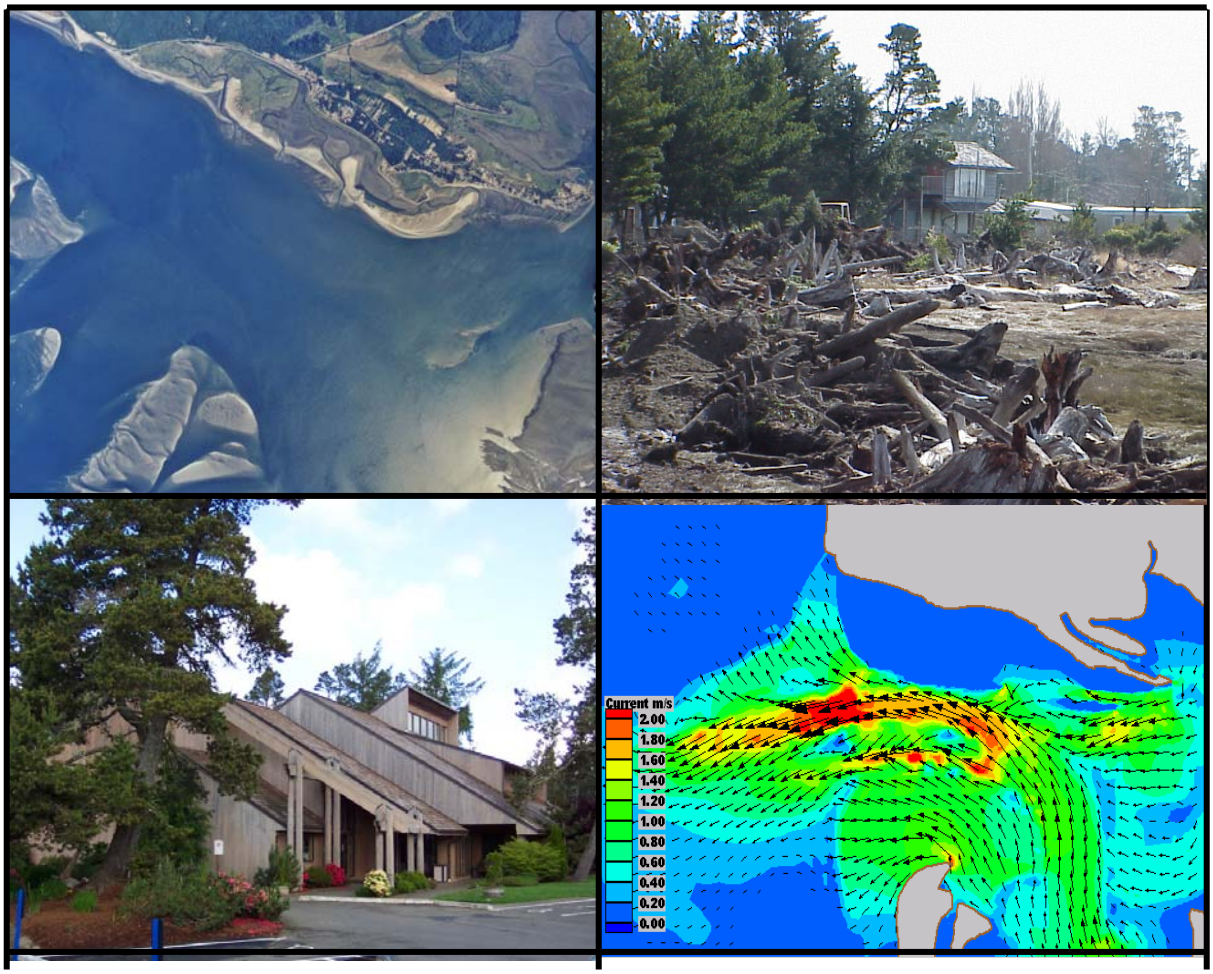
POST-AUTHORIZATION DECISION DOCUMENT

Shoalwater Bay Shoreline Erosion, Washington

FLOOD AND COASTAL STORM DAMAGE REDUCTION

Shoalwater Bay Indian Reservation



US Army Corps of Engineers®
Seattle District

FINAL DRAFT
(Subject to Revision)

March 2007

POST-AUTHORIZATION DECISION DOCUMENT

Shoalwater Bay Shoreline Erosion, Washington

This report is not intended as a final expression of the findings or conclusions of the United States Army Corps of Engineers, nor has it been adopted by the Corps as such. Rather, this is a draft report summarizing data and interim results compiled to date. As a draft report, this document and the information contained therein are subject to revisions and changes as additional information is obtained.

EXECUTIVE SUMMARY

The Shoalwater Bay Shoreline Erosion, Washington, study was conducted in accordance with Section 545 of the Water Resources Development Act (WRDA) of 2000, Public Law 106-541. Section 545(a) of WRDA 2000 directed the Secretary of the Army (Secretary) to conduct a study to determine the feasibility of providing coastal erosion protection for the tribal reservation of the Shoalwater Bay Indian Tribe in the State of Washington. Section 545(b) provides that the Secretary may construct and maintain a project at Federal expense if the Secretary determines that the project: (a) is a cost-effective means of providing erosion protection; (b) is environmentally acceptable and technically feasible; and (c) will improve the economic and social conditions of the Shoalwater Bay Indian Tribe (Shoalwater Tribe).

In accordance with Section 545(a), an investigation of the coastal processes at Willapa Bay affecting the Shoalwater Bay Indian Reservation (Shoalwater Reservation) has been completed. The collaborative interagency investigation conclusively demonstrated that modest engineering solutions are technically feasible to protect the Shoalwater Reservation from coastal erosion and resulting flooding associated with storm events that coincide with extreme high tides. Without action, the Shoalwater Bay Indian Reservation will be increasingly vulnerable to severe shoreline erosion and the resulting damaging flooding associated with wind-driven storm waves, particularly during periods of extreme high tides.

The Shoalwater Reservation was established in 1866 by Executive Order of President Andrew Johnson. The Reservation is located on the Tokeland Peninsula on the north shore of the entrance to Willapa Bay, a very large estuarine system on the Pacific Ocean coast of Washington. Willapa Bay is approximately 28 miles north of the mouth of the Columbia River and 12 miles south of the entrance to Grays Harbor. The Reservation is slightly greater than one-square mile in area and consists of 440 acres of uplands and 700 acres of important tidal flat and marine salt marsh habitats in North Cove. All Reservation land is tribally owned, and is bounded by steep natural hillsides to the east and north and by Willapa Bay to the south.

