incorporated into Dredged Material Management Program for Half Moon Bay

The remaining 15 alternatives (Table 9) included variations of six themes (alternatives under the "dune construction" theme [2D and 2E] are included in Table 9 with the "beach nourishment" alternatives):

Brief descriptions of these alternatives can be found in Appendix A and Appendix D. The next steps following the 2009 workshop included screening and evaluation of these remaining 15 alternatives using multi-criteria decision analysis (MCDA).

Table 9. Alternatives Carried Forward after 2009 Screening

Theme	Alternative
Current Practice	1 - NEPA "No Action" Alternative
Beach Nourishment	2A – Sand on South Beach and Half Moon Bay shoreline (5-year intervals) 2B – Sand on South Beach shoreline (5-year intervals) and Half Moon Bay shoreline (10-year intervals) with modified diffraction structure 2C – Sand on South Beach shoreline (5-year intervals) and gravel on Half Moon Bay shoreline (25-year intervals) with diffraction structure 2D – Dune construction and modified diffraction structure with a sand and gravel mix on Half Moon Bay shoreline (10-year intervals) 2E – Dune construction and diffraction structure with gravel on Half Moon Bay shoreline (25-year intervals)
Jetty Extension	3A – Jetty extension with sand on Half Moon Bay shoreline (10-year intervals) and modified diffraction structure 3B – Jetty extension with gravel on Half Moon Bay shoreline (25-year intervals) and modified diffraction structure 3C – Jetty extension with weir and modified diffraction structure

[5] Realignment of the navigation channel mainly has implications on the sediment available from O&M dredging, which could potentially be used for beach nourishment in various alternatives. In the past, the PDT considered channel realignment mainly as a different scenario affecting the study assumptions rather than as an alternative, so navigation channel modifications were not included among alternatives considered in subsequent screenings and evaluation during the LTMS study.

Deferred Action/Breach Closure	4A – Trestle over Half Moon Bay 4B-1 – Close breach with sand 6 months after trigger 4B-2 – Close breach with sand 2 years after trigger 4B-3 – Close breach with sand when next jetty maintenance is required (approximate 25 year intervals) 4C – Emergency closure of breach
No Response Alternative	5 – Allow breach to form (major repair or rehabilitation only)

The screening by the Corps revealed the difficulty and complexity of selecting or eliminating alternatives. In general, the alternatives that ranked highest for engineering feasibility were ranked lowest for biological and environmental impacts and vice versa. To help resolve these differences, the Corps engaged in a multi-criteria decision analysis (MCDA) process in 2009. The MCDA process has been successfully implemented on recent Corps coastal protection and ecosystem restoration projects including the Louisiana Coastal Protection and Restoration Project (LACPR) and the Mississippi Coastal Improvements Project (MCIP).

6.3 MULTI-CRITERIA DECISION ANALYSIS (MCDA)

The MCDA process encourages communication and collaboration among decision makers and other stakeholders by providing structured opportunities for interaction. The MCDA process integrates the information obtained through stakeholder engagement in an analytically sound, defensible, and quantitative approach to plan selection. This process enables decision makers to consider a diverse set of decision objectives and evaluate plan outcomes while making tradeoffs among those objectives in a manner consistent with their own preferences and the preferences of other stakeholders. Because preferences vary among stakeholders, as do the valuations assigned to the various selection criteria, usually no single alternative will fully satisfy every stakeholder.

MCDA also encourages transparency in the decision-making process, as all information used in making judgments about outcomes and tradeoffs are revealed. The intent of MCDA is to improve the quality of decisions involving multiple criteria by making a decision more explicit, rational, and efficient. For these reasons, the LTMS team used the MCDA process to facilitate decision making. Appendix B contains the full report detailing the MCDA process for this project and Appendix C contains a supplemental report on the iterative step the LTMS team took after completing the initial MCDA process.

6.3.1 MCDA ALTERNATIVES SCREENING

The LTMS decision process considered a comprehensive set of criteria within four evaluation categories: engineering feasibility; environmental and biological impacts; the construction, operations, and maintenance costs associated with any particular alternative; and social

impacts such as public safety. The criteria are the parameters for quantifying the performance of alternatives.

For simple systems, criteria may be easy to enumerate and interpret and inexpensive to parameterize. However, for the Grays Harbor LTMS, which involves both human and natural complex system drivers, development of measurable performance standards poses significant challenges. Both natural and human systems involved in water resources project planning are complicated and relate to one another in a myriad of ways. Consequently, any set of criteria is incomplete and may at best be considered only representative of the decision factors that could be brought to bear on the situation. For this reason, criteria are often referred to as indicators to emphasize the representational relationship these measures have to the state of complex systems. They are indicative – but not definitive – gauges, and consequently must be interpreted with their limitations in mind.

To select criteria, the public input received and resulting discussions from the 2005 workshop and LTMS technical team's inputs were used. However, some public inputs were not related to new criteria per se; rather, they referred to uncertainties or risk factors such as climate change. Many concerns voiced by the public were redundant; such concerns were screened and consolidated. Table 9 lists the alternatives screening and evaluation criteria used during the MCDA process.

Table 10 MCDA Screening and Evaluation Criteria

Criteria Category	Criteria
Engineering	Navigation functionality (including: efficiency, navigation risk and reliability, navigation safety) Technical feasibility Sediment budget (in thousands of cubic yards) Impacts to surrounding project features
Environmental/biological	Habitat above extreme high water (EHW) Habitat between EHW and +6.0 feet mean lower low water (MLLW) Habitat between +6.0 feet MLLW and -4 feet MLLW Habitat below -4 feet MLLW
Economic	Net present value (50 year project life)
Social	Impacts on recreation Public safety

Once the team established these evaluation criteria, each alternative's performance with respect to all criteria was summarized in a decision matrix, showing the relative performance and tradeoffs between alternatives. Next, a tradeoff analysis was used to eliminate alternatives with performances inferior to other alternatives, as relative to all criteria, and these lower-ranking alternatives were removed from further consideration. Table 11 shows

the results of this tradeoff analysis. A detailed explanation of how this process was accomplished for the Grays Harbor LTMS is in Appendix B.

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Table 11. Performance of 15 Alternatives Based on Expert Judgments during MCDA

	Engineering Feasibility						Biological and Environmental Impacts				Construction, Operation, and Maintenance Costs	Social Impacts	
	Navigation Functionality												
	1.1.1 Navigation Efficiency	1.1.2 Navigation risk & reliability	1.1.3 Navigation safety	1.2 Technical feasibility	1.3 Sediment Budget deficit for maintenance of Navigational Features	1.4 Impacts to surrounding project features	2.1 Habitat above Extreme High Water (EHW)	2.2 Habitat between EHW and +6.0 ft MLLW	2.3 Habitat between +6.0 ft MLLW and -4 ft MLLW	2.4 Habitat from -4 ft MLLW seaward	3.3 Total Cost (in Millions)	4.1 Recreation Impacts	4.2 Public Safety
Alt 1	10	15	8	7	162,500	6	8	7	8	10	$ 12.2	7	8
Alt 2A	7	9	9	8	650,000	8	9	5	5	10	$ 90.6	8	9
Alt 2B	8	8	9	9	525,000	10	9	4	3	8	$ 79.8	7	6
Alt 2C	10	8	9	8	400,000	10	9	4	3	8	$ 82.9	4	6
Alt 2D	8	12	7	7	600,000	4	5	5	4	7	$ 47.9	4	6
Alt 2E	9	12	8	6	600,000	4	5	5	4	7	$ 40.9	2	6
Alt 3A	9	5	10	10	250,000	8	7	5	5	7	$ 43.3	3	4
Alt 3B	10	5	10	9	0	9	7	5	5	8	$ 45.7	1	4
Alt 3C	6	12	5	2	0	5	5	6	6	7	$ 38.6	2	3
Alt 4A	1	25	1	1	0	1	7	9	9	9	$ 22.7	1	4
Alt 4B-1	3	20	4	2	600,000	3	7	8	8	10	$ 9.0	7	6
Alt 4B-2	2	20	3	1	900,000	2	6	7	7	10	$ 13.4	6	6
Alt 4B-3	2	25	2	2	1,200,000	2	7	9	9	10	$ 17.6	4	4
Alt 4C	4	16	6	8	300,000	4	7	7	8	10	$ 3.7	8	7
Alt 5	0	30	0	0	0	0	7	9	9	10	$ 1,000.0	1	3

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When comparing alternatives, the objective was to rank the alternatives using a multi-criteria value score that integrates information about anticipated alternative performance outcomes and expert judgment for weighting each criterion. For example, under the social impacts category, there are two criteria (recreation and public safety). Public safety was valued higher than recreation; therefore, its weighted factor is 0.6 compared to recreation, which is 0.4. To obtain the weighted total, the criterion scores derived from expert judgment was multiplied by the weighted factor. The results for each criterion were then summed up for a total weighted score under each category for each alternative. Table 12 shows a decision matrix performance for each category given for an alternative. The numbers in the table reflect each alternative's multi-criteria value score, by category, where a higher number reflects a more positive rating.

Table 12. Weighted and normalized score by category for each of the 15 Alternatives

Alternatives	Engineering Feasibility	Biological and Environmental Impacts	Construction, Operation, and Maintenance Costs	Social Impacts	Sum	Rank
1	0.592	0.800	0.857	0.868	3.117	**1**
2A	0.634	0.378	0.071	1.000	2.084	**4**
2B	0.800	0.067	0.214	0.559	1.640	**10**
2C	0.779	0.067	0.143	0.441	1.430	12
2D	0.431	0.000	0.286	0.441	1.157	14
2E	0.448	0.000	0.500	0.353	1.301	13
3A	0.980	0.111	0.429	0.235	1.755	**8**
3B	1.000	0.200	0.357	0.088	1.645	**9**
3C	0.434	0.389	0.571	0.088	1.483	11
4A	0.079	0.978	0.643	0.088	1.788	**7**
4B-1	0.166	0.856	0.929	0.559	2.509	**3**
4B-2	0.046	0.678	0.786	0.529	2.039	**5**
4B-3	0.003	1.000	0.714	0.265	1.982	**6**
4C	0.456	0.722	1.000	0.912	3.090	**2**
5	0.000	1.000	0.000	0.000	1.000	15

Some alternatives ranked low against other alternatives for all criteria, indicating that these alternatives were dominated by the higher-ranking alternatives and, therefore, could be eliminated from further consideration. Using this approach, five alternatives were eliminated from further consideration: Alternatives 2C, 2D, 2E, 3C, and 5. This yielded the top 10 dominating alternatives. The LTMS team conducted further evaluation of the 10 remaining alternatives after eliminating these five low-ranking alternatives. Figure 13 shows the relative importance of each criterion in the decision matrix score.

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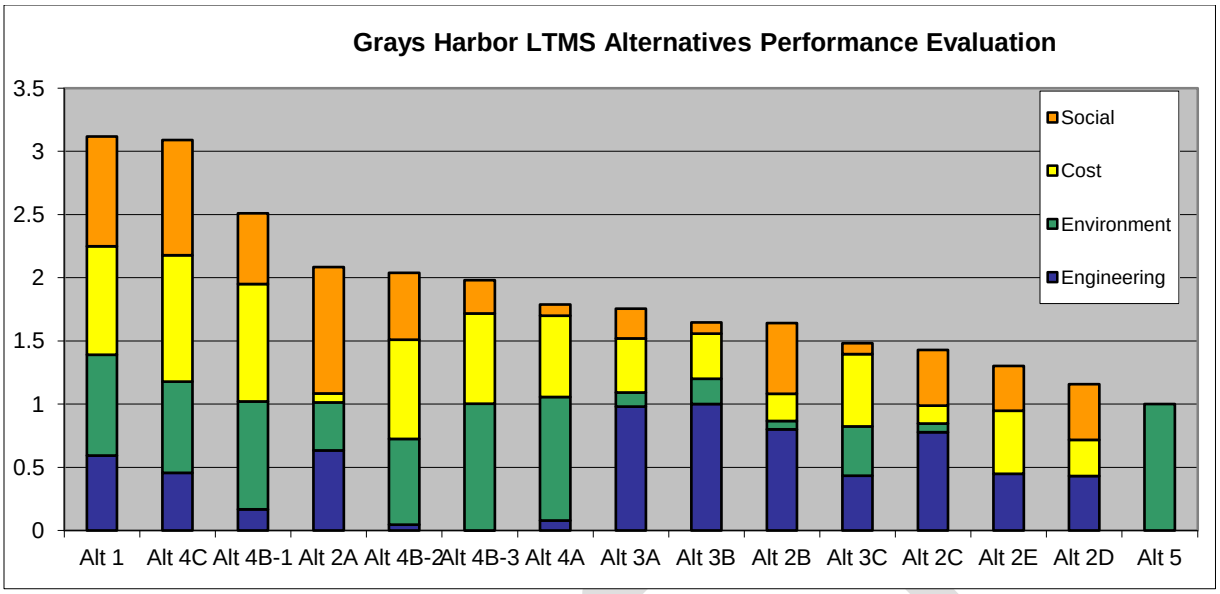

Figure 13. Relative importance of each criteria in decision matrix score

To conduct the next evaluation step, the ERDC Environmental Laboratory (ERDC-EL) convened a workshop in May 2009, comprised of nine Corps staff members, representing multiple disciplines and a variety of levels of the Corps organization, as part of the MCDA process to attempt to further screen out alternatives, if possible. The purpose of this workshop was to elicit only the comparative weighting among evaluation categories (the criteria weights, within each category, had been assigned previously). Once relative weightings had been given for each evaluation category, normalized weightings were calculated for use in scoring the alternatives. The normalized criteria weights (i.e., sum to 1) for each criterion are a combination of category weights and each criteria weight. Figure 14 shows the relative weights that were averaged, based on input of the nine multi-disciplinary team members for each criterion. The data show that the Engineering criterion (0.45736) is ranked about two times higher than the Environmental criterion (0.20784) and Cost criterion (0.19953) and over three times higher than the Social criterion (0.13527). Collectively, the team members therefore determined that, for purposes of comparative evaluation of the considerations present in the LTMS Study, the Engineering criterion is over two times more important than the Environmental and Cost criteria, and over three times more important than the Social criterion.

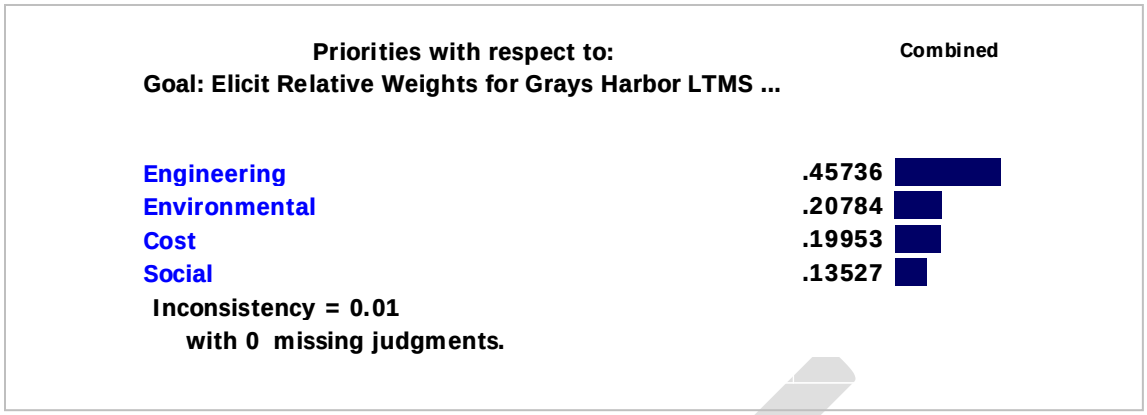

Figure 14. MCDA Criteria Priorities for Weighting

Once the elicited category-level weights were applied, it became apparent that there was an ascertainable "break point" between a top tier of seven relatively high-performing alternatives, and three that were ranked decidedly lower. This process thus resulted in the elimination of three alternatives: 4A, 4B-2, and 4B-3, as shown in Figure 15. The remaining seven alternatives were:

- Alternative 1 - No Action Alternative
- Alternative 2A - Sand on South Beach and Half Moon Bay shoreline (5-year intervals)
- Alternative 2B - Sand on South Beach shoreline (5-year intervals) and Half Moon Bay shoreline (10-year intervals) with modified diffraction structure
- Alternative 3A - Jetty extension with sand on Half Moon Bay shoreline (10-year intervals) and modified diffraction structure
- Alternative 3B - Jetty extension with gravel on Half Moon Bay shoreline (25-year intervals) and modified diffraction structure
- Alternative 4B-1 - Close breach with sand 6 months after trigger
- Alternative 4C - Emergency closure of breach

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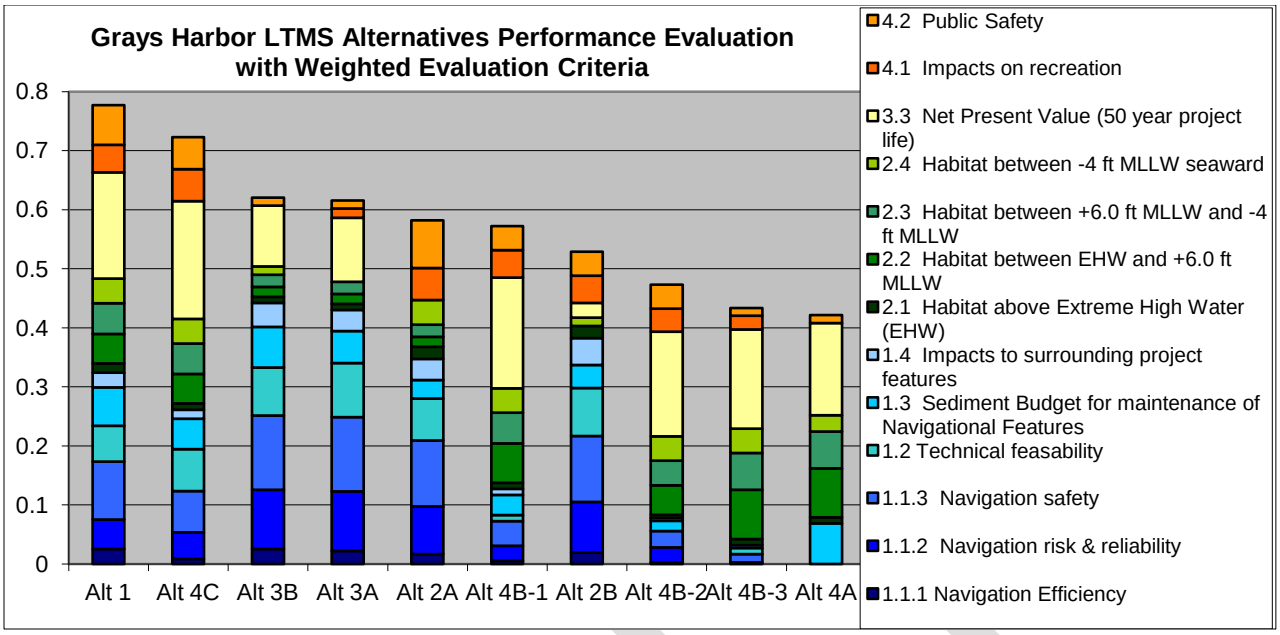

Figure 15. Ranking of alternatives after including weighted evaluation criteria

Following the weight elicitation workshop it became more evident that Alternative 1 (NEPA "No Action" alternative) and alternatives comprised of a diffraction structure (Alternatives 2B and 3B) performed well amongst all criteria. The diffraction structure would increase the length between nourishment cycles and decrease the required sand quantities for each nourishment event. As a result, the LTMS Team proposed an additional Alternative 1B (Modified NEPA "No Action" (with diffraction structure)) after internal discussion and team review of the individual benefits of each alternative. Alternative 1B had not been part of the original scoring process. Therefore, a performance score was completed by the evaluation team using the same criteria, and a second iteration of the MCDA decision matrix was conducted, as further described below. The results from this iterative decision analysis are in Appendix C. For tracking purposes, what had previously been labeled as Alternative 1 (the No Action alternative) was called Alternative 1A for the remainder of the study.

In April 2010, the cost estimates for the alternatives were escalated for inflation. To keep the analysis to a manageable size, the LTMS Team performed an additional episode of culling out low-performing alternatives. An ascertainable "break point" was identified between the top four alternatives and the remaining three from the first MCDA iteration. The Team then proceeded to evaluate the four highest-performing alternatives from the previous analysis, in addition to Alternative 1B. These were:

- Alternative 1A – NEPA "No Action" Alternative
- Alternative 1B – Modified NEPA "No Action" Alternative with Diffraction structure
- Alternative 4C - Emergency closure of breach
- Alternative 3B - Jetty extension with gravel on Half Moon Bay shoreline (25-year intervals) and modified diffraction structure

- Alternative 3A - Jetty extension with sand on Half Moon Bay shoreline (10-year intervals) and modified diffraction structure.

A life cycle cost analysis was performed for the alternatives carried forward to inform the MCDA process. Costs were escalated to 2nd quarter (Jan-Mar) 2010 costs using CWBS Feature Code 17, Beach Replenishment. The Federal fiscal year 2010 (FY10) discount rate of 4.375% was used to obtain present value calculations. A contingency of 25% was used and 2012 was used as the base year across alternatives. Other assumptions that went into the life cycle analysis included:

- All sand alternatives estimated require less than 300,000 cy of sand per nourishment action, which is within reason given the projected sand available from dredging in the future; and
- Assume no interest during construction since initial construction is 4 months or less for any alternative, and sand placement for nourishment takes 1 month and gravel placement for nourishment takes 2 months or less.

Based on those assumptions and when costs for initial construction, beach replenishment, and other operations and maintenance expenses were expected to be incurred, the net present value (NPV) and annual costs were estimated for each of the alternatives using a Federal fiscal year 2010 (FY10) discount rate of 4.375% (see Table 20). *Net present value* is the total implementation cost – construction, O&M, and mitigation – over the 50-year period of analysis, calculated in 2010 dollars, while *annual cost* is the annual implementation cost – construction, O&M, and mitigation – over the 50-year period of analysis, calculated in 2010 dollars.

Table 13. Summarized Net Present Value and Annual Costs (Assuming No Interest During Construction, Second Quarter 2010 Dollar Value)

Alternative	NPV (2nd Quarter 2010 Dollar Value)	Annual Cost (2nd Quarter 2010 Dollar Value)
1A	$6,725,467	$333,430
1B	$10,644,570	$527,728
3A	$27,948,661	$1,385,615
3B	$34,214,064	$1,696,236
4C	$4,500,833	$223,139

Following the addition of Alternative 1B and the cost estimates escalated for inflation, a second iteration in the MCDA analysis was performed. The second iteration retained the same performance scores issued in the first iteration (i.e., Table 12) for Alternatives 1A, 3A, 3B, and 4C for the Engineering Environmental, and Social Criteria. However, the new cost estimates were used to update the Construction, Operations and Maintenance Cost performance score. Alternative 1B was assigned a performance score for all criteria.

Figure 16 shows that the Net Present Value criterion was the single largest contributor to the overall utility value for the two top-ranked alternatives (Alternative 1B and Alternative 1A). In addition, Figure 17 shows two top-ranked alternatives possessed the most balanced contributions across all criteria indicating the best trade-off among alternatives. Likewise, Alternative 1B and Alternative 1A achieved the highest utility scores because they received the most balanced contributions across all four primary evaluation categories (i.e. engineering, environmental, cost, social). The highest score reflects the cumulative sum of utility scores across the four evaluation criteria. Thus by interpreting the results of Figure 17, Alternative 1B provides the highest overall score while achieving a balanced trade-off among engineering, environmental, cost, and social acceptance.

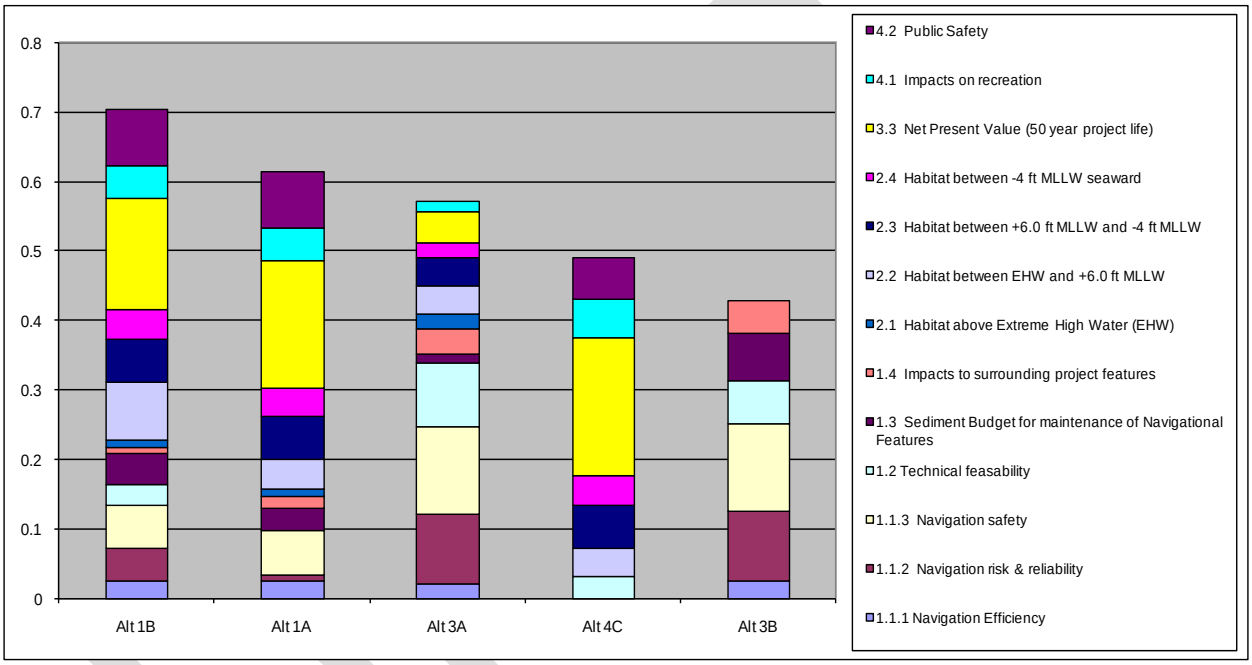

Figure 16. Contribution of Each Criterion to the Multi-Criteria Utility Score for Each Alternative

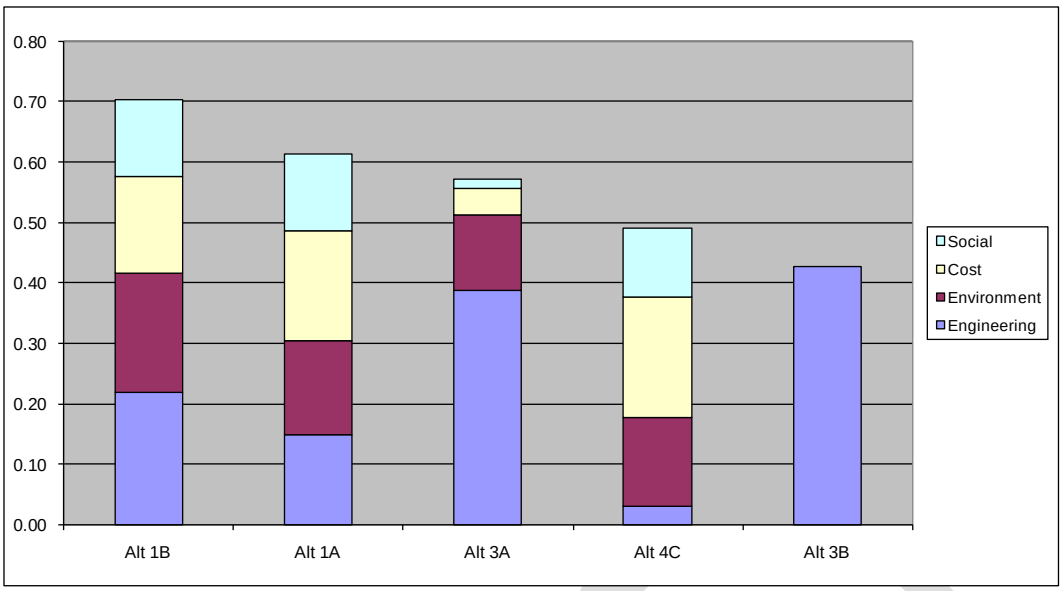

Figure 17. Contributions of Each Evaluation Category to the Multi-Criteria Utility Score

6.3.2 Alternatives Carried Forward Following MCDA Process

Through the iterative decision analysis process, the LTMS team identified the five alternatives that were analyzed in the second round of MCDA described above. Due to the distinctly inferior comparative performance of one of the evaluated alternatives, Alternative 3B was culled from the list of alternatives to be further considered. The LTMS team chose to carry forward only the following four top-performing alternatives for detailed analysis:

- Alternative 1A – No Action Alternative (Current Practice)
- Alternative 1B – Modified Current Practice (with modified diffraction structure)
- Alternative 3A– Jetty Extension (with beach nourishment and modified diffraction structure)
- Alternative 4C – Breach Closure (immediate closure after breach)

6.3.3 Sea Level Rise and Global Climate Change Considerations

Sea level change (SLC) must be considered in all USACE projects per the guidance presented in EC 1165-2-211 (USACE 2009). The guidance states that "engineering designs should consider alternatives that are developed and assessed for the entire range of possible future rates of sea-level change." Data from NOAA tide station 9440910, Toke Point, Washington was used for the analysis because data at the Westport gage has only been collected since 2006 and is of insufficient duration for determining sea level trends. The long-term trend line shown in Figure 18 indicates an increase of 1.6 mm/yr (0.063inches/yr) in water level. Table 14 provides the incremental (5-year) sea level change estimates calculated per the

guidance for the 50-year design life of the repair beginning from the estimated project implementation in 2012. Sea level rise ranges from 0.3 to 1.9 feet for the low and high scenarios, respectively, by the end of the 50-year design life.

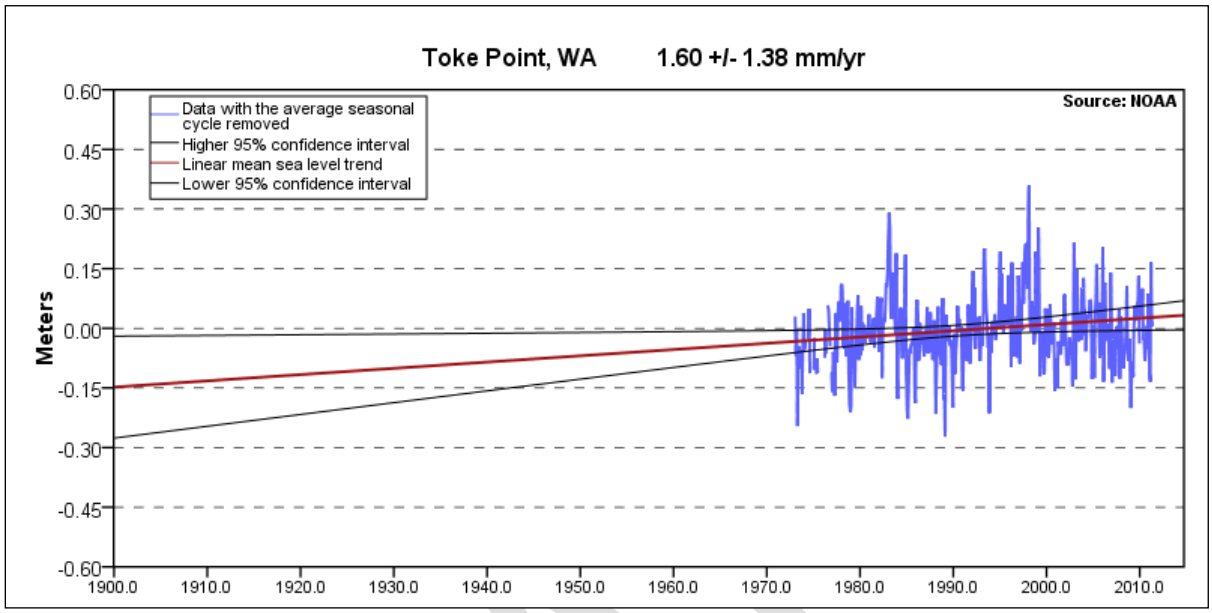

Figure 18. Mean Sea Level Trend at Toke Point, Washington (NOAA, Tides and Currents)

Table 14. Estimated Sea Level Change at Toke Point, Washington, calculated per EC 1165-2-211

Sea Level Change Estimates (in feet)			
Year	**Low**	**Medium**	**High**
2010	0.00	0.00	0.00
2015	0.03	0.05	0.11
2020	0.05	0.10	0.24
2025	0.08	0.15	0.39
2030	0.10	0.21	0.55
2035	0.13	0.27	0.73
2040	0.16	0.34	0.93
2045	0.18	0.41	1.14
2050	0.21	0.48	1.37
2055	0.24	0.56	1.62
2060	0.26	0.64	1.88

The potential impact of SLR on the four alternatives carried forward varies. Based on a qualitative analysis, the impact of SLR on alternatives 1A and 1B would likely be an increased quantity of beach fill required due to beach and dune profile adjustment associated

with sea level rise. For Alternative 3A, the structural nature of the alternative would provide less flexibility to adapt to future conditions as a result of SLR because the project would be committed to the as-built footprint. For Alternative 4C, SLR would likely increase the frequency of breaching events and increase the need for greater quantities of sand needed to maintain the land connection. Given these potential impacts, alternatives 1A and 1B have greater flexibility to adapt to SLR.

6.4 DESCRIPTION OF ALTERNATIVES ANALYZED

In addition to the design elements described below for each of the four alternatives brought forward for comparison and analysis of their effects, it is assumed the Corps will continue nearshore beneficial placement of approximately 200,000 cy per year of O&M dredged material at below -10 MLLW within Half Moon Bay via hopper dredge. The purpose of this placement is to supplement a net sediment sink with sand. This effectively minimizes the risk for beach profile steepening which is the precursor to beach and dune erosion on Half Moon Bay. Table 15 shows the comparison of each of the principal project components for each alternative.

Table 15. Comparison of Project Components by Alternative

Element of Concern	Alternatives			
	1A	1B	3A	4C
Initial sand placement at Half Moon Bay	—	110,000	—	—
Initial excavation and relocation of sand for jetty construction			130,000	
Periodic sand placement at Half Moon Bay (cy)	110,000	110,000	250,000	—
Interval	5 year	10 year	10 years	—
Periodic sand placement at South Beach (cy)	52,500	52,500	—	300,000
Interval	5 years	5 years	—	As required
Physical Structure – Jetty Extension	—	—	X	—
Modified Diffraction Structure	—	X	X	—
Hydraulic placement	—	X	X	X
Beach nourishment by truck placement	X	X	X	X
Allows breach to occur	—	—	—	X
Stockpile sand source	X	X	X	X
O&M sand source	X	X	X	X
Assumes ongoing O&M nearshore placement of 200,000 cy in Half Moon Bay	X	X	X	X

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6.4.1 ALTERNATIVE 1A – NO ACTION (CURRENT PRACTICE)

Section 1502.14 of the Council on Environmental Quality regulations implementing NEPA (42 United States Code [USC] 4371, et seq.) requires that the environmental review sharply define the issues and provide a clear basis for choice among options by the decision makers and the public. To comply with this requirement, NEPA requires that the review include a No Action Alternative. Therefore, a No Action Alternative was included in the analysis to ensure that impacts associated with no action are compared to the impacts associated with other reasonable alternatives.

Where ongoing programs are initiated under existing legislation and regulations would continue, No Action may be defined as no change from current management direction or level of management intensity (CEQ 1981). Therefore, the No Action Alternative may be thought of in terms of continuing with the present course of action until that action is changed. Accordingly, projected impacts of the alternatives would be compared to those impacts projected for the current practices; reasonable alternatives would include management strategies of both greater and lesser intensity, especially greater and lesser levels of resource development. For the Grays Harbor LTMS, Alternative 1A is the No Action Alternative.[6]

In 2005, the Corps put in place an interim action plan until an LTMS could be comprehensively evaluated. In the interim plan, the Corps established triggering criteria, or thresholds, that provide adequate reaction time to design, procure the necessary materials, and implement a response to any breach that may be identified as forming (Table 16). Alternative 1A has two triggering thresholds (Table 16). Sand placement is initiated only when topographic surveys (Trigger No. 1) or observed conditions (Trigger No. 2) indicate that an undue risk of a breach is developing.

Table 16. Trigger and Responsive Actions for Alternative 1A

[6] As noted in Chapter 5, for this study, the future without-project condition is different than the "no action" alternative described in the NEPA regulations. For this LTMS study, Alternative 1A is the No Action alternative. Alternative 1A continues the present course of action until that action is changed, while the future without project condition does *not* include the current practice. No Action is an alternative that was evaluated along with other alternatives. The "no response" alternative (i.e. allowing a breach to form) was used as the future without project condition for the purposes of evaluation and comparison of alternatives. The "no response alternative" assumes no further action will be taken to prevent a breach, and response will be evaluated at such time that it is determined that the South Jetty is in need of major repair or rehabilitation.

No.	Trigger	Responsive Action
1	Survey data reveals that 15,000 cy of sand has eroded from the southwest corner of the Half Moon Bay shoreline since the most recent sand response action.	Placement of sand along approximately 1,000 linear feet of beach in the southwest corner of Half Moon Bay. The quantity of placed sand would be determined after analysis of erosion from annual survey data. Sand would be excavated from the existing Point Chehalis revetment stockpile site and trucked on the existing state park access road. The excavated material would be placed shoreward of the contour line of +9 feet MLLW (the MHHW contour) at its natural angle of repose to minimize impacts on intertidal ecology. Currents and wave action are expected to regrade and disperse this sand eastward along the beach and offshore. Sand grain size would be consistent with existing beach sand grain size.
2	The breach fill footprint south of the South Jetty is overtopped by water from the west due to one or more storm events.	Placement of clean sand on top of the breach fill, above elevation +9 feet MLLW at a location within the fill footprint. The precise location and quantity of placed sand would be selected based on an analysis of the most effective means of responding to the observed overtopping conditions and the most effective means of addressing the risk of further overtopping and end cutting. The sand would be excavated and mechanically transferred from the Point Chehalis revetment stockpile site to the placement area.

Half Moon Bay and South Beach are surveyed annually. Triggers and corresponding corrective actions are based on empirical data obtained during previous breaches at Grays Harbor (USACE 2008b). Since the sand placement event in December 2004 for breach maintenance, survey data have been collected in June 2005, September 2006, August 2007, January 2008, August 2009, November 2009, April 2010, November 2010, and January 2011. Figure 19 shows the elevation change along the Half Moon Bay shoreline from January 2005 to January 2008. The figure shows that the greatest area of erosion occurs in the northwest portion of Half Moon Bay, directly south of the South Jetty root. In this area, the beach scarp has moved approximately 40 to 50 feet landward, which is believed to be the result of the shoreline equilibrating to the classic log spiral shoreline shape (crenulate) described by Silvester and Hsu (1997).

Trigger No. 1 would be reached when, based on surveys, 15,000 cy of sand have eroded from the southwest corner of Half Moon Bay since the most recent sand response action. Trigger No. 2 would be reached when overtopping of the breach fill footprint from the west is observed. For example in September 2010 the trigger was met and 20,000 cy of sand was placed in the specified area (see Figure 20 for a representative illustrative of a responsive action). The placed sand would be excavated from the upland stockpile site maintained in the vicinity of the Point Chehalis revetment extension constructed in 1999. The sand stockpile serves as an upland supply of material to nourish the Half Moon Bay shoreline as the existing breach fill erodes.

Although the stockpile is located waterward of the revetment, all excavation work would occur landward and above the active littoral zone. The footprint of the stockpile site is approximately 10 acres. Excavation is allowed to +17 feet MLLW. Assuming the stockpile is filled to the maximum of +35 feet MLLW, the maximum stockpile capacity is 290,000 cy. The upland stockpile will be refilled with dredged material from the entrance channel during routine maintenance conducted approximately every 5 years.

Rather than end-dumping individual 10-cy loads directly on to the beach, larger quantities of sand would be temporarily stockpiled on upland areas adjacent to the shoreline. The sand would then be pushed off the beach scarp during low tides when water is not present at the placement site. By placing material uniformly over a larger area all at once, erosion of newly placed material may be minimized (i.e., no creation of small headlands to receive focused wave energy), and none of the material would be placed when water was over the project footprint.

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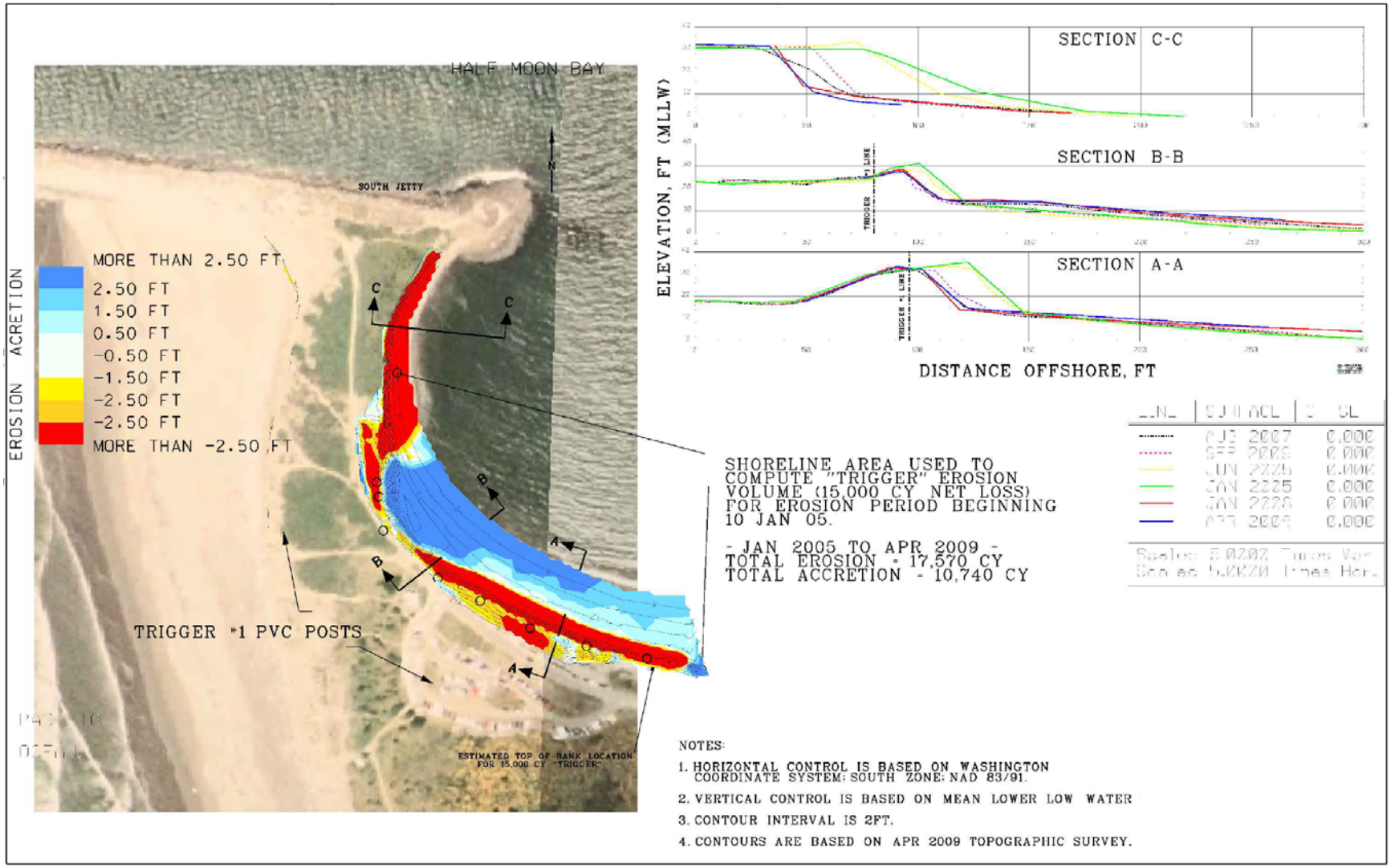

SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers, April 2011.