The investigation conducted as part of this study has shown that because of the erosion of the barrier dune, larger wind-driven waves at extreme high tide more frequently impact the shoreline, causing enhanced wave run-up to both erode and flood areas of tribal uplands. In addition, the erosion of the barrier dune has negatively impacted the North Cove embayment, thus decreasing the opportunity for subsistence and cultural activities by the Shoalwater Tribe.

The entire Shoalwater Reservation is at increasing risk of shoreline erosion and coastal flooding associated with storm events at extreme high tide. The flooding is the direct result of the gradual erosion and breaching of the barrier dune on Graveyard Spit that fronts the Reservation and the Tokeland Peninsula. As a result, the narrow shoreline strip of developable lands upon which tribal facilities and housing are located is at increasing risk of serious shoreline erosion and flood damage. Likewise, the productivity of the North Cove tide flats and salt marsh

upon which tribal members have relied for subsistence shellfish and harvesting of local native plant species for tribal crafts and ceremonial use will continue to decline due to its infilling with sand from storm wave overwash and erosion of the eroded barrier dune. Winter storms in 1998-1999 caused two breaches to form in the barrier dune, resulting in storm wave run-up and flooding of shoreline areas where tribal development is concentrated. Storm wave overwash has eroded the barrier dune, resulting in infilling of the North Cove tidal flats with sand. This has diminished the Cove's ability to sustain Tribal subsistence shellfish beds and native plant populations. To protect the Tribal Center, a 1,700-foot-long shoreline flood berm was constructed in 2001 by the Corps of Engineers. In February 2006, another storm at extreme high tide caused significant flooding and damage, with debris blocking the State highway that traverses the Reservation. Five of the eleven extreme high tides recorded since 1970 have occurred since 1999.

A wide array of alternative plans were formulated and evaluated against identified problems and opportunities, and planning objectives and criteria. Six plans that are neither technically feasible nor environmentally acceptable were screened out. Three alternative plans, plus the No Action alternative, were carried forward for further evaluation: sea dike (Alternative 4), barrier dune restoration (Alternative 6), and barrier dune restoration with flood berm extension (Alternative 7). Each plan would provide a complete solution to identified problems. The sea dike alternative was found to have the highest initial construction and annualized cost, and is not environmentally acceptable. The barrier dune restoration alternative meets all criteria specified in the project authorization, but requires frequent (every 5 years) periodic nourishment to ensure that the necessary level of coastal storm damage reduction is never compromised.

Barrier dune restoration with flood berm extension (Alternative 7) has been determined to be the most appropriate long term solution to the shoreline erosion and coastal storm damage problems affecting the Shoalwater Bay Indian Reservation. Alternative 7 is the best technical solution to the identified water resource needs and problems, and will afford effective protection to the entire Shoalwater Reservation. With an initial construction cost of $12,240,000 and an annualized cost of $1,282,000, **Alternative 7 best satisfies planning objectives and criteria, and meets all criteria specified in the WRDA 2000 Section 545 project authorization.**

Approval to implement Alternative 7 is recommended. Alternative 7 is a cost-effective means of providing coastal erosion protection, is environmentally acceptable, and is technically feasible. By reducing shoreline erosion and related coastal storm damage problems, the plan will improve the economic and social conditions of the Shoalwater Bay Indian Tribe. Alternative 7 will protect tribal uplands from storm-related shoreline erosion and flooding, as well as prevent further degradation of the 700-acre North Cove embayment subsistence intertidal habitat. Alternative 7 is fully consistent with the Corps' environmental operating principles, and will be environmentally sustainable; the project will improve the quality of life for present and future generations.

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APPENDIX (bound separately)

Appendix 1 Engineering Analysis and Design

INTERAGENCY PROJECT DELIVERY TEAM

An interagency team, under direction of the U.S. Army Corps of Engineers, Seattle District, conducted studies to determine the technical feasibility of, and to formulate alternative plans for, providing coastal erosion protection to the Shoalwater Bay Indian Reservation located on the Pacific coast at Willapa Bay, WA. Based on the studies, this report was prepared by Seattle District.

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ABBREVIATIONS AND ACRONYMS

ACES	Automated Coastal Engineering System (Corps of Engineers)
ASA (CW)	Assistant Secretary of the Army for Civil Works
BA	Biological Assessment
CHL	Coastal and Hydraulics Laboratory, at ERDC
Corps	U.S. Army Corps of Engineers
CY	Cubic yard
EA	Environmental assessment
Ecology	Washington Department of Ecology
EL	Elevation
EO	Executive Order
ERDC	U.S. Army Engineer Research and Development Center
ESA	Endangered Species Act
FWCA	Fish and Wildlife Coordination Act
GIS	Geospatial information system
HQUSACE	Headquarters, U. S. Army Corp of Engineers
H	Horizontal
HTRW	Hazardous, toxic and radiological waste
ITR	Independent technical review
LERD	Lands, Easements, rights-of-way, and dredged material disposal areas
M-CACES	Micro-computer aided cost engineering system
MHHW	Mean higher high water
MLLW	Mean lower low water
MOA	Memorandum of Agreement
NEPA	National Environmental Policy Act 1969
NMFS	National Marine Fisheries Service
NOS	National Ocean Survey
OMRR&R	Operation, maintenance, repair, replacement and rehabilitation
P&S	Plans and specifications
PED	Preconstruction engineering and design
PDT	Project delivery team
PL	Public Law
Shoalwater Reservation	Shoalwater Bay Indian Reservation
Shoalwater Tribe	Shoalwater Bay Indian Tribe
SR	State Route
STA	Station
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
V	Vertical
WDOT	Washington Department of Transportation
WRDA	Water Resources Development Act

CONVERSION FACTORS: NON-SI TO SI UNITS OF MEASUREMENT

The Metric System, a system of units used for physical measurements, is called the International System of Units, and its units are called SI units. Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply (non-SI Unit)	By	To Obtain (SI Unit)
acres	4,046.873	square meters
cubic yards	0.7645549	cubic meters
feet	0.3048	meters
inches	2.54	centimeters
miles (U.S. statute)	1.609347	kilometers
pounds	4.5359×10^2	grams
tons	1.016×10^3	kilograms
square miles	2,589,998	square meters

SECTION 1: INTRODUCTION

1.1 Study and Project Authorization

The Shoalwater Bay Shoreline Erosion, Washington, study was conducted in accordance with Section 545 of the Water Resources Development Act (WRDA) of 2000, Public Law 106-541. Section 545 of WRDA 2000, signed into law on December 11, 2000, authorized both a study and a project for coastal erosion protection for the tribal reservation of the Shoalwater Bay Indian Tribe. The complete text of Section 545 of WRDA 2000 is as follows:

SEC. 545. WILLAPA BAY, WASHINGTON.