Figure 19. Half Moon Bay Elevation Changes 2005-2009

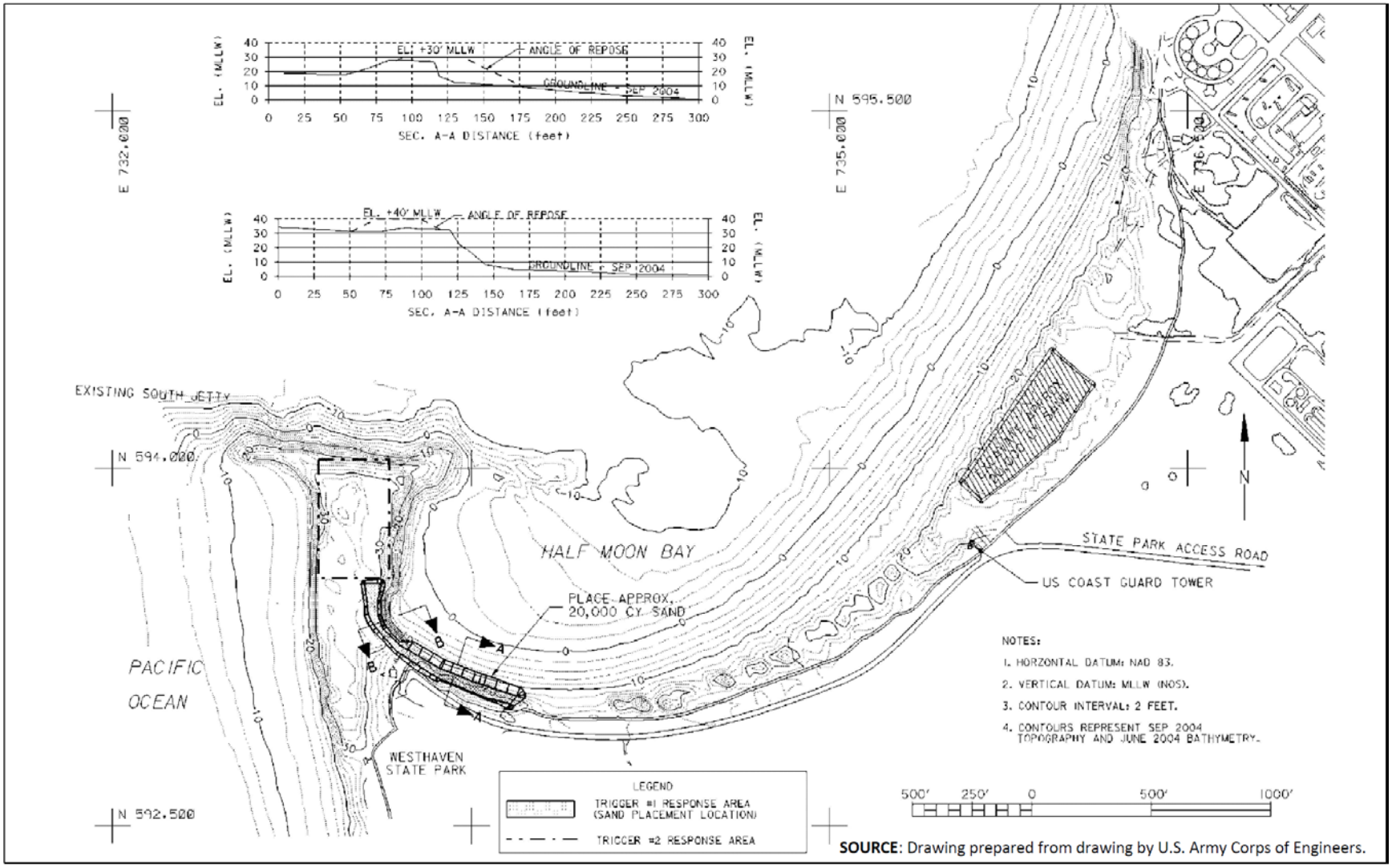

Figure 20. Alternative 1A - No Action Alternative (Current Practice)

If Trigger No. 2 (the over-topping trigger) is reached, the responsive beach nourishment would occur by placing sand in the region of beach immediately south of the jetty. Should that occur, alternate access to the fill area would be required. Off-road vehicles that do not require an improved road could be used in this situation. The haul road would be approximately 16 feet wide with occasional turnouts. Because these vehicles have off-road capabilities, no crushed rock would be placed along the haul road alignment. Closer to the jetty, trucks would use the rock haul road that is currently in place and providing access to the South Jetty for routine maintenance. Angular rock on the surface of the temporary haul road will be removed prior to fill being placed on its surface. Alternatively, a temporary access route would be constructed using removable steel plates for use by conventional trucks.

6.4.2 Alternative 1B – Modified Current Practice (with Modified Diffraction Structure)

Alternative 1B is a modification of the current practice, which would include the placement of sediment to prevent breaching when a trigger is met, combined with extending the existing diffraction mound, 500 feet to the east into Half Moon Bay along the footprint of a remnant jetty, to diffract wave energy. Modifying the diffraction structure would entail placing new rock on top of an existing remnant jetty to an elevation of +20 feet MLLW. This is 3 feet lower than the existing authorized crest elevation of +23 feet MLLW. The present remnant jetty elevation is approximately +2 feet MLLW. The modified diffraction structure would help stabilize the Half Moon Bay shoreline. The minimum cross-sectional area of dune required to provide adequate protection from a breach during a 50-year storm return interval was determined to be 275 feet in width and +30 feet MLLW in elevation, through performing a dune vulnerability analysis (see Appendix D). The trigger for this alternative is therefore defined as a minimum dune width of 275 feet at an elevation of +30 feet MLLW or a minimum dune reservoir area of 250 cy per linear foot above mean sea level (Figure 13). Similar to the existing practice, if the trigger is met, the Corps would perform a survey to determine the location and volume of sediment required to maintain the minimum dune cross-sectional area. The trigger response is expected to require approximately 52,500 cy of sand placement at South Beach every 5 years and placement of approximately 110,000 cy of sand at Half Moon Bay every 10 years. The nourishment is focused on only the 1,000 feet of shoreline and dune immediately south of the South Jetty where breaching is most probable.

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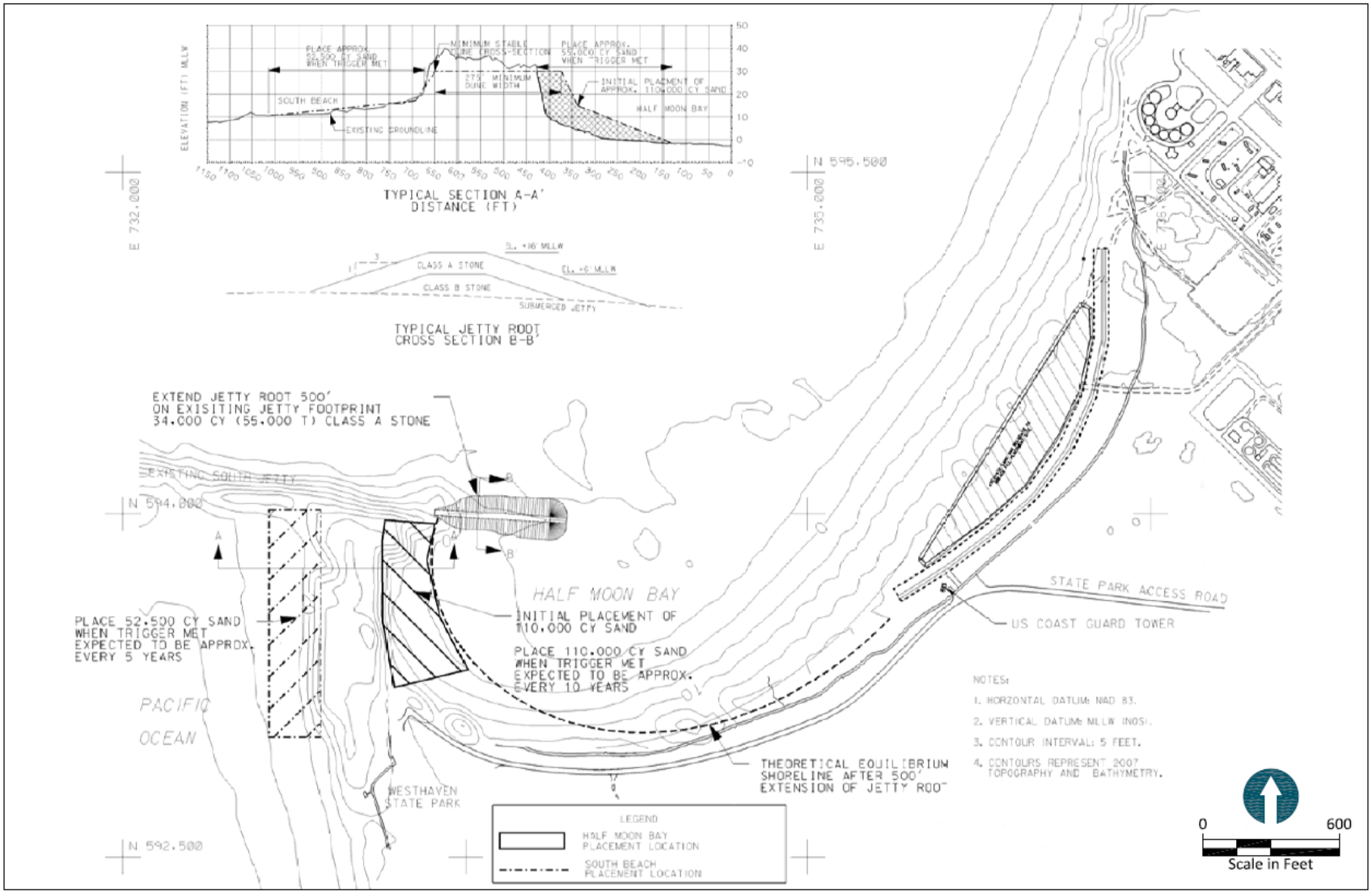

SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers dated June 18, 2009.

Figure 21. Alternative 1B - Modified Current Practice with Modified Diffraction Structure

Prior to the triggers previously mentioned, this alternative would require an initial placement of approximately 110,000 cy of sand on the Half Moon Bay shoreline to create the minimum dune required to withstand a 50-year storm event. The initial placement would re-establish a mildly sloping beach from the present beach scarp to the estimated equilibrium shoreline.

An additional feature of this alternative is construction of a diffraction structure 500 feet along the existing jetty remnant using approximately 55,000 tons of Class A stone. It is estimated that the diffraction structure would reduce the frequency and quantity of nourishment required for the Half Moon Bay shoreline.

Sand would be transported hydraulically from a hopper dredge, to the Point Chehalis revetment stockpile site or to the nourishment areas directly. If the sand is delivered to the Point Chehalis revetment stockpile site the sand would later be excavated and mechanically transferred by truck to the nourishment site when the triggers are met. The source of material would be outer harbor sediments from O&M dredging of the authorized navigation channel.

Construction of the modified diffraction structure would result in loss of about 2 acres of subtidal sand area that serves as habitat for benthic invertebrates, and a perimeter of 1,000 feet of additional rock riprap that could serve as habitat for ling cod and rockfish that could prey on juvenile salmonids. As mitigation for the impact on juvenile salmon, approximately 50 lineal feet of riprap would be removed from each of the east and west ends of a partially submerged remnant jetty near the North Jetty in the vicinity of the Oyhut Wildlife Recreation Area and Damon Point on the north side of the inlet to Grays Harbor. This removal would provide access to excellent shallow water habitat for fish, including ESA-listed salmonid species, at all tidal levels, would promote better circulation in the embayment, and would allow more wave energy into the bay that would aid in returning it to its pre-jetty condition.

6.4.3 Alternative 3A – Jetty Extension (with Beach Nourishment and Modified Diffraction Structure)

Under Alternative 3A, the South Jetty would be extended landward 1,828 feet, approximately 250,000 cy of sand would be placed along the Half Moon Bay shoreline by hopper dredge for protection of the South Jetty at 10-year intervals, and a 500-foot-long diffraction structure would be constructed to reduce the rate of erosion at the Half Moon Bay shoreline. The modified diffraction structure would entail placement of new rock on top of an existing remnant jetty, in the same manner as described in Alternative 1B. The modified diffraction structure would help stabilize the Half Moon Bay shoreline. Jetty construction

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would occur when funding is received to perform the work. Ultimately, timing is contingent on funding, not on when a breach occurs. Figure 21 illustrates these elements.

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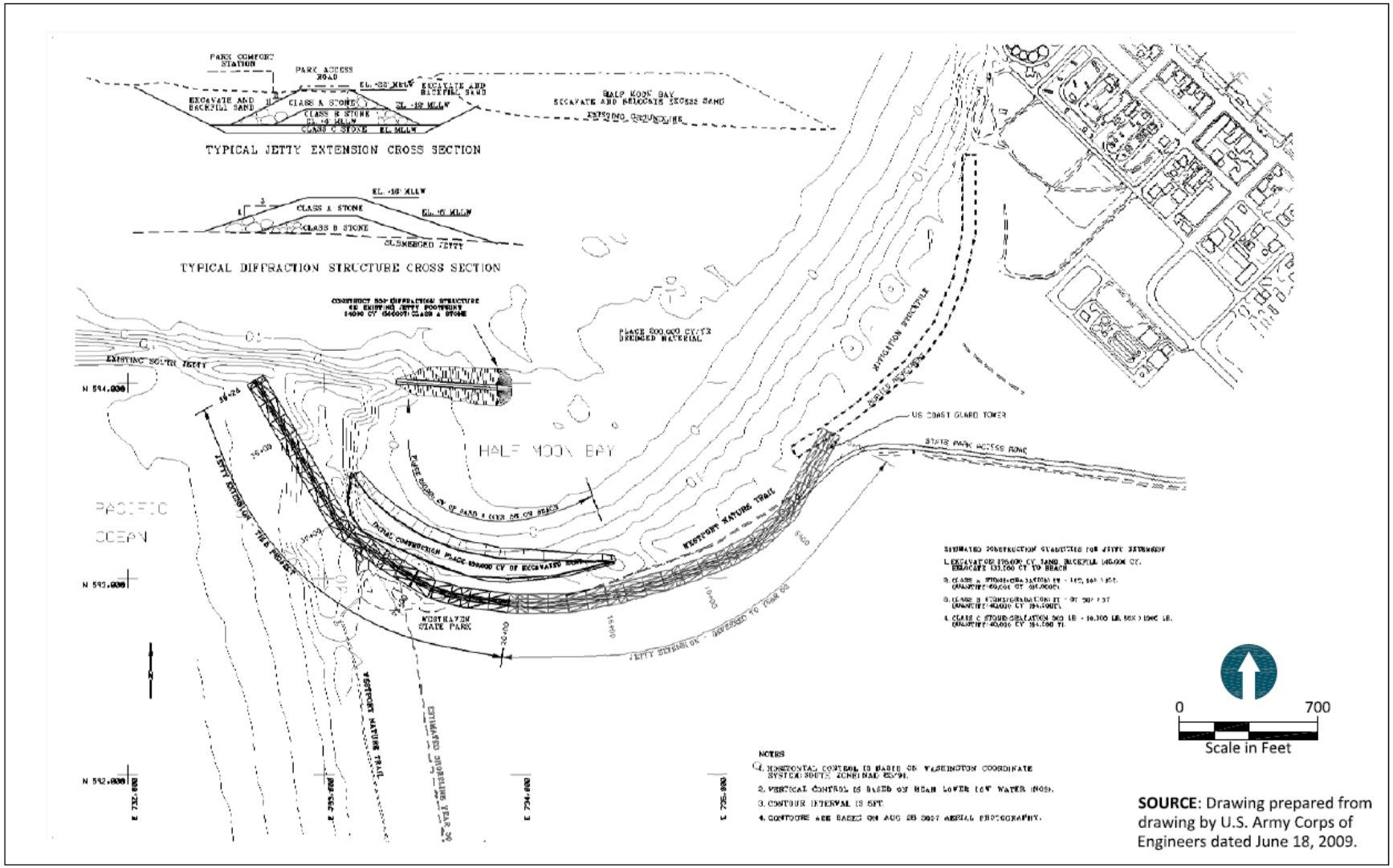

Figure 22. Alternative 3A - Jetty Extension with Beach Nourishment and Modified Diffraction Structure

Alternative 3A would use large armor stone to extend the existing jetty structure toward the Point Chehalis revetment so that erosion of South Beach may continue without creating a breach. The jetty alignment would follow the existing state park access road and then proceed through the breach area until it intersected the jetty. Construction would start at Station 20+00 (Figure 14), proceed along the access road alignment, and then under the breach fill to tie into the existing jetty. The jetty extension would have a top width of 30 feet and a top elevation of +22 feet MLLW. The entire structure would be buried under the state park access road and breach fill sand. The initial construction for a 50-year design life project includes only the western 1,828 feet of the structure. After 50 years the second phase connecting the south jetty to the Point Chehalis revetment would be re-evaluated.

Constructing the 1,828-foot jetty extension would require excavating 145,000 cy of sand and placing 64,000 tons of Class C stone, 64,000 tons of Class B stone, and 80,000 tons of Class A stone that would be delivered by truck. The jetty top width is designed to provide suitable access to the rest of the jetty structure. Approximately 130,000 cy of the excavated sand from the jetty extension would be graded to provide initial cover along the Half Moon Bay shoreline. The jetty extension would follow the present uplands. Initially the structure would be backfilled and buried with the sand excavated for its initial construction. However, over time the shoreline is expected to erode landward along South Beach, exposing the structure on the oceanside.

The diffraction structure would require placing armor stone, as previously described in Alternative 1B. The structure would slow the erosion rate at the Half Moon Bay shoreline by limiting the shoreline's exposure to wave energy. In the presence of the diffraction structure, a nourishment requirement of 250,000 cy at 10-year intervals is estimated to maintain the present shoreline configuration over the western portion of Half Moon Bay (approximately 2,000 feet). Alternative 3A would construct the same modified diffraction structure as described in Alternative 1B. However, Alternative 3A would place a higher volume of sand at the Half Moon Bay shoreline, as compared with Alternative 1B. Alternative 3A is designed to compensate for the historic beach erosion over the entire Half Moon Bay shoreline versus only the critical area most at risk of breaching as described in Alternative 1B. Similar to Alternative 1B, the expected method for beach nourishment would be hydraulic placement from a hopper dredge or truck from the Point Chehalis stockpile site.

As with Alternative 1B, Alternative 3A also proposes the removal of a portion of the submerged north jetty near the Oyhut Wildlife Recreation Area in order to mitigate for the loss of shallow sandy intertidal habitat, particularly salmonid habitat, from the construction of the modified wave diffraction structure.

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With Alternative 3A, the expected exposure of the jetty extension will result in a loss of about three acres of high elevation sandy beach, however this impact will be compensated for by the formation of several acres of lower elevation beach habitat adjacent to, and south of the extension, that will be far more biologically productive. Also, the jetty extension will be colonized by macroalgae such as rockweed, *Fucus* sp, and various invertebrates, adding to the overall increase in productivity of the area. Therefore mitigation for exposure of the jetty extension was not considered necessary.

6.4.4 ALTERNATIVE 4C – BREACH CLOSURE

The last breach fill occurred in 1994. Alternative 4C assumes that without intervention, in its present condition, a breach would reform within 5-10 years, and the Corps would re-establish or maintain land access to the South Jetty, for future repair or rehabilitation, immediately (within one dredging season) through emergency breach closure (Figure 23). This alternative would result in the discontinuation of the current practice (i.e. Alternative 1A).

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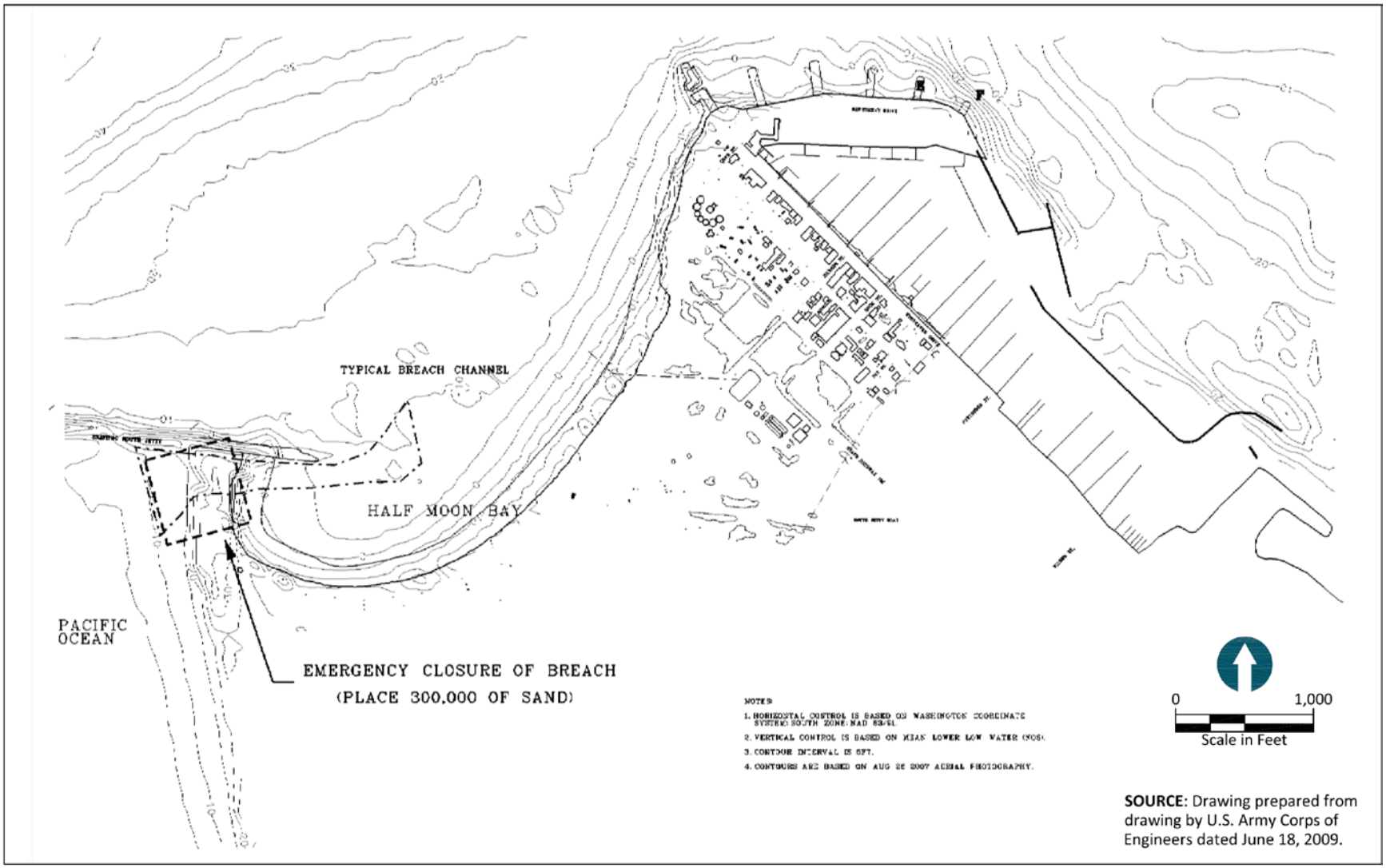

SOURCE: Drawing prepared from drawing by U.S. Army Corps of Engineers dated June 18, 2009.

Figure 23. Alternative 4C - Breach Closure (Immediate Response After Breach)

A breach is assumed to occur three times over the project design life, in light of the historical erosion rates and assuming no intervention. During construction, public access to South Beach would be relocated to a temporary corridor. Following construction and sand placement, American dune grass would be replanted on top of the dune and beach access would be re-established.