(a) STUDY. - The Secretary shall conduct a study to determine the feasibility of providing coastal erosion protection for the tribal reservation of the Shoalwater Bay Tribe on Willapa Bay, Washington.

(b) PROJECT. -

(1) IN GENERAL. - Notwithstanding any other provision of law (including any requirement for economic justification), the Secretary may construct and maintain a project to provide coastal erosion protection for the tribal reservation of the Shoalwater Bay Tribe on Willapa Bay, Washington, at Federal expense, if the Secretary determines that the project -

(A) is a cost-effective means of providing erosion protection;

(B) is environmentally acceptable and technically feasible; and

(C) will improve the economic and social conditions of the Shoalwater Bay Tribe.

(2) LANDS, EASEMENTS, AND RIGHTS-OF-WAY.- As a condition of the project, described in paragraph (1), the Shoalwater Bay Tribe shall provide lands, easements, rights-of-way, and dredged material disposal areas necessary for implementation of the project.

(NOTE: For purposes of this Act, the term Secretary means the Secretary of the Army)

1.2 Study Purpose and Scope

The study documents ongoing coastal erosion problems affecting the Shoalwater Bay Indian Reservation (Shoalwater Reservation) and describes the formulation and evaluation of the most appropriate and effective plan to provide long-term coastal erosion protection to the Shoalwater Reservation, in accordance with the WRDA 2000 Section 545 project authorization. The goal of the project is to reduce coastal erosion and the resulting flooding and coastal storm damage to the Shoalwater Reservation and to the Shoalwater Bay Indian Tribe (Shoalwater Tribe). Accomplishment of this goal will enhance the quality of life for tribal members by

reducing flood and storm damage risk to both human life and tribal infrastructure. The project will provide direct benefits to the Shoalwater Tribe.

The scope of the investigation was to formulate and evaluate a plan that meets the following criteria, pursuant to criteria specified in project authorization:

- ***Is technically feasible;***
- ***Is a complete solution to the identified problems;***
- ***Is a cost-effective means of providing flood and coastal storm damage reduction and erosion protection;***
- ***Is environmentally acceptable; and***
- ***Will improve the economic and social conditions of the Shoalwater Bay Indian Tribe.***

1.3 Project Location

The project area is located on the north side of the entrance to Willapa Bay, a large estuarine system located on the southwest Pacific Ocean coast of the State of Washington, in Pacific County (see **Figure 1.1,** located at the end of Section 1). Willapa Bay is the second largest bay on the Pacific coast of the United States after San Francisco Bay. Willapa Bay is approximately 28 miles north of the mouth of the Columbia River and 12 miles south of the entrance to Grays Harbor. The bay has an area of 109 square miles at mean higher high water (MHHW) elevation and 62 square miles at mean lower low water (MLLW). Its spring or diurnal range tidal prism is more than 10^{10} cubic feet, making it one of the largest of all inlets of the continental United States. The magnitude of the tidal prism is produced by the broad bay area and relatively large tidal range (approximately 7 feet). The Willapa Bay entrance is about 6 miles wide between Cape Shoalwater on the north and Leadbetter Point on the south. Willapa Bay has served ocean-going vessels for nearly two centuries, but passage in and out of the bay has always been treacherous due to intense waves and currents at its unstructured entrance. The Willapa River is its principal tributary and enters from the east, and the Naselle River enters the bay at its southerly end. Willapa Bay has a southerly arm 19 miles long and an easterly arm 12 miles long. Both arms have numerous shoals and tide flats, with intervening channels formed by the discharge of tributary streams. The south arm is separated from the Pacific Ocean by a sandy peninsula (Long Beach Peninsula) having an average width of 1 ½ miles and elevations ranging up to 40 feet above MLLW and is terminated at its northern end by Leadbetter Point. Cape Shoalwater, bordering the bay's entrance channel on the north, consists of sand dunes adjacent to an actively eroding shoreline, wooded sand ridges about 40 feet high in the central part, and relatively low ground to the east.

1.4 Shoalwater Bay Indian Reservation and Tribe

1.4.1 Reservation Establishment and Federal Recognition

The Shoalwater Reservation was established by Executive Order of President Andrew Johnson on September 22, 1866. Note that the State of Washington was not admitted into the Union until 1889, whereas the Shoalwater Reservation was established in 1866. The complete text of the Executive Order reads as follows:

Shoalwater Reserve

[In Puyallup Agency; area, one-half square mile; occupied by Shoalwater and Chehalis.]

Executive Mansion, *September 22, 1866.*

Let the tract of land as indicated on the within diagram be reserved from sale and set apart for Indian purposes, as recommended by the Secretary of the Interior in his letter of the 18th instant, said tract embracing portions of sections 2 and 3 in township 14 north, range 11 west, Washington Territory.

Andrew Johnson.

It was not until 1971 that the Shoalwater Tribe became federally recognized. The Shoalwater Tribe rejected the Indian Reorganization Act in 1934, but their descendents gained Federal recognition on March 10, 1971. Shortly thereafter, the tribe adopted a constitution and elected a tribal council. In 1999, they became a self-governance tribe. A five-member elected Tribal Council governs the Tribe. All land is tribally owned; there have been no individual allotments of reservation land to tribal members.

1.4.2 Tribal Membership and Origins

The Shoalwater Bay Indian Tribe is small, but increasing in population. The Tribe currently has 311 enrolled members and a resident service population of 1,148, with an annual tribal budget of approximately $2.5 million. The Shoalwater Tribe is the project sponsor and proponent, and has worked to secure funding for the project. They have been an active participant on the formulation and evaluation team. Tribal leadership and their consultants contributed to the initial choice and assessment of alternatives. Tribal biological and cultural resources staff have supported field surveys and provided documentation in support of the analyses of environmental and cultural effects of the proposed action. The Shoalwater Tribe also maintains an active dialogue with the adjacent non-reservation community, hosts community meetings and forums on the project, and has conducted mailings to affected community members with information on the project. Tribal members are also commercial fishermen within Willapa Bay, and make use of local native plant species for Tribal crafts and ceremonial use.

Shoalwater Tribe members are the offspring of peoples who inhabited the Willapa Bay and Grays Harbor areas (Note that at the turn of the 20th century, what is now called Willapa Bay was known as Shoalwater Bay). Those peoples subsisted on fish, clams, oysters and sea animals since time immemorial. After the Shoalwater Reservation was established in 1866, the non-treaty Indians of Shoalwater Bay continued to make their living by fishing, crabbing and oystering, selling their surplus to canneries much the same as non-Indians. Today's tribal members consist of persons (and their descendents) whose names appeared on the official eligible voters list which was prepared for the purpose of the Indian Reorganization Act.

Leslie Sapir [1] cites Curtis [2] in stating that the villages on the north side of Willapa Bay were Salish or Shoalwater Salish, and included: Hlímŭmi near North Cove, Mónĭlŭmsh at Georgetown, and Númoïha'nhl at Tokeland. Verne Ray [3] lists village Number 30 as: na·'mst'cat's which was located between Tokeland and North Cove and was a village occupied principally during the winter and that at that time (in 1938) it was called Georgetown. Hajda [4] places the project area within the traditional territory of the Lower Chehalis, a subdivision of the Southwestern Coast Salish speaking people. Hajda states that in the early 1830s, a malaria epidemic (as cited by Boyd [5]) devastated the Lower Columbia River and adjacent area populations and resulted in changes of group compositions. The surviving Chinook and Lower Chehalis in Willapa Bay became a bilingual population (as cited by Swan [6]) that were known as Shoalwater Bay Indians. The Lower Chinook were eventually totally replaced by Lower Chehalis (as cited by Ray [7]). A small reservation was established in 1866 for the Lower Chehalis, Chinooks, and others living in the area that came to be called the Georgetown Reservation and then later the Shoalwater Bay Indian Reservation.

1.4.3 Reservation Location and Description

The Shoalwater Bay Indian Reservation (Shoalwater Reservation) is located on the north shore of Willapa Bay between Cape Shoalwater and Toke Point, bounded by steep natural hillsides to the east and north and Willapa Bay to the south (**Figure 1.2**). State Route (SR) 105 traverses the Shoalwater Reservation. Today, the Shoalwater Reservation is slightly greater than one-square mile in area and consists of 440 acres of uplands and 700 acres of marine salt marsh and tidal flat habitats. The original Reservation encompassed only 335 acres of uplands. In January 1977, the Office of the Solicitor, U.S. Department of the Interior, issued a favorable

[1] Leslie Spier, "Tribal Distribution in Washington," General Series in Anthropology 3 (Menasha, Wisconsin, 1936), 30.
[2] Edward S. Curtis, The North American Indian, ed. Frederic W. Hodge, Volume IX (Norwood, MA : Plimpton Press, 1930), 6-7, 173. Reprinted: New York: Johnson Reprint, 1970.
[3] Verne F. Ray, Lower Chinook Ethnographic Notes (Seattle: University of Washington, 1938), 41.
[4] Yvonne P. Hajda, "Southwestern Coast Salish," Northwest Coast Handbook of North American Indians, eds. William C. Sturtevant and Wayne Suttles, Smithsonian Institution, Volume 7 (Washington, D.C.: GPO, 1990), 514.
[5] R. T. Boyd, "The Introduction of Infectious Diseases Among the Indians of the Pacific Northwest." (Seattle: Unpublished Ph.D. dissertation, Department of Anthropology, University of Washington, 1985).
[6] James G. Swan, The Northwest Coast; or Three Years Residence in Washington Territory, (New York, 1857), 211. Reprinted: Fairfield, WA: Ye Galleon Press, 1989.
[7] Ray, 30.

Opinion declaring that the Shoalwater Reservation includes the tidelands to the south of the Reservation within its present east and west boundaries and that the southern boundary of the Reservation is located at the low water mark of the bay. The 1977 Opinion reversed a 1962 Opinion of the Regional Solicitor in Portland, Oregon to the contrary. The new Opinion resulted in adding some 700 acres to the Reservation, and made it possible for the Shoalwater Tribe to pursue aqua-culture projects as part of their overall economic development strategy. In recent years, the Tribe has acquired an additional 105 acres of uplands which are to be held in trust, thus increasing the size of their tribal uplands to approximately 440 acres.

The uplands portion of the Reservation is primarily a steep cliff along the northeast edge of the Reservation boundary, with only a narrow strip of developable land extending along the shoreline. State Route 105 traverses this narrow strip of land, parallel to the shoreline and below the cliff. Due to the topography of the narrow strip of tribal uplands, virtually all tribal development is at very serious and increasing risk of coastal flooding and shoreline erosion associated with extreme high tide storm events. If this problem is not solved soon, the Tribe risks increasing levels of storm-related erosion and flooding, and will be forced to relocate entirely.

The steep topography of a significant portion of tribal uplands severely limits the land upon which tribal facilities and housing can be built. Developable land is relatively low-lying and immediately adjacent to the shoreline. Well-maintained tribal facilities and housing have been constructed by the Shoalwater Tribe on this narrow strip of shoreline, to support the growing needs of the tribal community. The Tribe has made significant investments in infrastructure and public facilities to serve the needs of current and future generations of tribal members. Despite its very small land base, the Tribe has a modern Tribal Center, a Wellness Center which opened in 2005 (tribal health clinic and programs, dental services, massage therapy, and office space for a doctor and nurse), a Learning Resources Center which opened in 2003 (library, education administrative offices, computer lab, and activity room), and a gymnasium which opening in 2002. The Shoalwater Tribe has one business enterprise, a small casino. The tribal cemetery is located across the road from the Tribal Center. The U.S. Post Office branch which serves the Reservation and the adjacent non-Indian community is located nearby. Modern housing has been constructed, and streets, walkways and parking areas have been improved. Tribal facilities are open to, and extensively utilized by, non-Indian residents of the adjacent Dexter community and other Tokeland Peninsula residents. There is a strong sense of community between the Shoalwater Tribe and their Pacific County neighbors.