The source of the sand to complete the emergency breach fill would be from O&M dredged material. Clean dredged material would be hydraulically pumped to the breach. While the Corps would attempt to close the breach quickly, it may not be possible to conduct the work during severe storms. Based on the time the breach is left open, it is estimated 300,000 cy of sand would require placement and grading. Dredged material is anticipated to be placed using hydraulic placement from a hopper dredge similar to Alternatives 1B and 3A.

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7 ENVIRONMENTAL EFFECTS OF ALTERNATIVES

This section provides information on expected environmental effects for each of the alternatives, in terms of the environmental characteristics of the project area that were described in section 3, broadly divided into categories of physical, biological (including requirements under the Magnuson-Stevens Act), and human use. (In the human use category, potential noise effects are considered separately from potential air quality effects.)

7.1 EFFECTS ON PHYSICAL CHARACTERISTICS

The following section describes the potential impacts of the alternatives to bathymetry and geology, hydrology and hydraulics, water quality, and sediment quality within the project area. Impacts from dredging conducted as part of the Federal Navigation Channel O&M dredging are not considered in this document, even though material dredged through the O&M authority is considered for use under various alternatives. The environmental impacts associated with O&M dredging are described in *The Final Environmental Assessment, Fiscal Years 2012-2018 Maintenance Dredging and Disposal, Grays Harbor and Chehalis River Navigation Project* (USACE 2011).

7.1.1 BATHYMETRY AND GEOLOGY

Under Alternative 1A, long-term management of the project area would continue as currently practiced. Impacts to bathymetry and geology in the project area would include: 1) after the erosion of 15,000 cy of sand from the southwest corner of Half Moon Bay (trigger 1), placing of clean sand along 1,000 linear feet of beach in the southwest corner of Half Moon Bay shoreward of the +9 feet MLLW contour line, at its natural angle of repose to minimize impacts on intertidal ecology; or 2) after the breach fill footprint south of the South Jetty is overtopped by water from the west (resulting from a storm event; trigger 2), placing clean sand on top of the breach fill area above elevation +9 feet MLLW at a location within the fill footprint. The beach is dynamic and changes over time as waves, currents, and wind redistribute sand within Half Moon Bay. This alternative replaces only material lost from the breach area and does not restore all material lost from the project area. It is anticipated that erosion will continue at historical rates within the project area, requiring continual intermittent implementation of this alternative, i.e., sand placement, in order to maintain land access to the South Jetty. Thus, Alternative 1A affects the bathymetry and geology in the vicinity of the breach in the short term. Sand excavated from the Point Chehalis revetment stockpile site for project use would lower the elevation of the stockpile site by approximately 3 feet per typical excavation cycle. Overall, continual intermittent implementation of this alternative will not significantly impact the existing bathymetry and geology of Half Moon Bay.

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Alternative 1B—the preferred alternative—would have similar impacts as Alternative 1A, such as periodic beach nourishment to Half Moon Bay and South Beach. Alternative 1B would also include a modification to the existing wave diffraction structure in Half Moon Bay by adding stone along a 500-foot reach of the existing jetty root. The intent of the modified diffraction structure is to reduce the rate of erosion stemming from wave energy along the Half Moon Bay shoreline; however, given the distinct dynamics of crenulated bays, altering the terminal point at the east end of the South Jetty could gradually redefine the equilibrium shoreline both near- and far-field of the modified diffraction structure. These changes to hydrodynamics will have a long-term impact to the bathymetry near the South Jetty as compared to Alternative 1A. However, the modified diffraction structure will greatly reduce the erosion rate of the Half Moon Bay shoreline. This structure will have a beneficial impact for Alternative 1B as compared to Alternative 1A or the status quo in that it will result in a more stable beach for benthic invertebrate and fish habitation, and will result in a lower frequency of required beach nourishment.

Alternative 3A would impact the geology and topography due to the construction of a diffraction structure, extension of the existing South Jetty along Half Moon Bay approximately 1,828 feet, and placement of 250,000 cy of sand on the Half Moon Bay shoreline at approximately 10-year intervals.

Under Alternative 3A, the proposed project would be expected to undergo the same types of erosion processes impact to the project area bathymetry and topography as Alternative 1B. However, these effects would be longer term due to the construction of the modified diffraction structure and jetty extension, which will alter hydrodynamics in and around the structure. These changes to hydrodynamics would have a long-term impact to the bathymetry of the project area.

Additionally, under Alternative 3A, an 1,828-foot extension of the South Jetty would be constructed at the location with a top width of 30 feet and top elevation of +22 feet MLLW. Approximately 130,000 cy of sand excavated from the jetty extension footprint would be placed on the Half Moon Bay shoreline and graded. In the long term, erosion along South Beach could expose the jetty extension structure resulting in the deepening of the bathymetry adjacent to the structure. The construction of an additional structure is anticipated to produce additional changes to local hydrodynamics; Alternative 3A is expected to have greater impacts on the status quo than Alternatives 1A and 1B due to continual erosion of South Beach adjacent to the jetty.

Under Alternative 4C, the more immediate impacts to bathymetry and topography include the formation of a breach within 5-10 years, in light of the absence of preventive action.[7]

[7] Alternative 4C would entail termination of the present management regime – i.e., the interim action plan initiated in 2005, which is intended to avert an undue risk of breach formation. Thus, the scope of environmental effects of implementation of

Hydrodynamic simulations of the project area under breach conditions indicate that likely impacts to bathymetry include an increase in sediment transport out of Half Moon Bay toward the Federal Navigation Channel, filling of the channel due to this transport and potential reduction in scouring due to an attenuation of ebb tidal flows, an increased potential for scour at the eastern end of the South Jetty, and deposition of sediment within Half Moon Bay (Wamsley et al. 2006). In the long term, these impacts would likely be limited and diminish following the closure of the breach with 300,000 cy of sand. Bathymetric impacts would be temporary due to the limited time breach conditions would be present. Compared to Alternatives 1A, 1B, and 3A, Alternative 4C has the greatest potential to impact bathymetry within the project area during the short term because a breach is allowed to form.

7.1.2 HYDROLOGY AND HYDRAULICS

7.1.2.1 Tides

Implementation of any of the alternatives is not expected to impact tidal elevations in the vicinity of the project area.

7.1.2.2 Currents

Impacts to currents in the vicinity of the project area are not anticipated under Alternative 1A. Currents are expected to continue to regrade and redistribute sand along the shoreline and offshore areas.

The modified diffraction structure proposed for Alternative 1B could impact currents within Half Moon Bay. In particular, the longshore and cross-shore sediment transport of sand would be altered to minimize erosion to the breach fill area along the western shoreline of Half Moon Bay. This may result in increased longshore transport of sediment from the southern portion of Half Moon Bay; however, the impacts will likely be benign as the beach is much wider and mildly sloping in this area.

Under Alternative 3A, potential current impacts associated with the modified diffraction structure would be similar to those proposed under Alternative 1B. Additionally, in the long term, if the jetty extension is exposed on the oceanside, nearshore current patterns could be modified on South Beach, potentially resulting in changes to the rip current commonly utilized by surfers along the South Jetty. Alternative 3A has a potentially greater impact on currents than Alternatives 1A or 1B.

Alternative 4C would extend to both the effects of a naturally occurring breach, as well as the subsequent Corps action to re-close that breach.

Regarding currents at the Oyhut Wildlife/Damon Point mitigation site near the North Jetty, removal of the western and eastern ends of the relic jetty would increase tidal flow and currents locally.

After a breach has formed under Alternative 4C, current patterns in Half Moon Bay and along South Beach would temporarily change to some degree until the breach was closed. The breach would allow flow to pass between Half Moon Bay and the ocean to the south of the jetty, which does not occur in non-breach conditions. These temporarily changed patterns are not expected to result in any substantial impacts on project area ecological resources. After the breach is closed, it is anticipated that currents would return to pre-breach patterns.

7.1.2.3 Waves

The actions implemented under Alternative 1A are not anticipated to impact waves within the project area.

Alternative 1B would be expected to have minimal impacts to waves within the project area following beach nourishment due to the size of the proposed fill. The fill would move the shoreline seaward and, thus, have some impact to the location of the surf zone immediately following placement. However, historical erosion rates will be reduced, and over time, the beach will become more mildly sloping near the breach fill.

Under Alternatives 1B and 3A, the modified diffraction structure would alter wave directions and heights in its vicinity and, therefore, reduce wave energy reaching the shoreline of Half Moon Bay. It is likely wave energy would be redistributed toward the south-southeast shoreline of Half Moon Bay. These altered wave directions and heights would not be expected to substantially impact Half Moon Bay environmental resources.

The removal of a portion of the submerged jetty on the north side of the entrance to Grays Harbor could also increase wave energy reaching the Oyhut Wildlife Recreation Area (WRA). These increases in energy are not expected to substantially impact fisheries, bird populations or invertebrate populations in the shoreline area at Oyhut WRA.

Under Alternative 4C, the primary impact to waves could occur during breach conditions. During breach conditions, west-southwest storm waves could propagate through the breach resulting in hydrodynamic conditions within Half Moon Bay that do not exist at present (non-breach conditions). At these times, impacts to waves from Alternative 4C would be greater than from Alternative 1A. It is difficult to evaluate the relative magnitude of impacts to waves between Alternative 4C and Alternatives 1B and 3A.

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Alternative 4C would also cause changes to wave patterns within the breached area. After the breach is filled, no long-term impacts to waves within the project area are anticipated. However, there is the possibility that significant infilling of Half Moon Bay by sediment eroded from the breach location during breach conditions may alter the wave patterns within the bay in the long term.

7.1.2.4 Sea Level Rise

Sea level rise could gradually intensify the effects of erosion along the Half Moon Bay and South Beach shorelines. While no modeling has been conducted, Corps experts are of the opinion that a gradual rise in sea level over the next 50 years could gradually create additional intertidal habitat, as the increased sea level height would draw additional sand from upland nourishment sites into Half Moon Bay, thereby raising the elevation of the seabed. This effect would also result in somewhat increased frequency of beach nourishment required to keep pace with gradually increasing beach erosion. Overall, gradual sea level rise would have minor but not significant long-term impacts on the four evaluated alternatives or the quality of the human environment.

7.1.2.5 Water Quality

Water quality impacts associated with all the alternatives would typically be due to increases in turbidity from sand and riprap placement activities or erosion. In the cases of Alternatives 1A, 1B, and 3A, water quality impacts attributed to erosion would likely be similar to those of natural processes because of the similarity between the placed and existing materials. For Alternatives 1B and 3A, nourishment sand placed at and above the EHW line is intended to nourish the nearshore environment and minimize dune retreat. It will therefore continuously erode into the intertidal zones and eastward as a result of natural forces, including wave action, wind, and storm events. This process will continue until the placed nourishment sand is exhausted. The nourishment process will have temporary minor impacts on water quality (primarily increased turbidity and slightly decreased dissolved oxygen) during and after placement times, but over the long term (several months following placement), water quality impacts are not expected as the smaller silt particles that are responsible for turbidity conditions will eventually be diluted and carried away from the project area. This is true whether the sand will be placed by hydraulic means or mechanically following truck transport, both using traditional best management practices (BMPs).

To ensure that the construction of the preferred alternative will conform to state water quality standards, the Corps will request a water quality certification (WQC) through the promulgation of this draft EA, and will obtain the WQC prior to finalizing the EA.

Under each alternative, temporary increases in turbidity and an associated temporary reduction in DO would be realized during sand placement. There is a potential for fuel,

hydraulic fluid, or other spills from heavy equipment to occur during placement; however; the potential for spills to occur will be minimized through the use of BMPs. Material to be placed will be screened for suitability for placement prior to being placed, and only material meeting screening criteria will be used. Therefore, no impacts from contaminated sediments are expected.

As stated above, impacts to water quality with Alternative 1A would occur due to nourishment sand continuously (and purposefully) slowly eroding and entering intertidal areas where it would produce temporary and minor turbidity due to the washing of fine silty material associated with the sand.

Alternative 1B would have less impact on Half Moon Bay shoreline water quality in the long term compared to Alternative 1A, due to the projected decreased frequency of placement (every 10 years for Alternative 1A vs. every 5-10 years for Alternative 1B). The temporary impact would be due to short-term increases in turbidity, and slightly decreased dissolved oxygen, during each placement event. Turbidity would be controlled through the use of beach-sand containment dikes around the placement footprint, through which the decant water would filter prior to returning to waters of the U.S. Construction of the modified diffraction structure would also result in short-term, minor impacts from silt-caused turbidity and lowered dissolved oxygen, limited to the period of construction. Alternative 1B also would have water quality impacts to the high beach on the Pacific Ocean side if a required trigger is met necessitating the placement of 52,000 cubic yards of sand. Impacts would result from very gradual erosion of material into the ocean especially during high tides and storm surges. Overall, Alternative 1B would have less water quality impact over the years than Alternative 1A.

Under Alternative 3A, impacts to water quality would occur during the construction of the modified diffraction structure, the construction of the 1,828-foot jetty extension, the initial placement of 130,000 cy of material along the bay's intertidal shoreline, and periodic placement of 250,000 cy of nourishment material along the shoreline. Erosion of the beach area west of the jetty extension would eventually, after several years, cause minor elevated turbidity conditions at South Beach due to loss of the beach resulting from the jetty extension. These construction and maintenance activities would all result in periodic, short-term and temporary elevated turbidity levels and a temporary reduction in dissolved oxygen. In comparison to Alternatives 1A and 1B, water quality impacts with Alternative 3A would be relatively greater, but still only minor in nature, periodic and short-term.

The primary water quality impacts under Alternative 4C would be due to elevated turbidity from the natural movement of sand and silt into the bay due to currents and tidal action following breach formation, material placement during closure of the breach, and gradual

erosion of placed material along the bay shoreline by natural sediment processes. As with the other alternatives, the placement and movement of sand and silt would result in temporarily increased turbidity and lowered dissolved oxygen levels. Overall, water quality impacts from this alternative would be roughly comparable to those of Alternatives 1A, 1B and 3A.

Overall, implementation of any of these alternatives would result in short-term, minor impacts on turbidity and dissolved oxygen levels, but the materials placed would be selected so as not to contain any contaminated material. Implementation of any of these alternatives would not result in a significant impact on the project area water quality.

7.1.2.6 Sediment Quality

Sand placed within the project area will be obtained from various sources, such as the Point Chehalis revetment stockpile site (composed of material derived from channel dredging) and Federal Navigation Channel O&M dredging. Sand from these sources is generally consistent with existing grain size of material found in the project area, and it is not expected to significantly impact project area sediment quality. Nourishment material to be placed will be from outer Grays Harbor O&M maintenance areas where historical periodic testing and laboratory evaluations using the multi-agency dredged material management plan (DMMP) rigorous standards and screening criteria have demonstrated it to be primarily clean sand and silt with no or low contaminant concentrations, suitable for open-water and upland disposal. Therefore, use of these sands with any of the alternatives will not have a significant impact on the human environment.

7.2 Effects on Biological Characteristics

7.2.1 Habitat and Vegetation

This section primarily describes habitats in the project area that would be affected by each alternative. Habitats described are: rock jetty, subtidal sand flats/sandy intertidal, sand dunes/dune grass, and wetlands. Section 7.2.2. then describes groups/species of organisms that reside in these habitats and the degree to which they would, or would not, be affected. Groups addressed in 7.2.2. are: zooplankton and benthic invertebrates, fish, birds, and turtles.

The project area consists of a rocky jetty (South Jetty), subtidal sand flats, mostly sandy intertidal beaches (Half Moon Bay and South Beach), and sand dunes. The Half Moon Bay shoreline is a mix of gravel, rock, and sand, while the South Beach shoreline is primarily sand. Freshwater wetlands are located in the project vicinity but would not be impacted by the project, because they are outside of the area where any project activities would take place.

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Primary macroalgae vegetation present in the project area is rockweed (*Fucus* sp.) and sea lettuce (*Ulva lactuca*). These species are attached to rocky riprap remnants east of the South Jetty's eastern end At times, bull kelp (*Nereocystis luetkeana*) has been observed also attached to the existing riprap and remnant riprap (USACE 2004). These algae perform several ecological functions, including the provision of habitat for small fishes and various invertebrate species, and contribution of detritus into the bay food web. Alternatives 1A and 1B would include construction of the modified diffraction structure which would cover over the areas of remnant jetty rock riprap as indicated above. However, the new riprap would be quickly colonized by these algal species and there would be no substantial loss of habitat or provision of ecological functions.

Native dune wild rye is present within the project area on sand dunes and would be impacted through sand placement for Alternatives 1A, 1B and 3A and by the breach itself in Alternative 4C. This impact would be mitigated by planting dune wild rye in the project area as appropriate soon after construction is completed, as was successfully done in the early 2000s after similar nourishment actions at Half Moon Bay.

The creation of the modified diffraction structure in Alternatives 1B and 3A would result in burial of about two acres of subtidal sand flats and relic jetty stone, but this is a minor impact as there are hundreds of acres of such habitat along the south shore of Grays Harbor. Mitigation for this loss would involve removal of 100 feet of riprap from a partially submerged, remnant rock jetty at Oyhut Wildlife Recreation Area near Damon Point at the north side of the Grays Harbor entrance channel. This would allow fish access to the small bay at all tidal levels and invertebrate colonization of several acres of subtidal sandy habitat. Overall, none of the project alternatives would result in significant impacts on project area vegetation.

7.2.1.1 Rock Jetty

Alternatives 1A and 4C would not impact existing rock jetty habitat, because project elements would not occur in this habitat zone. Alternatives 1B and 3A would increase rock jetty habitat in the project area by the construction of a modified diffraction structure that would extend the South Jetty 500 feet to the east. This modification to the existing diffraction structure would result in a conversion of about two acres of subtidal sand flat habitat to hard substrate habitat in Half Moon Bay. The diffraction structure would slow erosion and reduce the frequency and quantity of nourishment required for the Half Moon Bay shoreline, which would lend the beach more stability and less ecosystem disruption. The structure would provide about two additional acres of rocky habitat that would be used by various invertebrate and fish species preferring this habitat type, but it would cover a subtidal sandy habitat that is preferred by infaunal benthic invertebrates and various fishes. However, this impact zone would cover only an area of about two acres compared to several hundred acres of this same habitat type in the project vicinity and outer Grays Harbor. The

structure would also cover over small populations of rockweed (*Fucus* sp.) and sea lettuce (*Ulva* sp.), macroalgae presently inhabiting rock jetty remnants east of the present jetty. However, the modified diffraction structure would provide approximately 1,000 lineal feet of new riprap habitat that would be colonized by these macroalgal species.

The diffraction structure would extend the nearshore distance travelled by nearshore obligate emigrating salmonids by about 1,000 feet, as they proceed for their final emigration to the Pacific Ocean, only a few hundred feet from Half Moon Bay. An additional project feature to reduce fish predator habitat availability along the diffraction structure would be the placement of small angular rock to fill interstices within the rock riprap on the south side of the diffraction structure. Refer to section 7.2.2 for species effects due to rock jetty construction. Overall, none of the project alternatives will result in significant impacts to rock jetty habitat.

7.2.1.2 Subtidal Sand Flats/Sandy Intertidal

All four alternatives would result in a loss of existing sandy intertidal habitat due to sand placement and/or migration. With Alternative 1A, when 15,000 cy of sand has eroded from the southwest corner of the Half Moon Bay shoreline, sand would be deposited along 1,000 feet of beach in the same area to replace the eroded sand. Alternatives 1B and 3A would reduce the frequency of sand placement compared to Alternative 1A due to the protection from wave action afforded by the modified diffraction structure. Placement of approximately 110,000 cy of sand every 10 years (1B) or 250,000 cy of sand every 10 years (3A) at the western shoreline in Half Moon Bay would cover intertidal sandy beach habitat. Also, with Alternative 3A there would be a gain of intertidal and shallow sandy habitat due to the jetty extension allowing waves and currents to gradually lower the beach profile south of the extension. This would provide opportunities for benthic invertebrates to colonize this habitat that is periodically or continually inundated by ocean waters, increasing biological productivity of the area. With Alternative 4C, the estimated frequency of filling the breach is unknown. With a breach, fine sands would be carried by wave and current actions from South Beach to Half Moon Bay intertidal and shallow subtidal areas, especially during and after storm events.

With all alternatives, sand placement and/or movements via tidal currents and wave action would affect intertidal habitat used by benthic invertebrates, such as gastropods, amphipods, decapod crustaceans (crab) and various infaunal species, including polychaetes. But the placed sand would derive from compatible marine sources. Furthermore, affected habitat would quickly recover as new populations of benthic invertebrates colonize new sandy habitat, from adjacent areas.

The proposed jetty extension under Alternative 3A would result in the erosion of the ocean beach located primarily above high tide at the north end of South Beach. Sand would

gradually be transported by wave action out of the area leaving a jetty and rocky beach shoreline. The jetty extension would initially be buried by sand, but would eventually be exposed by erosive forces, resulting in the formation of a steep rocky exposed face. This loss of sandy upper beach area would not be significant as the area is considered to be harsh habitat for plants and small insects and is devoid of macroaquatic vegetation and is a very small area compared to the abundant similar habitat in outer harbor shorelines. As for the jetty extension, benthic invertebrates and fish able to successfully utilize/inhabit rocky riprap areas would colonize the jetty extension at each species' preferred tidal heights.

Under Alternatives 1A, 1B and 3A, sandy intertidal beach habitat would be covered with various quantities of sand across different tidal ranges depending on the quantity of sand placed. Alternative 4C would result in sand movement from South Beach into Half Moon Bay covering intertidal areas until the breach was repaired. Sand placed in intertidal areas would be colonized by benthic invertebrates and fish populations, generally expected within one year.

With Alternatives 1B and 3A, the 2-acre subtidal area impacted by the new diffraction structure will not be totally offset on a 1:1 geographic basis by removal of remnant jetty ends near the North Jetty; however, there is likely to be a disproportionately greater positive effect to fish and invertebrate communities that inhabit the bay near the North Jetty mitigation area as compared to the negative effects to fish and invertebrates caused by the modified diffraction structure. This is because removal of remnant jetty riprap will allow access to several times as much habitat in the North Jetty area as would be covered by the modifications to the diffraction structure. Also, a large amount of very similar habitat already exists in outer Grays Harbor. Mitigation to offset the two-acre loss of sandy habitat involves the removal of portions of the remnant jetty near North Jetty that will provide several hundred feet of excellent and protected nearshore habitat for juvenile salmonids emigrating along the northern Grays Harbor shoreline and into the bay near Damon Point and the North Jetty. Removal of riprap there will also allow the availability of several acres of shallow subtidal habitat (now blocked by the remnant jetty) at all tidal levels for colonization by invertebrates, including various crab and fish species. Alternative 4C would allow a breach to form between South Beach and Half Moon Bay, causing movement of sand into Half Moon Bay. Effects of sand movement into Half Moon Bay would be similar to those of Alternatives 1B and 3A by covering of existing habitat. Overall, none of the project alternatives would result in significant impacts to sandy intertidal or subtidal habitat.