The Shoalwater Tribe relied heavily, both historically and in recent times, on the diversity and productivity of the 700 acres of intertidal habitat and tide flats in the North Cove embayment. The barrier dune on Graveyard Spit afforded protection to the Cove from winter storm wave attack. The Shoalwater Tribe grew and harvested shellfish in North Cove, on which, along with ocean fisheries, they relied heavily for subsistence food supply. In addition, tribal members harvested local native plant species from the North Cove embayment for tribal crafts and ceremonial use.

Tribal Center

Shoalwater Bay Casino

Wellness Center

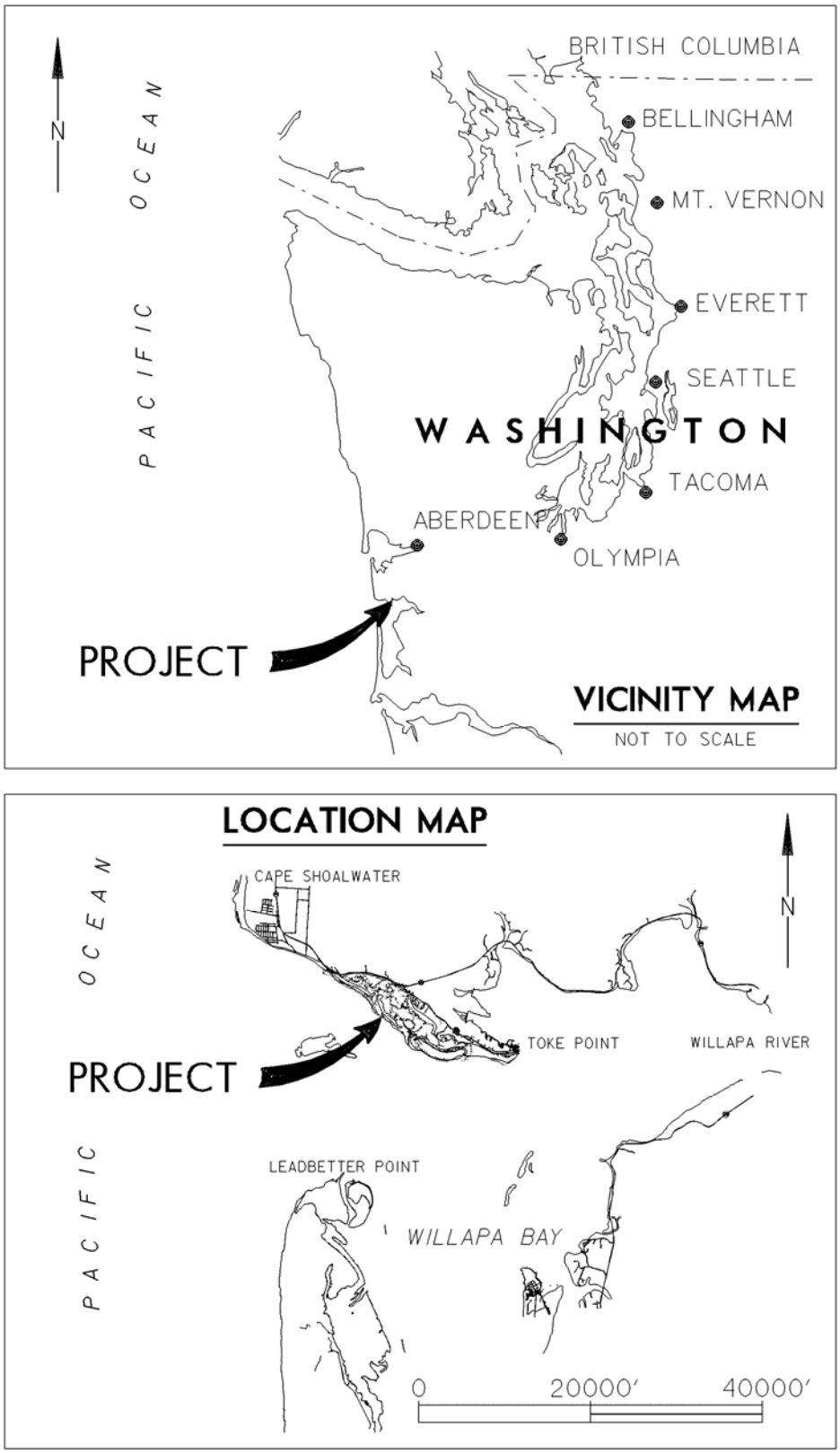


Figure 1.1 Project Vicinity and Location

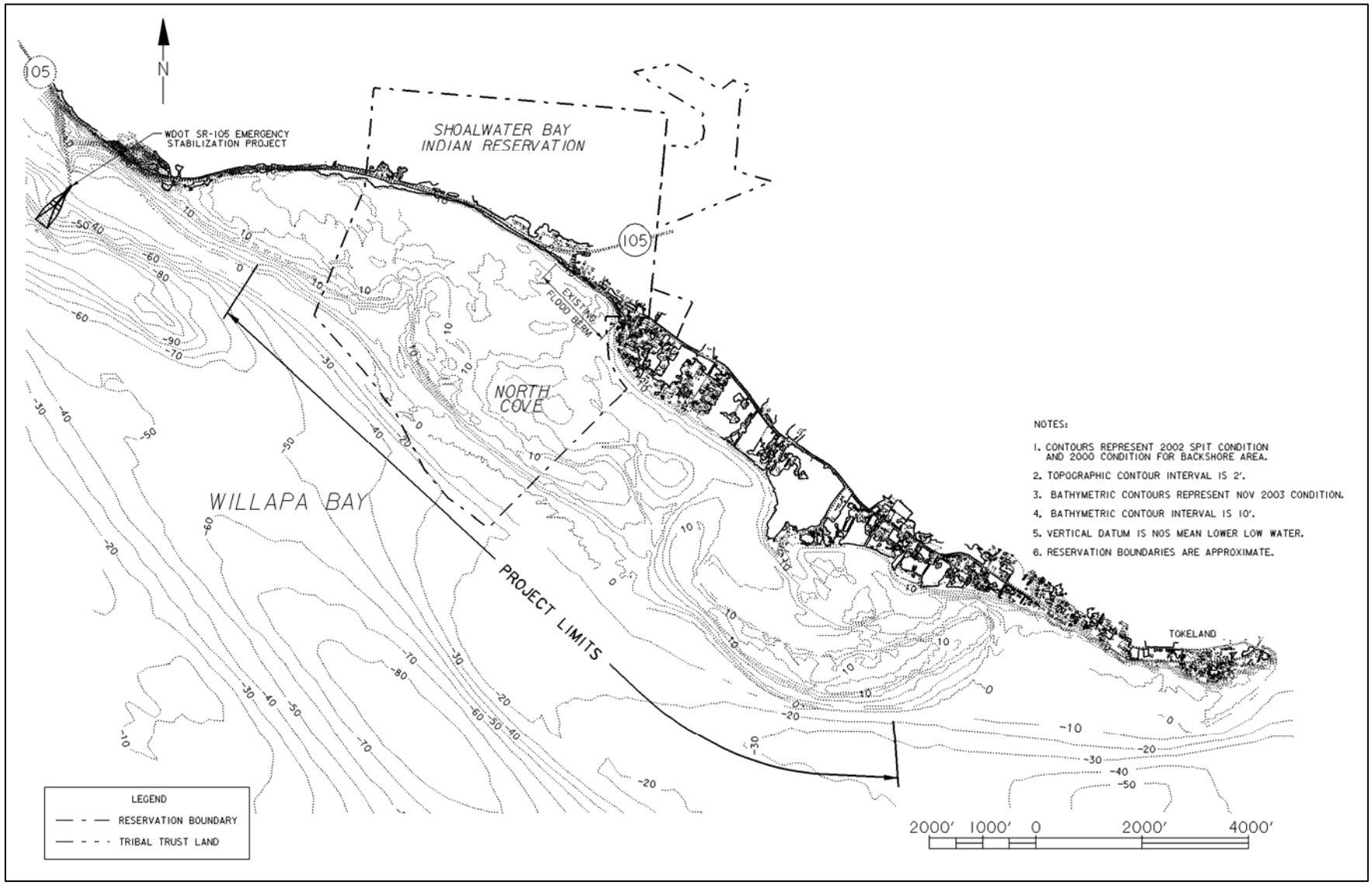


Figure 1.2 Shoalwater Bay Indian Reservation

SECTION 2: PRIOR STUDIES, REPORTS AND EXISTING WATER PROJECTS

2.1 Prior Studies and Reports

There are a number of pertinent prior studies and reports, both by the Corps and other agencies, pertaining to coastal erosion and navigation at Willapa Bay[8]. They include the following:

Year	Study or Report
2004	U.S. Geological Survey. Shoalwater Bay Tribe Erosion Study Report. As-yet unpublished draft Scientific Investigation Report, December 2, 2004, Menlo Park, CA, 362 pages. Prepared in cooperation with Washington Department of Ecology. Study funded by U.S Army Corps of Engineers, Seattle District.
2002	U.S. Army Corps of Engineers, Engineer Research and Development Center. Study of Navigation Channel Feasibility, Willapa Bay, Washington: Report 2, Entrance Channel Monitoring and Study of Bay Center Entrance Channel. ERDC/CHL TR-00-6 Report 2.
2002	U.S. Geological Survey. Large-Scale Cycles of Holocene Deposition and Erosion at the Entrance to Willapa Bay, Washington: Implications for Future Land Loss and Coastal Change. Prepared for the Southwest Washington Coastal Erosion Study in cooperation with the Washington Department of Ecology and the U.S. Army Corps of Engineers. Open File Report 02-46.
2000	U.S. Army Corps of Engineers, Engineer Research and Development Center. Study of Navigation Channel Feasibility, Willapa Bay, Washington. ERDC/CHL TR-00-6.