7.2.1.3 Sand Dunes/Dune Grass

Terrestrial vegetation and sand dune habitat would be affected by Alternatives 1A and1B, because sand would be placed over existing native dune wild rye habitat. With Alternative 3A, the jetty extension rock will initially be covered over by sand/dunal habitat but as the beach and dune area is gradually eroded over time and the jetty extension rock is exposed,

there will be an eventual loss of approximately three acres of dune habitat and an equal gain of rock riprap habitat. This would be a very gradual process and the loss of beach sand dune habitat s considered very minor in view of the fact that there are hundreds of acres of such habitat in the project vicinity. Also, the extension would eventually be colonized with macroalgae, such as rockweed (*Fucus* sp) and various invertebrates, adding to biological productivity of the project area. With Alternative 4C, a gradual loss of upland dune habitat and dune grasses would occur in the high intertidal and upland areas between South Beach and Half Moon Bay as these areas underwent erosion and breach formation.

Under all alternatives, minor effects on native dune wild rye would occur as a result of construction, including due to equipment that is used to transport rock and sand; however, care would be taken to minimize impacts, and existing roads would be used whenever possible.

For all the alternatives, the Corps would mitigate the loss of native dune wild ryegrass by replanting this grass following standard practices after construction is complete. None of the alternatives would be expected to have significant impacts on terrestrial vegetation or sand dune habitat in the long term.

7.2.1.4 Wetlands

Because wetland habitat and vegetation is outside of the project area, the project will not impact these habitat types in Grays Harbor.

7.2.2 BIOLOGICAL EFFECTS

The degree and intensity of predicted adverse biological effects vary with each of the alternatives in terms of type of habitat impacted, project design, and the utilization of project area habitat by specific groups of organisms.

7.2.2.1 Zooplankton and Benthic Invertebrates

Several project components within each alternative would affect localized zooplankton and benthic invertebrate populations due to short-term increases in turbidity and decreases in water quality from construction activities with all the alternatives. Benthic invertebrate populations would also be affected due to habitat conversion, and direct burial. These actions include placement of the modified diffraction structure (Alternatives 1B and 3A), construction of a temporary road (Alternatives 1A, 1B, and 4C), and completion of the jetty extension along Half Moon Bay (Alternative 3A).

Loss of 2 acres of subtidal benthic invertebrate habitat in the footprint of the modified diffraction structure proposed in Alternatives 1B and 3A will not be totally offset on a 1:1 geographic basis by removal of remnant jetty ends near the North Jetty (See section 7.2.1.2.); however, there is likely to be a disproportionately greater positive effect to invertebrate

communities that inhabit the bay near the North Jetty mitigation area compared to the negative effects to invertebrates caused by the modifications to the diffraction structure. This is because proposed removal of two 50-foot ends of remnant jetty riprap near the North Jetty will provide access to several times as much similar habitat in the North Jetty area at all tidal levels for mobile, sand-dwelling invertebrates as would be covered by the diffraction structure. Also, the 2-acre area affected by the diffraction structure is very small compared to similar habitat in the entire outer Grays Harbor area. Regarding the diffraction structure, it would provide habitat for mobile and attached invertebrates that can successfully colonize rock riprap surfaces and niches.

Placement of sand in Alternatives 1A, 1B, and 3A would occur in intertidal and shallow subtidal areas and would result in the disruption and loss of immobile or slowly mobile benthic invertebrates. This would also occur with expected movement of sands through the breach area in Alternative 4C. The impact to benthic invertebrate populations would be significant with Alternative 3A as (1) very large quantities of sandy nourishment material (ca. 350,000 cubic yards) would be initially placed in productive intertidal and shallow subtidal areas in the bay compared to Alternative 1B (ca. 110,000 cy), and (2) additional large quantities (250,000 cy) of sand would be placed on the same beach at approximately ten-year intervals. These quantities would significantly impact the current stable benthic community by covering over whole populations of invertebrates over a relatively large area. Recolonization of the large impact area will gradually take place but a stable benthic community equivalent to the existing community will take several years. Zooplankton populations inhabit the water column above beach substrate and would not be seriously impacted by any of the alternatives.

None of the project alternatives has the potential to substantially impact Pacific razor clams, (Siliqua patula) because this species does not inhabit Half Moon Bay and is not common in the project area at South Beach. Although Alternative 1B involves placement of 52,500 cubic yards of sand at South Beach when a trigger is met to prevent breaching, it would be placed largely in the higher intertidal zones (above + 9.0 feet) and therefore would not affect Pacific razor clam preferred habitat.

Dungeness crab (*Cancer magister*) typically have only a minor, scattered presence in Half Moon Bay (Burkle 2005). Any adults present in the bay during construction of the modified diffraction structure in Alternatives 1B and 3A would likely move from the area unharmed as they are a highly mobile species sensitive to noise and vibration. It is possible that random individuals could be buried by rock riprap and large quantities of sand. Relative to beach sand placement, Alternatives 1A, 1B and 4C would have no effect on Dungeness crab as the placement of sand for these alternatives would be in higher elevation areas not typically inhabited by the species. Overall, due to the paucity of this species in the project area and

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their high reactivity and mobility, none of the alternatives would significantly impact their population in the project vicinity.

Under Alternatives 1B and 3A, removal of a portion of a partially submerged jetty at Oyhut Wildlife Recreation Area near Damon Point would create access to approximately 200 acres of excellent intertidal and subtidal habitat for adult Dungeness crabs, that currently is not accessible for these benthic inhabitants due to access blockage by the jetty.

7.2.2.2 Fish

Fish expected to be in the project area primarily include forage fish and salmonids; however, other species may use the project area during various life stages. Table 3 (page 37) provides a list of documented fish species in Grays Harbor that could be present in the project area.

Though potential spawning habitat for surf smelt and Pacific sand lance exists in the project area, project activities will occur in areas that have not been documented as forage fish spawning areas. Additionally, sampling conducted by the Corps in Half Moon Bay yielded no forage fish eggs (R2 Resource Consultants, Inc. 2005). Coordination with WDFW will occur at the time of consultation with the USFWS to ensure that project activities are not conducted during forage fish spawning seasons. The greatest potential for impacts to forage fish and salmonids would be expected to occur by burial during placement of stone for the modified diffraction structure (Alternatives 1B and 3A) and by burial during placement of sand (Alternatives 1A, 1B and 3A). Impacts to fish are expected to be short term and localized.

Agency-set environmental work "windows" (times when construction will least impact various species) for salmonids, including bull trout, are in place in Half Moon Bay and vicinity, and construction will proceed only during approved resource agency dates in order to minimize any project impacts on these species during their juvenile life stages.

With Alternative 1B, the additional 1,000 feet perimeter of riprap on the modified diffraction structure would have some impact on juvenile salmon and bull trout due to the increased length of this habitat, inhabited periodically by fish and bird predators, that they would need to swim along as they approach the ocean. However, a previous Corps' study involving juvenile chinook salmon stomach contents analyses (USACE, 2004) indicated that they fed in and around the Westport Marina and consumed large quantities of amphipods that typically inhabit marina pilings. At that time, sampling in Half Moon Bay did not find juvenile salmonids in high numbers, indicating that they had already migrated to the ocean and did not spend time in Half Moon Bay. Whether or not this was merely a one-time event is not known, but it is still presumed that some salmon populations will migrate at least in part along the Half Moon Bay shoreline.

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Nevertheless, salmonids, including bull trout, may be present in the project area during construction; however, these salmonids are expected to be either emigrant juveniles or adult immigrants and, therefore, very mobile. Due to this mobility, it is anticipated that they would be able to avoid direct construction impacts. Impacts to prey resources are expected to be minimal and temporary.

Burial of forage fish could occur to a minor extent during placement of stone as part of construction of the diffraction structure. Alternatives 1A, 1B and 3A have the potential to also cause impacts to forage fish and salmonids via placement of sediment in the intertidal zone of Half Moon Bay. Placement of sand and subsequent distribution by wave and current actions could potentially cause burial of some fish and would result in temporary increases in turbidity, which may cause clogging of gills and feeding apparatuses of fish and filter feeding invertebrates.

Under Alternatives 1B and 3A, the planned mitigation (i.e., the removal of a portion of a submerged jetty near the Oyhut Wildlife Recreation Area and Damon Point) would create access to nearly 200 acres of intertidal and shallow subtidal sand flat habitat for fish, especially salmonids, that otherwise would not be accessible. Removal of the eastern and western ends of the submerged jetty would allow increased access to high intertidal sandy beaches in the Oyhut Wildlife Recreation Area, for potential forage fish spawning areas at all tidal stages. This fish access to about 200 aces of intertidal and subtidal habitat and 1.5 miles of shoreline contrasts favorably with the loss of approximately 2 acres of similar habitat that will be covered by the modified diffraction structure and another 2 acres from periodic sand placement along the Half Moon Bay shoreline. With Alternative 4C, the breach could have considerable impacts on fish resources inhabiting the breached area when exit from this area could relatively quickly be closed off during and after storms, trapping these fish for long periods during which time dissolved oxygen concentrations in ponded areas would likely become very low. Impacted fish could include juvenile salmonids attempting to emigrate to the ocean.

Impacts to forage fish and salmonids from increased turbidity that are less than significant and short-term may occur under all alternatives. Turbidity would be localized and most fish species, particularly salmonids, actively avoid turbidity plumes (Bash et al. 2001). By following BMPs used routinely for these project types during construction, impacts to fish are expected to be short term and insignificant. In addition, the placement of sand would occur during a time when particularly sensitive life history stages (e.g., out-migrating juvenile salmon) are not present in significant numbers in the project vicinity.

7.2.2.3 Birds

Birds have the potential to be impacted by all alternatives, primarily through short-term disturbances due to construction activities. Impacts to bird populations using Half Moon Bay

would be short term and insignificant due to the abundance and diversity of birds in this area.

With Alternative 1A, the current practice of periodic sand placement activities is not expected to have a significant impact on bird roosting in the project vicinity. During construction of the jetty extension in Alternative 3A, the sand dunes and roosting habitat (during very high tides) would be disrupted; however shortly after completion of construction, the jetty would be covered with sand and bird roosting habitat would return to pre-construction conditions. Assuming erosion of the South Beach shoreline would occur due to the jetty extension construction there would be a minor, gradual loss of bird roosting habitat.

Construction of the modified diffraction structure in Alternatives 1B and 3A would likely disturb species of birds that use the South Jetty riprap habitat, including black oystercatchers, ruddy and black turnstones, surfbirds, rock sandpipers, and wandering tattlers. There would be little or no effect to these species during construction because they can travel to nearby areas to roost without detrimental impacts. After construction of the modified diffraction structure under Alternative 1B or 3A, these species could also utilize the new diffraction structure and newly placed sand nourishment areas of the bay.

Western snowy plover nesting does not occur at South Beach. However, there are known nesting areas in the Oyhut Wildlife Recreation Area near where mitigation is proposed under Alternatives 1B and 3A. Primary disturbances to birds as a result of this work would occur through project construction activities. Steps would be taken to ensure that removal of the east and west ends of the submerged jetty would occur outside of nesting periods. The uncovered jetty extension that would gradually uncover over time would not be expected to impact shorebirds or waterfowl in the project vicinity. Mitigation planned at the Oyhut Wildlife Recreation Area near Damon Point is expected to result in improved habitat conditions for western snowy plover.

Species of birds that also use Half Moon Bay for roosting are killdeers, semipalmated plovers, and western sandpipers. Under Alternative 3A, these species would be temporarily disturbed by placement of material at the Half Moon Bay shoreline. Disturbance would be short term and occur during construction activities. With Alternative 4C, the eventual formation of a breach between Half Moon Bay and South Beach would not be suitable for roosting or nesting activities as discussed above, until responsive sand placement re-closed the breach.

In conclusion, based on the availability of identical nesting and roosting habitat in the immediate vicinity of the project, and on the high mobility of bird species, none of the alternatives would have a significant impact on bird populations or their habitat.

7.2.2.4 Turtles

It is highly unlikely that turtles would enter the project area, because they generally occur in offshore areas. If turtles were to enter the area, they would likely be dissuaded from the project area due to noise and overall disturbance associated with construction activities.

7.2.2.5 Mammals

Several marine mammal species occur outside of the project area and could transit the project area. The most likely species of mammals to be present in the project area include pinnipeds, such as California sea lions and harbor seals, which may occasionally use the South Jetty for a haul-out site. For all the alternatives, California sea lions and harbor seals would likely avoid the project area during sand placement activities due to the noise associated with these activities. Under Alternatives 1B and 3A, California sea lions and harbor seals may also avoid haul-out sites located close to the construction area for the modified diffraction structure during dredging and stone placement. The diffraction structure may result in a larger haul-out site for these species on the diffraction structure, once complete.

Alternatives 1B and 3A both include mitigation through partial removal of submerged jetty segments at the Oyhut Wildlife Recreation Area near Damon Point. The removal of jetty ends will provide access to the 200-acre bay at all tidal levels for marine mammals.

7.2.2.6 Effects Determination Summary for Species Listed as Threatened or Endangered Under Endangered Species Act, Marine Mammal Protection Act, Bald and Golden Eagle Protection Act, Migratory Bird Treaty Act, and Essential Fish Habitat

7.2.2.6.1 Endangered Species Act

Several threatened and endangered ESA-listed species have the potential to occur within the project area. The Corps is preparing a biological evaluation (BE) to address impacts to ESA-listed species and their designated critical habitat. The Corps will initiate Section 7 consultation with NMFS and USFWS when the BE is completed. The Corps has determined that the effects to the ESA-listed species in the project area are "may affect, not likely to adversely affect" any of the species listed in Table 17. Also, there will be no adverse effects to the designated critical habitats listed in Table 17. Consultation with NMFS and USFWS will be completed prior to finalization of the EA.

Table 16 indicates the anticipated effects determination for each ESA-listed species and critical habitat with the potential to occur in Grays Harbor. Determinations are based on how the construction and operation of the project may affect ESA-listed species and their critical habitat.

Table 17. Effects to ESA-Listed Species with the Potential to Occur in Grays Harbor

Common Name	Scientific Name	Critical Habitat	Effects Determination Species/Critical Habitat
Bull trout	*Salvelinus confluentus*	Designated	NLAA/NLAA
Lower Columbia River ESU Chinook salmon	*Oncorhynchus tshawytscha*	Designated	NLAA/NE
Columbia River Chum salmon	*Oncorhynchus keta*	Designated	NLAA/NE
Upper Willamette River Chinook salmon	*Oncorhynchus tshawytscha*	Designated	NLAA/NE
Green sturgeon	*Acipenser medirostris*	Designated	NLAA/NLAA
Pacific eulachon	*Thaleichthys pacificus*	Proposed	NLAA/NA
Western snowy plover	*Charadrius alexandrinus nivosus*	Designated	NLAA/NLAA
Marbled murrelet	*Brachyramphus marmoratus*	Designated	NLAA/NE
Leatherback sea turtle	*Dermochelys coriacea*	Proposed	NE/NA
Loggerhead sea turtle	*Caretta caretta*	None designated	NE/NA
Green sea turtle	*Chelonia mydas*	Designated	NE/NE
Olive Ridley sea turtle	*Lepidochelys olivacea*	None designated	NE/NA
Humpback whale	*Megaptera novaeangliae*	None designated	NE/NA
Steller sea lion	*Eumetopias jubatus*	Designated	NE/NE
Blue whale	*Balaenoptera musculus*	None designated	NE/NA
Fin whale	*Balaenoptera physalus*	None designated	NE/NA
Sei whale	*Balaenoptera borealis*	None designated	NE/NA
Sperm whale	*Physeter macrocephalus*	None designated	NE/NA
Southern resident killer whale	*Orcinus orca*	Designated	NE/NE

Notes:
This table has been modified slightly from Table 2 in Corps 2000.
NA = Not Applicable
NE = No Effect
NLAA = Not likely to adversely affect
Designated = Critical habitat has been designated for the species
Proposed = Critical habitat has been proposed for the species

<u>Marbled Murrelet.</u> The project may have short-term effects on marbled murrelet foraging because of increases in turbidity and anthropogenic noise. However, these effects would be temporary and occur only during project activities. Only adult marbled murrelets are known to occur in the open-water areas in Grays Harbor during various times of the year (Speich and Wahl 1995). As stated earlier, marbled murrelets are relatively opportunistic foragers;, which likely enables them to respond to changes in prey abundance and location (USFWS 1996). Also, forage fish, a common marbled murrelet prey, would incur only temporary effects from any of the alternatives and are not expected to incur any impacts that would affect their long-term abundance in the project area. Therefore, the project "may affect, not likely to adversely affect," marbled murrelets. As no suitable nesting habitat is in the project

area, the project is not expected to impact their nests or nesting habitat. The project would have no effect on critical habitat for marbled murrelets.

Western Snowy Plover. None of the four alternatives, including 3A with the eventual exposure of the western jetty extension, would occur in the vicinity of western snowy plover roosting or nesting habitat, with the exception of the mitigation plan areas proposed for Alternatives 1B and 3A, across the harbor from Half Moon Bay. The mitigation proposal, involving a partial jetty removal at its western and eastern ends, would occur near designated critical habitat; however, the conservation measure of removing the remnant ends outside of the nesting period would prevent any substantial impacts to these birds. Also, though removal of the jetty remnant ends would allow some increased wave action into the embayment, according to Corps coastal engineers, the waves would be directed towards the north coastline, and away from snowy plover habitat. This mitigation site at Oyhut Wildlife Recreation Area near Damon Point would provide improved habitat for western snowy plover resulting in a beneficial effect to both the species and critical habitat. The effect determination for the preferred alternative is "may affect, not likely to adversely affect," for western snowy plover. For designated critical habitat of the western snowy plover, the effect determination for the preferred alternative is "may affect, not likely to adversely affect."

Lower Columbia River Chinook Salmon, Columbia River Chum Salmon and Upper Willamette River Chinook Salmon. Life history stages of all three species in the project area are expected to be emigrant juveniles and adult fish, both of which are highly mobile and able to avoid potential construction activities. Chinook and chum salmon presence would be limited to life history stage transiting or foraging in the project area. They would likely avoid project construction activities largely due to project noise. Chinook and chum salmon prey species, including forage fish, and macro and micro invertebrate species, would incur only minor effects from any of the alternatives and are not expected to incur any impacts that would affect their long-term abundance in the project area. For Alternatives 1B and 3A, the modified diffraction structure would provide an opportunity for some predation on juvenile salmon by larger fishes, including ling cod. This impact will be minimized by the insertion of small angular rock in rock riprap interstices on the southern side of the diffraction structure, thereby reducing preferred habitat for these predators. Predation impacts will not have significant impacts on the juvenile salmon migration as in general the juveniles are largely outmigrating offshore by the time they reach the outer harbor. Overall, none of the alternatives will result in significant impacts to these juvenile salmon species. Therefore, the project "may affect, not likely to adversely affect," Lower Columbia River Chinook salmon, Columbia River Chum Salmon and Upper Willamette River Chinook Salmon. Critical habitat for these species is not designated in Grays Harbor, so the project would have no effect on critical habitat.

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Bull Trout. Although the project area occurs within bull trout critical habitat, it is unlikely that this species will be present within the area. A 2005 fish survey of Half Moon Bay did not find bull trout in the area (USACE 2005a). A separate study in 2006 on native char use of the Lower Chehalis River and Gray Harbor estuary also concluded that bull trout does not use Half Moon Bay (Jeanes et al. 2006). No suitable spawning habitat exists within or nearby the project area, and the project does not occur directly within a bull trout migratory pathway; therefore, bull trout presence would be limited to species transiting or foraging. Bull trout prey species, including juvenile salmonids, forage fish, and macro and micro invertebrate species, would incur only temporary, if any, effects from any of the alternatives and are not expected to incur any impacts that would affect their long-term abundance in the project area. For Alternatives 1B and 3A, the construction of the modified diffraction structure impacting about 2 acres of potential bull trout foraging habitat would be ameliorated through the planned partial removal of the remnant jetty near the north jetty, allowing access of bull trout into that bay at all tidal levels. This would provide, if they are present, increased opportunity for bull trout foraging in outer Grays Harbor. The modified diffraction structure itself will not impede bull trout migration or their ability to forage, or affect forage prey abundance. Overall, none of the alternatives would be expected to have a significant impact on bull trout or their habitat in Grays Harbor. The project "may affect, not likely to adversely affect," bull trout, and the project "may affect, not likely to adversely affect" bull trout critical habitat.

Green Sturgeon. During late summer, green sturgeon concentrate in coastal estuaries, particularly in the Columbia River estuary, Willapa Bay, and Grays Harbor (Moyle et al. 2002). Adults are common in the seawater and mixing zones of Grays Harbor during high salinity periods, with the highest abundances from July through early October (Monaco et al. 1990). Green sturgeon would not typically be found in the shallow nearshore areas as found in the project area and would likely avoid the project area due to construction activities and associated project noise. Only minor impacts to green sturgeon and their prey, such as shrimp, crabs, and polychaete worms, would occur with either Alternative 1B or 3A due to the covering of 2 acres of subtidal sandy habitat by the modified diffraction structure, in light of the presence of several hundred acres of this habitat type in outer Grays Harbor. Also, the new access to additional subtidal sandy gravel habitat due to the partial removal of remnant jetty segments near the North Jetty would completely offset the impact of a loss of 2 acres of similar habitat in the project area. Alternatives 1A (current practice) and 4C (breach closure) would not impact green sturgeon habitat or their habitat as they would not involve placement of sand in areas likely to be inhabited by this species and would not involve construction of a diffraction structure. The Corps has determined that all the alternatives "may affect, not likely to adversely affect" green sturgeon, and also will have no adverse effect on its critical habitat, because the impacts both to the species and its critical habitat are minor and short-term.

Pacific Eulachon. As part of a separate study, Pacific eulachon (*Thaleichthys pacificus*) were found during beach seine efforts in Half Moon Bay (Jeanes et al. 2005). Although eulachon have been documented, the high-energy environment, associated naturally occurring erosion plumes, and lack of proper spawning habitat is expected to minimize their use of the area (USACE 2010). Further, eulachon prey species, including macro and micro invertebrate species, would incur only temporary or minor effects from any of the alternatives and are not expected to incur any impacts that would affect their long-term abundance in the project area. Therefore, the project "may affect, not likely to adversely affect," eulachon.

Turtles and Marine Mammals. Several threatened and endangered species of marine mammals and turtles may transit offshore waters adjacent to the project area; however, Grays Harbor is not habitat for any of these species nor is it likely that they would traverse this area. Because these species have large home ranges, it is likely that they would avoid the project area during construction activities if in the vicinity. Therefore, the project will have "no effect" on leatherback sea turtles, loggerhead sea turtles, green sea turtles, Olive Ridley sea turtles, sperm whales, southern resident killer whales and Steller sea lions. There is no critical habitat for these species in the project area.