1996-2000	**Southwest Washington Coastal Erosion Study**. U.S. Geological Survey and Washington Department of Ecology, joint sponsors and directors. Conceived as a result of the recognition by public officials of a lack of basic understanding of coastal processes and shoreline changes along the southwest Washington coast. Study area extended from Tillamook Head, Oregon to Point Grenville, Washington, referred to as the Columbia River littoral cell, and including Willapa Bay. Numerous scientific reports, papers, and related products were developed.
1975	U.S. Army Corps of Engineers, Seattle District. Willapa River and Harbor Navigation Project, Washington, Environmental Impact Statement – Revised.
1972	U.S. Army Corps of Engineers, Seattle District. Willapa River and Harbor Navigation Project, Washington, Final Environmental Impact Statement.
1971	U.S. Army Corps of Engineers, Seattle District. Feasibility Report: Navigation and Beach Erosion, Willapa River and Harbor and Naselle River, Washington.

[8] The term "Willapa Harbor" is used in various congressional authorizations and in reports of the Corps of Engineers and is synonymous with "Willapa Bay".

Year	Study or Report (continued)
1967	U.S. Army Corps of Engineers, Committee on Tidal Hydraulics. Willapa Bay, Washington.
1967	U.S. Army Corps of Engineers, Seattle District. Willapa River and Harbor (Navigation) and Cape Shoalwater (Erosion), Washington, Feasibility Studies Plan of Survey.
1967	U.S. Army Corps of Engineers, Seattle District. Record of Public Hearing Held at Raymond, Washington 26 March 1967, Review of Reports: Willapa River and Harbor and Naselle River, Washington, and Cape Shoalwater, Washington.
1967	U.S. Army Corps of Engineers, Committee on Tidal Hydraulics. Study of Erosion at Cape Shoalwater. Report prepared by committee members Dwain Hogan, Chief, Tidal Hydraulics Unit, Seattle District, and Eugene Richey, Associate Professor of Civil Engineering, University of Washington.
1966	State of Washington Department of Conservation. Considerations for the Temporary Arresting of the Erosion at Cape Shoalwater, Washington. Report by Erosion Advisory Committee composed of four professors at University of Washington, with advisors and consultants from the Corps' Seattle District, North Pacific Division, and Coastal Engineering Research Center.
1956	U.S. Army Corps of Engineers, Seattle District. Review of Reports on Willapa River and Harbor, Washington.