7.2.2.6.2 Marine Mammal Protection Act

Although they are not endangered species, some species of pinnipeds are present in the project area and are protected under the MMPA. Cetaceans are not expected to regularly frequent Grays Harbor. Alternatives 1B and 3A have the potential to disturb California sea lions and harbor seals during construction of the diffraction structure. This construction would ultimately result in expanded haul-out habitat for these species. Alternatives 1A and 4C would have temporary impacts due to disturbance, resulting in marine mammal avoidance of the project area. Noise levels from construction are not expected to result in levels that would harm or injure marine mammals, although construction noise could result in some short-term behavioral changes, such as avoidance of the project area during construction.

7.2.2.6.3 Migratory Bird Treaty Act

Some migratory bird species protected under the MBTA may transit the project area, but the project area is not nesting habitat or primary foraging habitat for these MBTA species. Therefore, the project will have no effect on birds protected under MBTA.

7.2.2.6.4 Bald and Golden Eagle Protection Act

Bald eagle sightings are most frequent during winter months, as Grays Harbor provides important bald eagle winter-feeding habitat. Construction will likely occur during the summer/fall months. Anadromous fish returning to spawn, waterfowl, and shorebirds are primary prey in the estuary. Because bald eagles tend to congregate near the mouths of the Chehalis, Elk, Humptulips, Hoquiam, Johns, and Wishkah rivers and near Newskah and

Charley creeks, it is unlikely that bald eagles would visit the project area rather than transiting through. Therefore, no take of either bald or golden eagles is likely during the construction of this project.

7.2.2.7 Essential Fish Habitat

The proposed project is located within areas designated as EFH for three fish management plans (FMPs): the Pacific Coast Groundfish FMP, Coastal Pelagic Species FMP, and Salmonid FMP (PFMC 1998a, 1998b). The EFH species likely to occur in Grays Harbor are shown in Table 5 (page 43). Coastal pelagic species EFH is not likely to be impacted by the project, as the project occurs in upland and nearshore areas. Coastal pelagic species generally occur offshore above the thermocline in the upper mixed layer and, therefore, are considered pelagic. The project is not expected to impact waters or substrate necessary for pelagic species for spawning, breeding, feeding, or growth to maturity.

All project alternatives would have impacts to EFH. Temporary impacts are primarily related to turbidity from beach nourishment material placement, and permanent impacts are related to construction of the modified diffraction structure and removal of a portion of the partially submerged remnant jetty at Oyhut Wildlife Recreation Area near Damon Point.

Pacific Coast Groundfish and Salmonid EFH could be affected by the project. Alternatives 1A, 1B and 3A would affect Pacific Coast groundfish and salmonid EFH through placement of nourishment material in Half Moon Bay intertidal and shallow subtidal areas; however, these impacts would be minor and short term. Alternative 4C impacts to EFH would not be substantial as the 300,000 cubic yards of sandy fill material would be placed primarily on supratidal areas to fill the breach, with some runoff into the HMB to follow. All alternative actions would lead to temporarily heightened turbidity within Half Moon Bay. There is a chance that heightened turbidity could be present immediately following placement, because wave and tidal action distribute sand. However, again, these effects would be short term and temporary. Under these alternatives, there would be temporary and insignificant effects to EFH due to sand placement.

Alternatives 1B and 3A would affect EFH and could have permanent effects to the substrate as both alternatives propose to construct a modified diffraction structure, extending east from the existing South Jetty. The diffraction structure would convert 2 acres of sandy substrate to rocky habitat. To mitigate for the loss of 2 acres of sandy fish habitat, rock riprap will be removed from the western and eastern ends of a partially submerged remnant jetty near the Oyhut Wildlife Recreation Area and Damon Point. The removal would expose nearly 200 acres of sandy habitat similar to that lost through construction of the modified diffraction structure, and would provide access to EFH habitat that is currently not accessible to EFH species. This increased access to habitat is expected to fully offset the impacts from the modified diffraction structure in Alternatives 1B and 3A. Alternatives 1B and 3A involve periodic placement of approximately 110,000 and 250,000 cubic yards, respectively, of

nourishment material at 10-year intervals in the intertidal zone along the Half Moon Bay shoreline. These placements would cover over several acres of benthic habitat, but in a short period of time, within one year, the substrate would stabilize to native conditions, and would be repopulated with a stable benthic invertebrate community. The periodic placement of sand at South Beach in Alternative 1B (every 5 years) would cover over a relatively impoverished sand dunal environment above most tidal influence and would have no discernible impact on essential fish habitat. In summary, the principal impacts of a modified diffraction structure under Alternatives 1B and 3A are virtually completely mitigated by the conservation measure of removal of remnant jetty ends near North Jetty and Damon Point. This action would actually result in an improvement to EFH in the region.

None of the elements of any of these alternatives would have a significant impact on Essential Fish Habitat in the project area.

7.3 EFFECTS ON HUMAN USE CHARACTERISTICS OF THE AQUATIC ENVIRONMENT

The following subsections describe the potential impacts of Alternatives 1A, 1B, 3A, and 4C to the human use characteristics found within the project area.

7.3.1 AESTHETICS

Under Alternatives 1A, 1B and 4C, current views of the ocean, surfing, and beachcombing would be maintained in Half Moon Bay and South Beach. Potential short-term impacts to aesthetics include scarping of the beach until placement is triggered.

Impacts to the immediate viewshed would occur during construction activities (including placement of sand, construction of diffraction structure, and installation of jetty extension and state park access road extension) due to the temporary presence of heavy machinery and equipment. During construction activities, access to the project area would be restricted to the public for safety purposes (limiting recreation such as surfing and beachcombing). Access restrictions would be maintained for the extent of construction, and no permanent closures would be anticipated.

Construction times for the alternatives would vary according to the method proposed. With Alternative 1A, placement of sand in response to triggers would take an estimated one to two months. The construction of the modified diffraction structure in Alternatives 1B and 3A, involving transportation of 55,000 tons of jetty rock by trucks and lowboy trailers, would also take about one to two months. Construction would result in temporary negative impacts to the immediate viewshed for some, but others would consider it a relatively short extension of the existing jetty structure and would view it as neither positive nor negative. The extension would help reduce beach erosion and help retain an aesthetically pleasing beach area in Half Moon Bay for longer time periods. The structure could provide a

challenging climbing opportunity for recreational hikers and a potential hazard for recreational boaters.

Alternatives 3A and 4C would have substantially longer construction times, with the jetty extension for 3A expected to take three to four months to excavate, transport, and place 208,000 tons of jetty rock using trucks and lowboy trailers, while for 4C the breach fill would take about two months for the hydraulically pumped placement of 300,000 cy of sand. The modified diffraction structure in Alternatives 1B and 3Awould reduce beach erosion and would not result in a significant impact to the aesthetics of the area.

Overall, no significant impacts would result from Alternatives 1A or1B in light of continued periodic beach nourishment activities. However, with Alternative 3A, after several years, wave erosion from the Pacific Ocean would eventually cause movement of beach sands offshore, exposing the long jetty extension. This would be a substantial impact on area aesthetics.

7.3.2 AIR QUALITY

A reduction in air quality would be temporary and localized under all alternatives, due to the emissions of equipment operating during dredged material transport. Sources of emissions under all the alternatives would be primarily from truck traffic traveling from the Point Chehalis revetment stockpile site. For Alternatives 1B and 3A, emission sources would be from truck transport and placement of riprap for a modified diffraction structure. For alternative 3A, additional emissions would occur from truck transport and placement of riprap for a jetty extension.

Construction activities could temporarily decrease air quality; specifically, particulate matter from fugitive dust and exhaust from construction equipment. Air quality impacts are anticipated to be less for Alternative 1B and 3A if a hopper dredge is used to place the sand, thus eliminating the need for dump trucks. Following construction of the modified diffraction structure and/or jetty extension these hard structures would not generate air quality disturbances in the project area. However, all the alternatives would involve perennial sand placement over the 50-year planning horizon, on a recurring periodic or triggered basis, and this placement would generate minor air emissions from the hydraulic placement activities. As stated in Section 3.3.2, Grays Harbor County meets USEPA National Ambient Air Quality Standards for the six common air pollutants and those set by Washington State for particulate matter and sulfur dioxide. The project area is not located in a Clean Air Act (CAA) non-attainment area because concentrations of pollutants are below the standards enforced by USEPA due to de minimis emission levels; air quality in the area is exceptional due to the westerly winds off the Pacific Ocean. Reduction of air quality for any of the alternatives is not expected to be significant, because it would be temporary and localized and should not result in violation of applicable air quality standards set by USEPA.

7.3.3 CULTURAL AND HISTORIC RESOURCES

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires that the effects on potential sites, structures, or objects included or qualified for the National Register of Historic Places (NRHP) be considered prior to proposed actions. The project area is located in an estuarine area, in a region that is generally of cultural significance due to Native American usage and early European settlement (USACE 2007a).

For decades, the project area has been primarily composed of fill material and wind-blown and current transported sand deposits. Several archaeological sites have been recorded within the vicinity of the project area and include the remains of a disturbed shell midden and pestle, and a shell midden and possible village site. Both sites are located within less than 0.50 miles of the project area. Several cultural resources surveys have been conducted for previous Corps projects within the vicinity of Gray's Harbor. In 1986, Shapiro and Associates conducted a survey for historic sunken shipwrecks. Based on the information they compiled there are no shipwrecks within the vicinity of Half Moon Bay and South Jetty (Shapiro and Associates 1986). In 2002, the Corps conducted a cultural resource survey for the Half Moon Bay transition gravel and cobble placement project located within the current Grays Harbor LTMS project area. The 2002 report determined that the Half Moon Bay portion of the project area is composed of recent dredge spoil fill and twentieth-century sand dune deposits (Kent 2003). The remaining portion of the Grays Harbor LTMS project has not yet been surveyed for this project nor has Section 106 consultation began for this project. As the North and South jetties are over fifty years old they will need to be recorded and evaluated for inclusion on the National Register of Historic Places (NRHP). Section 106 consultation and evaluation of the North and South jetties will occur prior to the draft EA being finalized. As the North and South jetties have not been surveyed nor Section 106 consultation begun it is unknown at this time what the effects of this project would have on cultural resources.

For decades, the project area has been primarily composed of fill material and wind-blown and current transported sand deposits. These conditions make it unlikely that any archaeological deposits are present. Several cultural resources surveys have been conducted for previous Corps projects within the vicinity of Gray's Harbor. In 1984, Shapiro and Associates conducted a survey for historic sunken shipwrecks. Based on the information they compiled there are no shipwrecks within the vicinity of the project (Shapiro and Associates 1984). In 2002, the Corps conducted a cultural resource survey of the project area and determined that the project area is composed of recent dredge spoil fill and twentieth-century sand dune deposits. The Corps determined that no historic properties would be affected by project (Kent 2003). The State Historic Preservation Office (SHPO) concurred with the determination in correspondence with the Corps in September, 2003.

The project area is located in an estuarine environment; an environment that is generally regarded for its cultural significance due to Native American usage and early European settlement. This area is prone to significant wave activity resulting in rapid erosion of the beach and adjacent dunes. As a result, the site is composed primarily of fill material and is periodically maintained with sand deposits. Because the area consists primarily of recently deposited material, the possibility of prehistoric or early historic-period archaeological deposits, cultural resources, or historic properties being present is minimal. As a result, Alternatives 1A, 1B, 3A, and 4C are expected to have no effect on cultural resources because there are no shipwrecks in the area. The only historic resource in the project vicinity is the Grays Harbor Light Station which is located upland and will not be affected by the project.

7.3.4 Tribal Usual and Accustomed Areas

As mentioned earlier in section 3 of this document the Quinault Tribe does not typically fish in the project vicinity, but farther east in Grays Harbor. Therefore, none of the project alternatives would be expected to impact their fisheries. The Corps plans to contact the Tribe to discuss project plans prior to completion of the Final Environmental Assessment for this project. If, during or following construction, circumstances arise where there may be a conflict between construction activities, environmental impacts or location of project structures and Quinault Tribal fisheries operations, the Tribe will be consulted by the Corps.

7.3.5 Commercial Shellfisheries/Aquaculture

Impacts to commercial shellfisheries by all alternatives would be minimal, because of the relatively small project impact area due to sand placement and the modified diffraction structure and the fact that the Dungeness crab fishery and oyster aquaculture operations do not presently exist in the Half Moon Bay vicinity. The crab fishery exists in outer Grays Harbor and not close to Half Moon Bay. The commercial oyster fishery, located at Whitcomb Flats, is several miles southeast of Half Moon Bay and Westport Marina. According to reports and studies mentioned earlier in this document, there is not a direct relationship between erosional processes at Half Moon Bay and migration of sand at Whitcomb Flats. Also, given the consistency of the sand in the outer Grays Harbor area, erosion occurs at a natural rate during sediment transport processes in Grays Harbor. For these reasons, no adverse effects to shellfisheries in the outer Grays Harbor area, including Half Moon Bay are anticipated from construction activities, including sand placement and a diffraction structure, for any of the alternatives.

7.3.6 Land Use

Under Alternatives 1A, 1B, and 4C, land use activities would be maintained in the long-term in Half Moon Bay and South Beach. For all the alternatives, impacts to land use would occur during construction activities (including placement of sand, construction of diffraction structure, and installation of jetty extension and state park access road extension). During

construction activities, access to the project area would be restricted to the public for safety purposes (limiting recreational opportunities). Access restrictions would be maintained for the extent of construction, and no permanent closures are anticipated. All of the alternatives would result in protection of the jetty and adjacent land south of the jetty that could be available for multiple uses as authorized under state and local law. It would also incidentally provide protection for the sewage treatment plant and other local infrastructure. The uncovered jetty extension could provide a challenging climbing opportunity for recreational hikers and a potential hazard for recreational boaters. Implementation of any of the alternatives would not result in a significant impact on land use in the project vicinity.

7.3.7 NOISE

Noise impacts would only occur during construction activities (including placement of sand, construction of diffraction structure, and installation of jetty extension and state park access road extension) due to the use of transport trucks and equipment.

All noise impacts resulting from these activities would be temporary and localized. The expected noise levels for the construction equipment proposed for the project (at 50 feet from the source) includes excavators (85 decibels [dBA]), dump trucks (84 dBA), hydraulic pumps (75-85 dBA) and backhoes (80 dBA; FHWA 2006). By comparison, per the Occupational Safety and Health Administration (OSHA), daily permissible noise level exposure to 90 decibels is 8 hours per day. Therefore, because of these levels and because they would be localized and not extend over four months, construction of any of the alternatives will not result in a significant impact on project area noise levels.

7.3.8 NAVIGATION

Impacts to navigation by all alternatives would be minimal, as construction would be primarily conducted in an intertidal, shallow subtidal, or upland location or outside of the Federal Navigation Channel. Given the compatibility of the placed material with existing sands, erosion would occur at a natural rate for sediment transport processes so no threat to the channel is anticipated, assuming routine maintenance dredging continues as needed.

7.3.9 RECREATION

Pedestrian and vehicle access to Half Moon Bay from the state park parking area would be restricted during construction for safety purposes, with all the alternatives. Access restrictions would be maintained for the extent of construction, but no permanent closures would be anticipated. Potential long-term impacts for all the alternatives include the steepening and retreat of the shoreline (until sand nourishment would be triggered) resulting in the loss of beach area to some recreational users. With Alternative 1A, when alert triggers were met due to loss of beach area, sand would be placed in the beach scarp at the west end of the bay and also along 1,000 feet of intertidal shoreline to maintain this beach area. This alternative would not impact recreation at Half Moon Bay or South Beach in the long-term.

With Alternative 1B, triggers would be in place as in 1A but also the 500-foot long modified diffraction structure would be constructed at the east end of the existing jetty to deflect wave energy and slow erosion of the Half Moon Bay beach.

The modified diffraction structure could provide challenging recreation walks and could also be a hazard for recreational boaters. Regarding surfing activities, based on a recently conducted modeling study by Corps coastal engineers, the modified diffraction structure would not impact wave strength or direction in the prime surfing areas along the eastern shore of Half Moon Bay and Point Chehalis. Removal of the west and east ends of the submerged jetty at Oyhut Wildlife Recreation Area near Damon Point would increase access to the bay by boat users as it would provide two 50-foot wide entrances into the bay at all tidal levels.

Alternative 3A would also involve construction of a jetty extension that would result in loss of upland dune habitat which would be replaced by the Corps. Although the extension would initially be covered by sand, eventually the sand and dune habitat would be lost due to weather erosion exposing the jetty extension. In time, the beach area south and west of the jetty would erode and be generally lost. This would be a substantial impact to the recreation community, especially surfers, beachcombers, and hikers.

7.3.10 SOCIOECONOMICS

Grays Harbor is a popular tourist destination and recreational activities (e.g., wildlife viewing, surfing, and beachcombing) would be maintained by preserving the beach. Land preservation, to various degrees, and incidental protection of local infrastructure including the local sewage treatment plant, would result from all four alternatives, providing an overall benefit to socioeconomics. Regarding economics, the most costly alternative, to a significant degree, is Alternative 3A, because of the expense involved in (1) excavating 145,000 cubic yards of sand and placing 128,000 tons of stone for the 1,828-foot landward extension of the South Jetty, (2) depositing 250,000 cubic yards of sand at 10-yard intervals along the Half Moon Bay shoreline, and (3) constructing the 500-foot-long diffraction structure.

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8 CUMULATIVE EFFECTS OF THE ALTERNATIVES

As defined by the White House Council on Environmental Quality implementing regulations for NEPA at 40 CFR 1508.7, "cumulative impact" means the "impact on the environment which results from the incremental impacts of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or Non-Federal) or person undertakes such other actions."

8.1 HISTORIC AND EXISTING CONDITIONS

Historic habitats of the Lower Chehalis River and Grays Harbor have been altered by previous dredging, diking, filling, jetty construction, industrial discharges, and other anthropogenic activities conducted throughout the past century. These activities have resulted in the loss of wetland and other intertidal habitats, conversion of shallow water habitats to deeper water, erosion and migration of sand islands, and a reduction in water quality. By one estimate, approximately 14,579 acres, or 30 percent, of historic intertidal habitat in Grays Harbor have been lost (National Research Council, 1996). Degradation of Grays Harbor ecological function associated with these changes has affected the capacity of these habitats to support fish and wildlife populations.

Maintenance dredging has occurred periodically since 1910, but no new areas have been dredged and no new disposal sites have been designated since the late 1990s. Up to 1,725 acres are annually affected by the Corps' maintenance dredging, with an approximately 700 additional acres affected by annual disposal of this material. This area is equivalent to approximately 12 percent of the total acreage of subtidal habitat in the harbor. Several dredged material disposal sites are located within the higher tidal areas of Half Moon Bay and vicinity. Throughout the past decade, millions of cubic yards of dredged material have been placed in these sites (see Appendix D, Section 2.3). Despite all of the material placed into the bay, it is transported out of the region into deeper waters.

Dredged material disposal practices no longer contribute to the conversion of intertidal wetlands to uplands. Previous Corps studies and activities in Grays Harbor are listed in Table 2 of this EA.

8.2 REASONABLY FORESEEABLE FUTURE ACTIONS

Annual maintenance dredging by the Corps is likely to continue for the foreseeable future. In addition, the Port of Grays Harbor (Port) conducts maintenance dredging of its marine terminal facilities adjacent to the Federal Navigation Channel. An average of 30,000 cubic yards (cy) (maximum of 70,000 cy) is removed by the Port annually. Impacts of and regulatory restrictions on Port of Grays Harbor dredging are similar to those constraining the Corps' dredging program, but the scale of port dredging activities is much smaller.

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Construction of other new projects with substantial impacts would likely require project-specific analysis and mitigation to avoid further significant degradation. Besides the Federal Grays Harbor navigation project, with ongoing maintenance of both its channel and structural features, other reasonably foreseeable Federal actions include the Corps' proposed Navigation Improvement Project, with channel widening and deepening and periodic major jetty and groin rehabilitation. Both of these latter efforts would be subject to project-specific NEPA analysis, when and if proposed. and outer channel realignment.

8.3 INCREMENTAL EFFECTS OF THE PROPOSED ACTION

It should be emphasized that the effect of the preferred LTMS action is not just an incremental load on the environment to be superimposed over the load already generated by navigation project maintenance. The object of the preferred action is to streamline navigation project maintenance (structural and channel) by making each maintenance episode less costly, less time-consuming, and less environmentally impacting.

Implementation of the preferred action would be an incremental action that, when added to the baseline condition, considering historic actions, present actions, and reasonably foreseeable future actions, would not contribute significantly to cumulative impacts on the Grays Harbor human environment. From a net change perspective, the incremental contribution of the preferred action on cumulative environmental effects would be less than the effects of the action viewed in isolation.

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9 SELECTION AND JUSTIFICATION OF RECOMMENDED PLAN

This section summarizes the reasons that Alternative 1B was selected as the recommended plan and preferred alternative, along with summarizing the non-selected alternatives.

9.1 ALTERNATIVE 1B – RECOMMENDED PLAN/PREFERRED ALTERNATIVE

Based on these analyses, the LTMS team identified Alternative 1B as the recommended plan, or the NEPA preferred alternative. Alternative 1B was selected using a combination of the Multi-Criteria Decision Analysis (MCDA) described in Chapter 6 and the Corps' evaluation of the environmental impacts of the four remaining alternatives carried forward for additional analysis and evaluation, described in Chapter 7 and summarized below. Alternative 1B achieved the highest cumulative utility score, as determined through the MCDA process, and was determined to minimize collective environmental effects as compared with the other alternatives brought forward for full consideration.

Alternative 1B– including proposed mitigation measures – best achieves the project purpose and need, while minimizing impacts to the environment and providing excellent mitigation for impacts resulting from the modified diffraction structure, and achieves this at a reasonable cost. Alternative 1B would entail placement of sand on the dune area between Half Moon Bay and South Beach if a trigger is met that corresponds to minimum dune width that can protect against a breach during a 50-year storm event, along with construction of a modified diffraction structure at the eastern terminus of the South Jetty. After the initial placement of 110,000 cubic yards of sand, additional sand placement is expected to be triggered approximately every ten years (section 6.4.2), or about half as frequently as with the current practice, Alternative 1A. The modified diffraction structure would reduce vertical beach scarping at the northwest corner of the bay and would substantially reduce beach erosion along the western Half Moon Bay shoreline. Thus it would reduce the required frequency of sand placement along the shoreline. It would also result in formation of a mildly sloping beach and more intertidal habitat. (See section 6.4.2.)

The modified diffraction structure would result in loss of about 2 acres of shallow subtidal habitat, used by bottom-dwelling benthic invertebrates and emigrating juvenile salmonids. However, this is considered a minor impact as there are hundreds of acres of such habitat along the south shore of Grays Harbor.

The modified diffraction structure would add about 1,000 linear feet of rock riprap habitat that is used by predator fishes, including ling cod and rockfishes that prey on juvenile salmonids. To help offset these impacts, small angular rock would be placed along the diffraction structure to settle into rock interstices and decrease hiding habitat for these fishes. An additional mitigation feature would be the removal of 100 feet of riprap from the remnant North Jetty near the Oyhut Recreation Area and Damon Point. This removal will promote better water movement along the shorelines near the Oyhut Wildlife Recreation

Area and provide access to over 1,500 feet of excellent shoreline feeding and migratory habitat for fish, including Endangered Species Act (ESA)-listed salmonid species, at all tidal levels. The removal will also allow mobile invertebrates, especially Dungeness crab, access to several hundred acres of sandy, intertidal/subtidal environment. Overall, Alternative 1B is the only alternative that would not have long-term significant impacts on any of the environmental elements analyzed in this environmental assessment.

9.2 ALTERNATIVE 1A

Alternative 1A would respond to either, or both, of two different triggers, involving erosion to Half Moon Bay and South Beach; however; without a modified diffraction structure, the relatively strong rate of erosion in the northwest corner of Half Moon Bay would continue, requiring more frequent beach nourishment (approximately every 5 years) compared to Alternatives 1B and 3A (approximately every 10 years). The comparative frequency of placement would induce related negative effects on benthic invertebrate and small fish populations due to decreases in preferred sloping beach area and increases in beach scarp area. Also, the more frequent beach nourishment would cover over and disrupt the benthic invertebrate community more often. The nourishment area would eventually be colonized by invertebrates but it would take 1-2 years for community maturation. This alternative would not have the benefits of the diffraction structure that would slow down erosion along the bay shoreline, reduce the need for sand placement every five years or so, and help provide a less disruptive habitat for fish and benthic invertebrates, including nematode worms and amphipods. Also, Alternative 1A would not provide the excellent mitigation of removing remnant jetty habitat on the north shore near the Oyhut Wildlife Recreation Area.

9.3 ALTERNATIVE 3A

Alternative 3A would also achieve the project purpose and need, but it would have substantial impacts on the aquatic environment including the placement of large quantities of nourishment material (clean sand) in the intertidal area, construction of a modified diffraction structure and the construction of the jetty extension, as compared to Alternatives 1A and 1B. Alternative 3A would require initial placement of 130,000 cubic yards of sand over 3.5 acres of high intertidal shoreline, and subsequent placements of 250,000 cubic yards approximately every ten years. These quantities of sand are greater than that required for Alternatives 1A and 1B, and would result in significant impacts to the intertidal and subtidal benthic invertebrate community. The time required for successful re-population of the disturbed beach area by benthic species would be substantially longer than with Alternatives 1B or 4C.

Alternative 3A would also include the same modified diffraction structure described above for Alternative 1B and the same proposed mitigation involving removing the eastern and western portions of a remnant jetty near the Oyhut Wildlife Recreation Area and Damon

Point as Alternative 1B, which would offset the habitat loss from the construction of the modified diffraction structure.

This alternative would also involve construction of a jetty extension that would result in loss of upland dune habitat which would be replaced by the Corps. Although the extension would initially be covered by sand, eventually the sand and dune habitat would be lost due to weather erosion exposing the jetty. In time, the beach area south and west of the jetty would erode and be generally lost. This would cause a substantial recreational and aesthetic impact to surfers, beachcombers, and hikers.

9.4 ALTERNATIVE 4C

Alternative 4C would call for awaiting a breach to naturally occur before any action would take place. The breach would be filled within one dredging season. This alternative would have significant short-term impacts, because after breach formation, public access would be closed and up to 300,000 cy of dredged sand would be transported via hydraulic pumping to close the breach. This alternative also has the highest risk of breaching to re-occur in the future. The breach could also have considerable impacts on fish resources inhabiting the breached area when exit from this area could relatively quickly be closed off during and after storms, trapping these fish for long periods during which time dissolved oxygen concentrations in ponded areas would likely become very low. Impacted fish could include juvenile salmonids attempting to emigrate to the ocean. Beachcombing and surfing could be significantly affected as well, as dunal areas and beach access would be substantially affected by a breach. Half Moon Bay intertidal land, and thus benthic invertebrate and small fish habitat, would also be significantly eroded or covered over by sands carried eastward through the breach. Most importantly, as discussed in Section 2.4, a breach would lead to compromising the integrity and stability of the South Jetty as well as the Federal Navigation Channel by increasing the rate of erosion to upland dune habitat.

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10 IMPLEMENTATION OF RECOMMENDED PLAN

Prior to reaching the triggers mentioned in section 6.4 of this report, Alternative 1B would require an initial placement of approximately 110,000 cy of sand on the Half Moon Bay shoreline to create the minimum dune required to withstand a 50-year storm event. The initial placement would re-establish a mildly sloping beach from the present beach scarp to the estimated equilibrium shoreline.

An additional feature of this alternative is the extension of the jetty root eastward approximately 500 feet along the existing jetty remnant by using approximately 55,000 tons of Class A stone. It is estimated that by extending the jetty root 500 feet along the existing jetty footprint, it will be possible to reduce the frequency and quantity of nourishment required for the Half Moon Bay shoreline.

Similarly, sand would be excavated from the Point Chehalis revetment stockpile site and mechanically transferred, or transported hydraulically from a hopper dredge, to the nourishment site. The Corps will prepare a demonstration project using the hydraulic method for the initial nourishment. The demonstration is expected to result in the more efficient transfer of nourishment material, in terms of cost and of duration, when compared to the mechanical method.

The preferred action (Alternative 1B) is a modification of the current practice, which includes the placement of sediment when a trigger is met to prevent breaching, combined with extending the existing diffraction mound 500 feet to the east into Half Moon Bay along the footprint of a remnant jetty to diffract wave energy. A dune vulnerability analysis determined the minimum cross-sectional area of dune required to provide adequate protection from a breach during a 50-year storm return interval is 275 feet in width and +30 feet MLLW in elevation. The trigger for this alternative is defined as a minimum dune width of 275 feet at an elevation of +30 feet MLLW and a minimum cross-sectional area above MSL of 250 cy per linear foot (Figure 21). Similar to the existing practice, if the trigger is met, the Corps will perform a survey to determine the location and volume of sediment required to maintain the minimum dune cross-sectional area. The trigger response is expected to require approximately 52,500 cy of sand placement at South Beach every 5 years and placement of approximately 110,000 cy of sand at Half Moon Bay every 10 years.

Modifying the diffraction structure will entail placing new rock on top of an existing remnant jetty to an elevation of +20 feet MLLW.

Alternative 1B seeks to restore the South Jetty (i.e., with a diffraction structure) to an optimal configuration to reduce the risk of a breach by minimizing the quantity and

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frequency of beach nourishment to Half Moon Bay. The modified diffraction structure would help stabilize the Half Moon Bay shoreline.

10.1 Construction Phasing

The components of Alternative 1B involve beach and/or dune nourishment and rubble mound modified diffraction structure construction. Beach and/or dune nourishment with sand would most likely occur in conjunction with annual hopper dredging of the entrance channel as this presents the most economical source and delivery of sediment to the area. Alternative 1B involves rubble mound jetty construction, and the diffraction structure would be constructed prior to beach nourishment on Half Moon Bay to minimize erosion to the beach fill. Alternative 1B involves significant quantities of beach fill. This material would be pumped from a hopper dredge onto the beach hydraulically. Containment dikes would be required to be constructed on the beach prior to hydraulic placement to ensure water quality standards are met.

10.2 Design and Construction Considerations

The diffraction structure would require placement of armor stone on top of relic jetty stone presently at +2 feet MLLW. In order to ensure proper interlock of stone, initial placement would require construction during low tides. Construction would occur from land and begin from the west and move east. Beach and dune fill would require use of sands from the entrance channel of similar gradation to the native beach sediments to ensure a stable beach profile and would be placed hydraulically via hopper dredge. Armor stone removed from sections of the east end of the north jetty will be excavated to the mud line and reincorporated into the jetty immediately adjacent to the excavation area. As the structure is fairly degraded in this area, this may require a barge to reach the areas without disrupting the adjacent shorelines.

10.3 Design and Implementation Phase Considerations

Appropriate environmental coordination will be necessary to begin construction. This will require a Water Quality Certification from the State of Washington Department of Ecology (Ecology) and concurrence letters from USFWS and NMFS. The Corps will request a Water Quality Certificate from Ecology and submit a biological evaluation (BE) to USFWS and NMFS. The project would be funded through the O&M program. The project must be fully funded prior to implementation of the recommended plan.

10.4 Operation and Maintenance (O&M) Considerations

Alternative 1B requires O&M in the life-cycle plan. Beach nourishment requires more frequent O&M (estimated at approximately five to 10 years) than rubblemound jetty

construction (estimated at 25 years). O&M costs have been integrated into the life-cycle cost estimates for the recommended plan.

10.5 Post-Construction Monitoring Plan

10.5.1 Adaptive Management

The Corps' Seattle District Hydrosurvey Section currently performs quarterly surveys of the South Beach and Half Moon Bay beach and dune. This monitoring would continue following project implementation. Monitoring data on erosion rates would be used to adapt the O&M plan to the observed conditions. Additionally, sea level change estimates would be re-evaluated on an incremental basis to determine if prior designs need to be adjusted to accommodate new conditions. Sea level rise will likely result in additional beach fill quantities as the beach profile adjusts to the new sea level.

10.5.2 Conservation Measures

The contractor will be instructed to avoid impacting native dune wild rye grass to the maximum extent possible. Construction techniques will include the use of unvegetated access ways to the extent possible, vehicles with large tires that require no improved road, or removable steel plates to construct temporary access routes. Any native dune grass plant areas that are that are covered over or trampled by construction will be compensated for by the planting of the affected beach fill areas with appropriate numbers of dune grass sprigs. Dune grasses that would be unavoidably present in the construction footprint will be harvested and potentially used as donor plants. This effort will concentrate on areas that were disturbed as part of construction activities and areas not densely planted as part of the 2002 revegetation effort.

The contractor will be instructed by Corps biologists not to remove rock riprap from the two 50-foot ends of the remnant jetty near North Jetty and the Oyhut Wildlife Recreation Area near Damon Point during times when snowy plover may be nesting.

10.5.2.1 Best Management Practices

BMPs include, but are not limited to, the following:

- No new access roads will be constructed, unless approved by Corps personnel.
- All in-water work will only be conducted within resource agency work windows, which only allow construction in nearshore areas used by juvenile salmon emigrants when these fish are expected in their smallest numbers during the year.
- All applicable local, state, and federal permits will be obtained and associated conditions and requirements will be followed.
- A Spill Prevention, Control, and Countermeasures (SPCC) Plan will be prepared prior to the start of construction to minimize and address potential spills.
- Construction materials will not be stored where high tides, wave action, or upland

runoff can cause materials to enter surface waters.

- During nourishment activities, containment dikes constructed from beach sand will be placed around the perimeter of the nourishment area in order to reduce the risk of turbidity entering water bodies. Slurry water will settle suspended sediments landward of the containment dikes and the decanted water will infiltrate through the containment dike and beach.

10.5.2.2 Mitigation Measures

Actions taken under Alternative 1B may result in loss of existing dune grass. Should Alternative 1B impact native dune grass, the Corps will plant sprigs of dune grass at a replacement ratio of 2:1 (replacement:impact).

Construction of the modified diffraction structure would result in loss of about 2 acres of subtidal sand area that serves as habitat for benthic invertebrates, replacing it with 1,000 feet of rock riprap that could serve as habitat for ling cod and rockfish that could prey on juvenile salmonids. As mitigation for this impact on bull trout and juvenile salmon emigrants, approximately 50 lineal feet of riprap would be removed from each of the east and west ends of a partially submerged remnant jetty near the North Jetty and the Oyhut Wildlife Recreation Area, and Damon Point on the north side of the inlet to Grays Harbor (Figure 24). This removal would provide access to a shallow subtidal/intertidal area of more than 200 acres and a long shallow intertidal shoreline for juvenile salmon migrating down the north side of the harbor, that is not presently accessible at all tidal levels. It will also promote better circulation in the embayment, and allow more wave energy into the bay that will aid in returning it to its pre-jetty condition. In addition, medium-sized angular rock, e.g. quarry spalls, will be placed amongst the large riprap on the south side of the modified diffraction structure to fill voids within the riprap rock. The angular rock will be large and angular enough to resist major movement out of the riprap interstices by wave action. The placement of the quarry spalls would reduce the potential for creating refugia and hunting habitat available to piscatory predatory species, such as lingcod (*Ophiodon elongatus*) and various rockfish species.

At the north jetty mitigation area, riprap jetty will be excavated and incorporated into the adjacent areas of the north jetty. The positive environmental impacts of the removal are described above and there is only one negative effect, that of minor temporary turbidity due to disturbance of bottom silt and that covering the riprap, which would have inconsequential effects on very localized phytoplankton populations.

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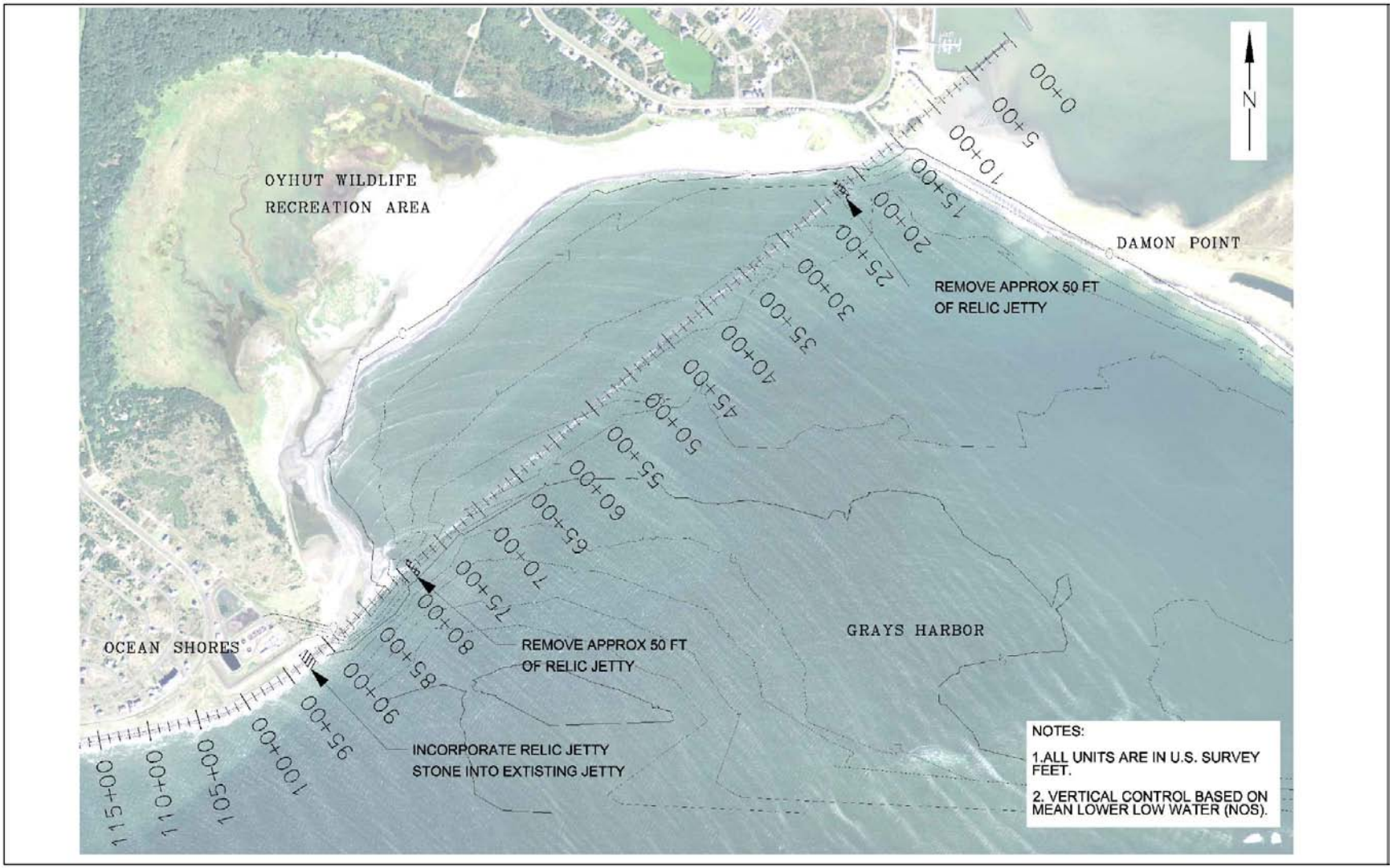

Figure 24. Proposed Mitigation at Oyhut Wildlife Recreation Area

10.6 RECOMMENDED PLAN COST ESTIMATE

Alternative 1B has a net present value (NPV) cost of $10,644,570 and annual cost of $527,728 over the 50 year period of analysis. Table 18 presents the present value costs, by year and expense for Alternative 1B. Second quarter 2006 costs were escalated to second quarter 2010 costs, and a contingency was applied to derive a current net present value (NPV) cost and annualized cost, using the FY10 federal discount rate. As noted earlier, the analysis assumed no interest during construction since initial construction was estimated to be four months or less for any alternative, and sand placement for nourishment takes one month and gravel placement for nourishment takes two months or less. Table 18 shows costs for Alternative 1B both with and without IDC simply for comparison. The following costs and assumptions went into the NPV calculation:

- O&M (sand renourishment) = 105,000 cy South Beach + 110,000 cy Half Moon Bay = 215,000 cy total per 10-yr nourishment.
    - Construction period for each nourishment: 1 month.
- Initial construction includes 55,000 tons of stone for the diffraction structure.
    - Construction period for diffraction structure: 2 months.
- Mitigation Plan:
    - Initial construction includes rock excavation of approximately 1,482 cy at an estimated cost of $88,900, and mobilization of an excavator/crane with clamshell bucket estimated at $60,000. Total initial construction estimate = $148,900.
    - Construction period: 1 month.
    - Annual mitigation estimated as approximately 2% of annual O&M costs, or $3,000/year.
    - Mitigation construction period: 1 month.

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Table 18. NPV Life Cycle Costs, Construction and Maintenance Schedule for Alternative 1B (With and Without Interest During Construction)

NPV Life Cycle Costs Construction and Maintenance Schedule Alt 1B - Modified Current Practice						Fed Intr rate 0.04375			
		Without Interest During Construction				With Interest During Construction			
#	Year	Initial Construction*	O&M	Mitigation	PV	Initial Construction*	O&M	Mitigation	PV
0	2010	$ -	$ -						
0	2011	$ -	$ -	$0					
1	2012	$ 3,930,000	$ 1,390,000	$151,900	$ 5,471,900	$ 3,937,024	$ 1,390,000	$151,900	$ 5,478,924
2	2013	$ -	$ -	$3,000	$ 2,869			$3,000	$ 2,869
3	2014	$ -	$ -	$3,000	$ 2,743			$3,000	$ 2,743
4	2015	$ -	$ -	$3,000	$ 2,623			$3,000	$ 2,623
5	2016	$ -	$ -	$3,000	$ 2,508			$3,000	$ 2,508
6	2017	$ -	$ -	$3,000	$ 2,399			$3,000	$ 2,399
7	2018	$ -	$ -	$3,000	$ 2,294			$3,000	$ 2,294
8	2019	$ -	$ -	$3,000	$ 2,193			$3,000	$ 2,193
9	2020	$ -	$ -	$3,000	$ 2,097			$3,000	$ 2,097
10	2021	$ -	$ -	$3,000	$ 2,006			$3,000	$ 2,006
11	2022	$ -	$ 1,390,000	$3,000	$ 890,565		$ 1,390,000	$3,000	$ 890,565
12	2023	$ -	$ -	$3,000	$ 1,834			$3,000	$ 1,834
13	2024	$ -	$ -	$3,000	$ 1,754			$3,000	$ 1,754
14	2025	$ -	$ -	$3,000	$ 1,677			$3,000	$ 1,677
15	2026	$ -	$ -	$3,000	$ 1,604			$3,000	$ 1,604
16	2027	$ -	$ -	$3,000	$ 1,534			$3,000	$ 1,534
17	2028	$ -	$ -	$3,000	$ 1,466			$3,000	$ 1,466
18	2029	$ -	$ -	$3,000	$ 1,402			$3,000	$ 1,402
19	2030	$ -	$ -	$3,000	$ 1,341			$3,000	$ 1,341
20	2031	$ -	$ -	$3,000	$ 1,282			$3,000	$ 1,282
21	2032	$ -	$ 1,390,000	$3,000	$ 569,351		$ 1,390,000	$3,000	$ 569,351
22	2033	$ -	$ -	$3,000	$ 1,173			$3,000	$ 1,173
23	2034	$ -	$ -	$3,000	$ 1,121			$3,000	$ 1,121
24	2035	$ -	$ -	$3,000	$ 1,072			$3,000	$ 1,072
25	2036	$ -	$ -	$3,000	$ 1,025			$3,000	$ 1,025
26	2037	$ -	$ -	$3,000	$ 980			$3,000	$ 980
27	2038	$ -	$ -	$3,000	$ 938			$3,000	$ 938
28	2039	$ -	$ -	$3,000	$ 897			$3,000	$ 897
29	2040	$ -	$ -	$3,000	$ 857			$3,000	$ 857
30	2041	$ -	$ -	$3,000	$ 820			$3,000	$ 820
31	2042	$ -	$ 1,390,000	$3,000	$ 363,994		$ 1,390,000	$3,000	$ 363,994
32	2043	$ -	$ -	$3,000	$ 750			$3,000	$ 750
33	2044	$ -	$ -	$3,000	$ 717			$3,000	$ 717
34	2045	$ -	$ -	$3,000	$ 685			$3,000	$ 685
35	2046	$ -	$ -	$3,000	$ 655			$3,000	$ 655
36	2047	$ -	$ -	$3,000	$ 627			$3,000	$ 627
37	2048	$ -	$ -	$3,000	$ 599			$3,000	$ 599
38	2049	$ -	$ -	$3,000	$ 573			$3,000	$ 573
39	2050	$ -	$ -	$3,000	$ 548			$3,000	$ 548
40	2051	$ -	$ -	$3,000	$ 524			$3,000	$ 524
41	2052	$ -	$ 1,390,000	$3,000	$ 232,707		$ 1,390,000	$3,000	$ 232,707
42	2053	$ -	$ -	$3,000	$ 479			$3,000	$ 479
43	2054	$ -	$ -	$3,000	$ 458			$3,000	$ 458
44	2055	$ -	$ -	$3,000	$ 438			$3,000	$ 438
45	2056	$ -	$ -	$3,000	$ 419			$3,000	$ 419
46	2057	$ -	$ -	$3,000	$ 401			$3,000	$ 401
47	2058	$ -	$ -	$3,000	$ 383			$3,000	$ 383
48	2059	$ -	$ -	$3,000	$ 366			$3,000	$ 366
49	2060	$ -	$ -	$3,000	$ 350			$3,000	$ 350
50	2061	$ -	$ -	$3,000	$ 335			$3,000	$ 335
			Total NPV	2Q2006$	$ 7,582,336		Total NPV	2Q2006$	$ 7,589,360
			Annualized	2Q2006$	$ 375,911		Annualized	2Q2006$	$ 376,259
			w/ 25% Contingency	2Q2006$ w/ Contingency	$ 9,477,920		w/ 25% Contingency	2Q2006$ w/ Contingency	$ 9,486,700
			Annualized	2Q2006$ w/ Contingency	$ 469,888			2Q2006$ w/ Contingency	$ 470,324

* Includes IDC (interest during construction)

Total Net Present Value (NPV)	$7,582,336
Escalation (Second quarter, 2006 to second quarter, 2010)	$933,320
Total NPV in 2010 dollars	$8,515,656
Contingency (25%)	$2,128,914
Total NPV in second quarter 2010 dollars w/ Contingency	$10,644,570
Annualized	$527,728

10.7 REAL ESTATE REQUIREMENTS OF THE RECOMMENDED PLAN

This Real Estate summary is presented in support of the recommended plan, Alternative 1B, Modified Current Practice with Modified Diffraction Structure, as described in chapters 6 and 11 of this report. The purpose of this Real Estate summary is to identify the rights-of-way necessary to support the preferred Long Term Maintenance Strategy (LTMS) and mitigation plan; and to identify the costs associated with securing the real estate interests required to support the LTMS.