2.2 Existing Water Projects

2.2.1 Willapa River and Harbor and Naselle River Navigation Project

The Willapa River and Harbor and Naselle River, Washington, project was authorized by the River and Harbor Act of July 27, 1916 and modified by subsequent Acts. The project includes about 26 miles of channel from the mouth of Willapa Bay through the Willapa River forks, 2,800 feet of the Palix River-Bay Center channel, and nine miles of Naselle River upstream of the U.S. Hwy 101 Bridge. The project was completed in 1958. Project features are not in close proximity to the Shoalwater Reservation, and thus are not believed to have any bearing on identified problems. Project features include the following:

- Channel over the bar at mouth of Willapa Bay, -26 ft MLLW and at least 500 ft wide;
- Channel -24 ft MLLW and 200 ft wide from deep water in Willapa Bay to the foot of Ferry Street at South Bend, Washington, thence 300 ft wide to the westerly end of the Narrows, thence 250 ft wide to the forks of the Willapa River at Raymond, WA;
- Channel -24 ft MLLW and 150 ft wide up the South Fork of the Willapa River and up the North Fork of the Willapa River;
- Channel -10 ft MLLW and 40 ft wide from deep water in Palix River to Bay Center, WA, dock, with widening at the shoreward end to provide a small mooring basin;

- Entrance channel -15 ft MLLW and 100 ft wide and a mooring basin 15 ft deep, 340 ft wide and 540 ft long adjacent to the port wharf at Tokeland, WA;
- Entrance channel at Nahcotta, WA, 10 ft deep and 200 ft wide, and a mooring basin -10 ft MLLW, 500 ft wide and 1,150 ft long, protected by a rubble mound breakwater about 1,500 ft long; and
- Removal of snags, piles and other obstructions in the navigable channel of the Naselle River between Naselle and the mouth.

The Corps discontinued maintenance dredging of the 26-foot channel over the bar in 1976 due to inadequate economic benefits. Since 1976, no maintenance dredging has been required along the Federal river channel leading up from Willapa Bay to port facilities located at Raymond, Washington. Maintenance dredging for shallow draft navigation continues at Willapa Bay for facilities at such locations as Toke Point, Bay Center, and Nahcotta.

2.2.2 Flood Berm Segment Constructed by Corps in 2001

A March 3, 1999 storm caused severe flooding and resulted in the initiation of an emergency flood protection planning process by the Corps Seattle District Emergency Management Branch. Subsequently, in March 2001, a 1,700-foot-long riprap flood berm segment was constructed along the Shoalwater Reservation shoreline under the Corps' Flood Control and Coastal Emergency (FC&CE) authority. While this segment of flood berm provides protection to this segment of the Shoalwater Reservation shoreline from direct wave attack, the structure fails to address flooding caused by storm wave overtopping of the adjacent Reservation shoreline areas. Portions of the shoreline that are not protected by the 1,700 foot-long flood berm will continue to be overtopped, causing flooding of all the low lying backshore areas of the Shoalwater Reservation with elevations lower than +15 feet MLLW.

Flooding Due to Storm Wave Overtopping on March 3, 1999

Flooding Due to Storm Wave Overtopping on March 3, 1999

Flood Berm Segment Constructed in 2001, Looking East

Flood Berm Segment Constructed in 2001, Looking West

SECTION 3: PLAN FORMULATION

3.1 Water and Related Land Resources Problems and Opportunities

3.1.1 Existing Conditions

The northern shoreline of Willapa Bay, specifically Cape Shoalwater to the west of the Shoalwater Reservation (see **Figure1.1**), was notorious during most of the 20th century for its rapid erosion. The north shoreline of Willapa Bay inshore (east) of the extensive ebb shoals which extend north of Leadbetter Point has, however, largely stopped migrating north. The massive tidal flow of the northernmost Willapa Channel, combined with energetic waves in the interior of Willapa Bay, has resulted in an actively eroding coast.

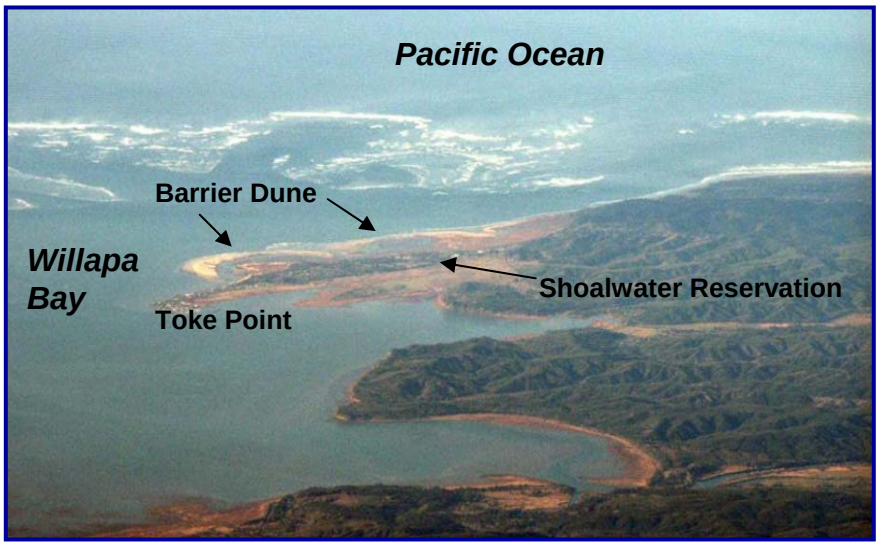
The historical trends of primary concern in this project involving the Shoalwater Reservation are related to the evolution of the spits fronting the Tokeland Peninsula (see **Figures 3.1 and 3.2**, located at end of Section 3). These spits formed the genesis of North Cove and have historically defined the environmental setting in which the Shoalwater Reservation was established. As Cape Shoalwater rapidly eroded during the early part of the 20th century, the main spit, which became known as Graveyard Spit, retreated landward to the north-northeast. The reason for this long-term shoreline retreat is now known to be directly related to the northerly migration of the northern Willapa Channel. By 1985, the Willapa Channel encountered erosion-resistant Pleistocene terrace unit exposed at the base of State Route (SR) 105, and its northerly migration at this location essentially halted. In fact, since that time, the channel thalweg has migrated slightly to the south.