The Port of Grays Harbor is the Non-Federal Sponsor (NFS) for the preferred LTMS measures, as the Port is the NFS for the principal features of the Federal navigation project, the operation and maintenance of which are being addressed under the LTMS. The NFS will be responsible for acquiring and certifying available for the project all real estate interests necessary to support the proposed measures. The proposed LTMS has three major components: recurring maintenance of the sand dune profile between South Beach and Half Moon Bay in the breach zone adjacent to the south jetty, construction of a modified diffraction structure that extends the jetty root approximately 500 LF east along the footprint of a jetty remnant to help reduce storm wave erosion at Half Moon Bay, and a mitigation measure consisting of the removal of a total of 100 LF of submerged jetty on the north side of the inlet to Grays Harbor to improve shallow water habitat in the Oyhut Wildlife Recreation Area.

The areas required for monitoring conditions in the breach fill area adjacent to the South Jetty, and areas necessary for transportation and placement of beach nourishment materials in the breach fill area under the preferred alternative are predominantly located within Westhaven State Park. The NFS would be responsible for acquiring and certifying available for the project a Perpetual Beach Storm Damage Reduction Easement estate for all project areas where material placement is proposed above the MHW tidal elevation. The current trigger response area abutting the South Jetty and the material placement sites at South Beach and Half Moon Bay have until now been secured via short term Right-of-Entry permits due to Washington State Park's policy prohibiting the conveyance of perpetual interests in Park lands. The temporary right-of-entry permits until now have been granted at no cost to the Corps. However, State Parks has recently indicated their concern with the deteriorating condition of the Park Entrance Road and the lack of state resources to accomplish road maintenance repairs. Therefore, it is likely that State Parks would request substantial road repairs in consideration for a long term easement to use the Park Entrance Road, parking lot and sand dune areas north of the parking lot for the preferred LTMS alternative.

The LTMS preferred alternative proposes the use of the Point Chehalis revetment/stockpile site to store materials drawn from the navigation channel during periodic maintenance

dredging operations, as an alternative source of sand nourishment materials in the breach fill area. The Point Chehalis revetment/stockpile site was certified available for a Section 111 navigation improvement project in 1995. The City of Westport, as NFS, acquired a perpetual easement from the Port of Grays Harbor for use of the stockpile site. The Section 111 project stored the dredged materials at the Point Chehalis revetment/stockpile site and periodically transported the materials and placed them on the beach at Half Moon Bay in support of O&M requirements. The easement for the Point Chehalis stockpile area carried a perpetual term. However, the purpose of the easement was expressly limited to the City's use in support of the Section 111 project. Further implementation of the Section 111 project, including O&M, has been curtailed. The Port of Grays Harbor as NFS for the LTMS would be obligated to certify available for the LTMS a perpetual interest for stockpiling dredged materials at the Point Chehalis revetment/stockpile site, if that sand supply alternative is to be utilized.

Construction of the modified diffraction structure on the east end of the South Jetty, all beach material placement activities below MHW, and the removal of a portion of submerged jetty located on the north side of the Grays Harbor entrance channel for mitigation purposes are all project activities that would occur in navigable waters of the United States. The Federal Navigation Servitude is available for this Federal navigation project and would be exercised for all activities that would occur below MHW. No additional property interests are required for project areas below MHW where the Federal Navigation Servitude applies.

Implementation of the preferred means of delivering sand for placement in the breach fill area, on either the western shoreline of Half Moon Bay or on the South Beach shoreline, would entail hydraulic pumping of dredged material transported via pipeline to the placement location. The origin of the pipeline in each case would be immediately offshore of South Beach or in Half Moon Bay, respectively; each pipeline would lead directly ashore to the area ringed by a containment dike for placement. A Perpetual Beach Storm Damage Reduction Easement interest over the affected areas within Westhaven Park and on adjoining parcels as necessary would need to be acquired and certified available for the project by the NFS.

Access over land from the Pt. Chehalis stockpile, or from a commercial sand quarry to the proposed LTMS material placement sites within the breach fill area, would require use of the Westhaven Park Entrance Road, use of the Park parking lot south of the breach fill area, and use of the sand dunes between the parking area and the South Jetty (See Figure 21, preferred Alternative 1B drawing). A perpetual easement interest over the Park road and over other areas within Westhaven Park required for the preferred LTMS alternative would need to be acquired and certified available for the project by the NFS for wheeled vehicle access.

A second alternative means of access proposed for Alternative 1B is the use of tracked vehicles to transport sand from the Point Chehalis stockpile to the breach fill area along an unpaved route between the Half Moon Bay beach and the boardwalk pedestrian trail within Westhaven Park that parallels the Park Entrance Road. This alternative would require the NFS to acquire and certify available for the project an interest in Westhaven Park lands for the tracked vehicle access route as well as the areas within the breach fill area required for the trigger response and placement of materials.

Application of the alternative means of delivering dredged materials from the Point Chehalis Stockpile to the material placement site in the breach fill area would require periodic replenishment of the Point Chehalis Stockpile. Replenishment would entail hydraulic pumping of dredged material transported via pipeline, from a point of origin immediately offshore in Half Moon Bay leading directly ashore to the area ringed by a containment dike for placement. A Perpetual Beach Storm Damage Reduction Easement interest in the Pt. Chehalis stockpile site and lands adjoining the eastern Half Moon Bay shoreline would need to be acquired by the NFS and certified available for the project to support Point Chehalis Stockpile replenishment.

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11 ENVIRONMENTAL COMPLIANCE WITH APPLICABLE LOCAL, STATE, AND FEDERAL REGULATIONS

The Corps has analyzed the environmental effects of the alternatives and the following sections describe how the preferred alternative complies with all pertinent environmental laws and executive orders.

11.1 NATIONAL ENVIRONMENTAL POLICY ACT

In accordance with the National Environmental Policy Act (42 USC 4321 et seq.), federal agencies are required to assess and disclose the potential environmental effects of their projects and to solicit public comment. The purpose of this document is to solicit public comment and fulfill the Corps of Engineers' documentation requirements under the National Environmental Policy Act, as well as to provide a basis for informed decision making. This EA, along with the documents listed in section2.5 (Table 2), satisfy the documentation requirements of NEPA. A draft Finding of No Significant Impact (FONSI) is provided in Appendix G.

11.2 CLEAN WATER ACT (SECTION 404[B][1])

Section 404 of the Clean Water Act (CWA) governs the discharge of dredged or fill material into waters of the United States. The regulations implementing the act disallow placement of dredged or fill material into waters (and excavation) unless it can be demonstrated there are no less-environmentally-damaging practicable alternatives. The Corps has prepared a 404(b)(1) Consistency Evaluation to document findings regarding this project pursuant to Section 404 requirements (Appendix E).

Relative to Section 401 of the CWA, USEPA has delegated Section 401 oversight authority to the Washington State Department of Ecology (Ecology). For compliance with Section 401, the Corps will request certification from Ecology through the promulgation of this draft EA in order to demonstrate compliance with state water quality standards, and will obtain water quality certification (WQC) prior to finalizing the EA and issuing the FONSI.

11.3 COASTAL ZONE MANAGEMENT ACT

The Coastal Zone Management Act (CZMA) of 1972, as amended, requires Federal agencies to carry out their activities in a manner that is consistent to the maximum extent practicable with the enforceable policies of the approved Washington Coastal Zone Management Program. The Corps has prepared a CZMA Consistency Determination (Appendix F) for the long term management strategy project. This Determination established that the preferred alternative complies with the policies, general conditions, and general activities specified in the approved Grays Harbor County Shoreline Management Master Plan, the City of

Westport Shoreline Management Master Plan, and the Grays Harbor Estuary Management Plan. The preferred action is thus considered consistent to the maximum extent practicable with the State of Washington Shoreline Management Program. The Consistency Determination will be submitted to the Washington Department of Ecology for concurrence.

11.4 Endangered Species Act

The ESA (16 USC 1531-1544) established a national program to protect and recover imperiled species and the habitat upon which they depend. Section 7 of the ESA requires federal agencies to consult with NMFS and the USFWS if their proposed actions may affect ESA-listed species or designated critical habitat. The ESA-listed species and their designated critical habitat are summarized in Table 17 (section 7.2.2.6). The Corps will consult with the USFWS and NMFS under the provisions of Section 7 of the ESA. Also, the Corps will conclude consultation with the Services prior to finalizing the EA and signing the FONSI. A synopsis of the Services' effects determinations will be summarized in the Final EA.

11.5 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC 661) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. Coordination with the agencies is not required for operations and maintenance projects.

11.6 Bald and Golden Eagle Protection Act

The BGEPA (16 USC 668-668d) prohibits the taking, possession, or commerce of bald and golden eagles, except under certain circumstances. Amendments in 1972 added to penalties for violations of the act or related regulations. It is unlikely that bald eagles or golden eagles would visit the project area rather than transiting through. Therefore, the preferred alternative would not affect bald or golden eagles.

11.7 Magnuson-Stevens Fishery Conservation and Management Act

In accordance with the EFH requirements of the MSFCMA, the Corps has determined that the proposed action may adversely affect EFH of federally managed fisheries in Grays Harbor but would be compensated by conservation measures. The Corps will consult with NMFS on EFH issues and finalize consultation prior to finalizing the EA and signing the FONSI.

11.8 Marine Mammal Protection Act

The Marine Mammal Protection Act (MMPA) of 1972, as amended, administered by NMFS, prohibits the taking of marine mammals by citizens of the United States except under certain conditions (16 U.S.C. 1361). A take as defined under the MMPA includes to harass, hunt,

capture, or kill, or attempt to harass, hunt, capture, or kill any marine mammal. Several species of marine mammals can be found in Grays Harbor or the adjacent Pacific Ocean waters. The most likely occurring marine mammals are harbor seals and California sea lions. None of the alternatives are expected to cause incidental harassment or incidental take of harbor seals or California sea lions in the project area, because these marine mammals have become habituated to human activity in Grays Harbor and any underwater sound generated by project construction activities will be below the threshold level for harm to these species. Therefore, it is not considered necessary for the Corps to apply to NMFS for incidental take authorization under the MMPA.

11.9 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) is the domestic law that affirms, or implements, the United States' commitment to four international conventions with Canada, Japan, Mexico, and Russia for the protection of shared migratory bird resources. The MBTA governs the taking, killing, possessing, transporting, and importing of migratory birds, their eggs, parts, and nests. The take of all migratory birds is governed by the MBTA's regulation of taking migratory birds for educational, scientific, and recreational purposes and requiring harvest to be limited to levels that prevent over-use. Some migratory bird species protected under the MBTA may transit the project area, but the project area is not nesting habitat or primary foraging habitat for these MBTA species, therefore the preferred alternative will have no effect on birds protected under the MBTA.

11.10 National Historic Preservation Act (Section 106)

Section 106 of the National Historic Preservation Act of 1966 (NHPA) requires that the effects on potential sites, structures, or objects included or qualified for the National Register of Historic Places (NRHP) be considered prior to proposed actions.

The project footprint has not changed markedly since the 1994 breach fill and subsequent sand placements. The action at the south jetty does not involve any excavation in previously undisturbed areas but adds additional material to a highly disturbed site, including a breach fill area that consists of accreted lands, formed since construction of the South Jetty, that has had multiple episodes of material added to it throughout the years. Sand placement with this project would be accomplished to slow the erosion process in an area of very high-energy and strong natural erosive properties. Further document review by Corps archeologists indicates that the project area has low probability for the existence of properties that could be eligible for listing in the NRHP. More pertinently, the nature of the undertaking (maintenance work associated with an existing Corps structure) is of a type that has No Potential to Cause Effects to Historic Properties. Accordingly, no additional work beyond inclusion of this document evidencing the Corps' compliance with Section 106 in the permanent project files is considered necessary.

11.11 Tribal Usual and Accustomed Areas

Tribal Usual and Accustomed (U&A) areas are locations where tribes retain the right to fish or harvest other species (including both plants and animals) as defined by treaty rights. The Tribal U&A areas in proximity to the proposed project area are those of the Quinault Tribe (Preston et al. 2004). Typically the Quinault tribe harvests spring and summer fish stock from April to July. In the winter season, a small Tribal steelhead fishery is in operation at the beginning of each week when fishing is allowed. Tribal fisheries, including salmon, steelhead, marine fishes, and Dungeness crab, are typically conducted farther east in Grays Harbor and generally not in Half Moon Bay.

The preferred alternative has been analyzed with respect to its effects on Quinalt Tribe treaty rights relative to their usual and accustomed fishing grounds in Grays Harbor. The Corps believes the following:

(1) The work will not interfere with access to their usual and accustomed fishing and gathering areas;

(2) The work will not cause the degradation of fish runs in usual and accustomed fishing grounds or with fishing activities or shellfish harvesting and habitat; and

(3) The work will not impair the Quinault Tribe's ability to meet moderate living needs.

11.12 Clean Air Act

The CAA as amended was established "to protect and enhance the quality of the nation's air resources so as to promote public health and welfare and the productive capacity of its population." Some temporary mobile source emission releases are expected during construction. However, these emissions will be temporary and localized. Air quality is not expected to be impacted to any measureable degree. Air quality impacts resulting from the preferred action are not expected to be significant, but temporary and localized. The action is considered exempt from the conformity requirements of the CAA because it constitutes a routine facility repair and maintenance activity generating an increase in emissions that is clearly *de minimis* under 40 CFR 93.153(c)(2)(iv).

11.13 Environmental Justice (EO 12898)

Each federal agency shall make achieving environmental justice part of its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations in the United States. Grays Harbor County has a very small minority population base and is arguably one of the more economically

challenged parts of the state (OFM 2007 and 2008). The project represents a potential for very few, short-term employment opportunities to the area. The project does not disproportionately impact minority or low-income populations.

11.14 FLOODPLAIN MANAGEMENT (EO 11988)

Executive Order 11988 requires federal agencies to consider how their activities may encourage future development in floodplains. The preferred action maintains existing facilities and uses, and is not expected to induce any additional occupancy or modification of floodplains, or otherwise affect land use in the vicinity.

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12 PUBLIC INVOLVEMENT

Since 2004, several efforts have been made to incorporate stakeholder involvement into the development of an LTMS for the Grays Harbor (Table 23). In 2004, a situation assessment was conducted to determine the potential to develop an LTMS in collaboration with the diverse stakeholders with interests in Grays Harbor. The assessment included interviews with 40 stakeholders from public entities (federal, state and local), private entities, Tribes, and nonprofit organizations. The purpose of the assessment was to better understand the range of perspectives and concerns regarding issues of importance to stakeholders and about the opportunities for collaboration in the development of the LTMS. A follow-up workshop was held in February 2005 to discuss the results of the situation assessment, understand the purpose and authorities of the Corps relative to the LTMS, define what would characterize success for developing the LTMS, review the evaluation criteria for alternatives, and engage in a mapping exercise to better understand the Corps authority and the parameters of the LTMS.

Table 19. LTMS Public Involvement Timeline

Date	Action
November 9, 2004	Open House at Grays Harbor College
December 2004	Situation assessment interviews with 40 stakeholders
February 9, 2005	Public workshop
July 12, 2005	Port Commission Meeting (public session)
September 14, 2005	Meeting regarding ITR findings
September 29, 2005	Public workshop on alternatives
February 16, 2006	Information meeting
July 18, 2006	Port Commission Meeting (public session)
August 2008	Update to Port Commission (public session)
January 21, 2009	Public meeting on narrowed list of alternatives
Fall 2011	Public workshop to receive comments on the Draft EA

In fall 2004, an open house was held at Grays Harbor Community College to provide the community with an opportunity to learn about the Corps' project in Grays Harbor and the science driving decisions about the maintenance of Federal Navigation Channel features and ecological and engineering concerns.

On September 14, 2005, the Corps held an informational public meeting on the ITR at which the ITR Committee and LTMS Team presented their perspectives on the results of studies completed by the ERDC CTH concerning the analysis of breaching at the South Jetty and the Half Moon Bay physical model.

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At the end of September 2005, a workshop was held at the Port of Grays Harbor. This workshop discussed alternatives for the LTMS and further discussed criteria for the LTMS strategy and decision making. Twenty-two alternatives resulted from this workshop, 15 presented by the Corps from previous studies and seven suggested by the stakeholders based on their experience and other consultant and agency studies.

The Corps presented information at a public meeting February 16, 2006, on a narrowed list of long-term strategies for maintaining, protecting, and effectively operating in Grays Harbor. The Corps followed up after the meeting asking the public to send any reports or additional technical information to the project manager for the LTMS Team's consideration.

Study team members from the Corps attended the July 18, 2006, Port Commission meeting to provide the Port of Grays Harbor and the public an update on the ongoing LTMS for continued operation and maintenance of the Grays Harbor Navigation Project.

In August 2008, the study manager gave a project update to the Port Commission at its public session.

In January 2009, a workshop was held to inform stakeholders about the 15 alternatives that evolved from the application of the screening criteria to the 22 alternatives from the February 2005 workshop. These 15 alternatives were organized into five categories. Stakeholders were given an opportunity to comment on the alternatives in small group sessions.

The Corps anticipates holding a public workshop in fall 2011 for the public, agencies, and stakeholders to present progress made since the last public workshop and receive comments on the Draft EA.

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13 CONCLUSION AND RECOMMENDATION

The Corps has identified a problem of shoreline erosion in the vicinity of the South Jetty at Grays Harbor, Washington which could again result in the breaching of the landmass adjacent to the jetty and adversely impact the Federal navigation project at Grays Harbor. The purpose of the LTMS study documented in this letter report/EA is (1) to assess the risk that such a breach may occur, (2) to evaluate the threat of adverse impact to the Grays Harbor Navigation Project resulting from any breach, and—if action is determined to be warranted—(3) assess and recommend the most appropriate long-term strategy for continued maintenance of the authorized Federal Navigation Project features.

As described in Chapter 4, if the South Beach and Half Moon Bay shorelines continue to recede at the historical rates, a breach will eventually re-form. Assuming the 1993-1994 breach scenario is repeated, and is not responded to with any sort of repair action, sand carried through the breach will fill most of Half Moon Bay, and, for a period of time, reduce, if not eliminate erosion along the Half Moon Bay shoreline. Continued erosion of the breach area will widen the gap between the South Jetty and the shoreline, and a permanent secondary channel to the ocean may be created through the remains of Half Moon Bay.

Despite decades of scientific evaluation, definitive conclusions have not been reached regarding the degree of risk a breach may have on the Federal navigation features. Historic knowledge of the breaching process, numerical modeling studies, and professional judgment have produced a significant body of work, described in chapters 2 and 4, which indicates there is elevated risk of adverse consequences associated with a breach. Therefore in light of the potential for these consequences to the integrity and operability of the South Jetty and the navigation channel, and recognizing the advisability of maintaining land access to the South Jetty structure for maintenance purposes, the Corps has concluded that it is both prudent and justified to proceed with the LTMS action on the presumption that a breach would eventually pose an unacceptable threat to the navigation project and its facilities. The projected long-term deleterious consequences include:

- Shoaling in the navigation channel
- Structural damage to the South Jetty
- Increased O&M to Point Chehalis revetment and groins
- Increase O&M to Westport marina features, and
- Adverse impacts to the North Jetty resulting from changes littoral drift.

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Based on the analyses conducted during the LTMS study, the LTMS team identified Alternative 1B as the recommended plan; the NEPA preferred alternative. The recommended action, including proposed mitigation measures, best achieves the project purpose and need while minimizing impacts to the environment. This alternative would entail placement of sand on the dune area between Half Moon Bay and South Beach, based on the existing triggering criteria used in the current practice, along with construction of a modified diffraction structure at the eastern terminus of the South Jetty.

When compared to the current practice (i.e., the NEPA No Action alternative), the proposed modified diffraction structure is expected to reduce the amount of sand needed to be placed at Half Moon Bay. The modified diffraction structure will impact aquatic habitat, primarily juvenile salmonid habitat. To offset this impact, riprap from the relic North Jetty will be removed near the land connection at Point Brown and Damon Point. This removal is expected to promote better water movement through the Oyhut Wildlife Recreation Area and provide access to excellent shallow water habitat for fish, including Endangered Species Act (ESA- listed salmonid species, at all tidal levels.

Implementation of the recommended plan—the NEPA preferred alternative—would not generate significant impacts on the quality of the human or natural environment, and the preparation of an Environmental Impact Statement is thus not required.

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Appendix A: Summary of 2009 LTMS Alternatives Public Workshop

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Appendix B: Multi-Criteria Decision Analysis

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Appendix C: Iteration of Multi-Criteria Decision Analysis

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Appendix D: Engineering Analysis

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Appendix E: Clean Water Act Section 404[B][1] Evaluation

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Appendix F: Coastal Zone Management Act (CZMA) Consistency Determination

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Appendix G: Draft Finding of No Significant Impact (FONSI)

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