The alignment and geometry of the northern Willapa channel thalweg has been relatively stable since the mid-1980's, indicating that future large-scale spit erosion due to channel migration is unlikely. The reason for changes to Graveyard Spit in the last two decades is attributable to the interruption of the natural littoral transport of sand from the west, during which time the spit has become lower and narrower. Reasons for interruption of the littoral supply are unknown, and there is no evidence that the littoral transport of sand will be reestablished.

By the 1990's, the diminishing protection afforded the Shoalwater Reservation by Graveyard Spit was increasingly evident, and winter storms in 1998-1999 caused breaches to form in the barrier dune on the spit. By 2003, the barrier dune had narrowed and lowered significantly and was breached in two locations (see **Figures 3.1 and 3.2**). Storm waves at extreme high tide continue to erode and overwash the dune, exposing the Shoalwater Reservation to increasing levels of shoreline erosion and flooding of uplands.

Presently, Graveyard Spit exists as a thin and fragmented landform that is anchored and aligned by the consolidated and erosion-resistant Pleistocene substrate. In contrast to historical

conditions, this fragile line of barrier beaches no longer receives sand supply from the eroding beach plain to the west, due to interruption of the littoral supply. The lack of sand supply means that this landform will remain of low relief unless nourished with sand. Presently, Graveyard Spit's historical function as a storm wave barrier for the Shoalwater Reservation is diminished.

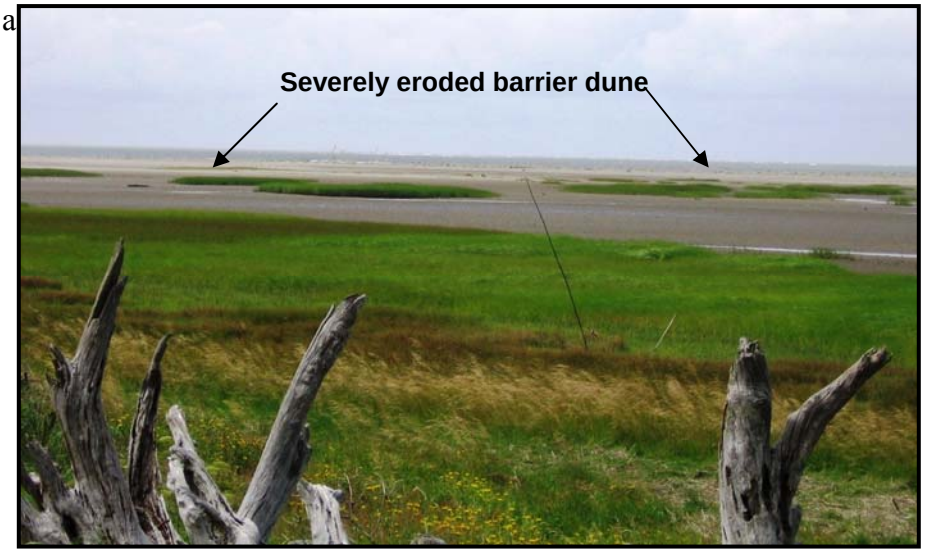


The erosion and breaching of the barrier dune has also resulted in a severe degradation of the habitat diversity and productivity of the Reservation's North Cove embayment. Winter storm waves at high tide frequently overtop the eroded dune, resulting in infilling of the tide flats with sand eroded from the dune. Due to storm overwash of the eroded and lowered barrier dune and the resulting infilling of North Cove with sand, the habitat in the cove is being transformed into high salt marsh. There has been a significant loss of intertidal areas that once supported Tribal subsistence shellfish growing and harvesting upon which the Tribe has relied heavily, both historically and in recent times. In addition, degradation of the North Cove habitat means that tribal members are less successful in harvesting local native plant species for tribal crafts and ceremonial use. The diversity and productivity of a significant portion of the Shoalwater Reservation has been degraded and is under continuing threat of total destruction. Equally important, Reservation uplands are increasingly exposed to the ravages of extreme high tide winter storms, resulting in both significant shoreline erosion and flooding of tribal uplands and infrastructure.

3.1.2 Future Without-Project Conditions

To understand and document future with- and without-project conditions relative to the Shoalwater Reservation, comprehensive scientific investigations of the coastal processes at Willapa Bay were conducted by an interagency team which included Seattle District; the Corps' Coastal and Hydraulics Laboratory (CHL) at the U.S. Army Engineer Research and Development Center; U.S. Geological Survey's Coastal and Marine Geology Program (USGS); and Washington Department of Ecology's Coastal Monitoring and Analysis Program (Ecology). The investigations were conducted by an interdisciplinary team of coastal and hydraulic engineers,

a



Eroded Barrier Dune, with Willapa Bay in Background and North Cove Embayment in Foreground (at Low Tide)

North Cove Embayment at High Tide, Following Severe Coastal Storm Which Occurred on February 4, 2006

coastal geologists, and oceanographers working in the context of a collaborative planning process. **Full documentation of the investigations conducted as part of the study is found in Appendix 1 to this report, entitled *Engineering Analysis and Design*:**

- Problem Identification and Study Approach (**Chapter 1 of Appendix 1**)
- Geologic Framework (**Chapter 2 of Appendix 1**)
- Geomorphic Cycles (**Chapter 2 of Appendix 1**)
- Shoreline Evolution (**Chapter 2 of Appendix 1**)
- Tidal Circulation (**Chapter 3 of Appendix 1**)
- Wave Analysis (**Chapter 3 of Appendix 1**)
- Waves, Currents and Sediment Transport (**Chapter 3 of Appendix 1**)
- Recent Bathymetric Changes (**Chapter 3 of Appendix 1**)
- Alternatives Analysis (**Chapter 4 of Appendix 1**)
- Sand Borrow Sites and Beneficial Use (**Chapter 5 of Appendix 1**)

These comprehensive investigations document that the erosion processes, driven by Willapa Channel migration, have undergone a profound change over time. The northward migration of the North Willapa Channel has slowed and reversed its course, sparing the last of the eroded barrier dune on Graveyard Spit. From the mid-1980's to the present, the slope of the north bank of the channel has been constant and has remained in a fixed position. This strongly suggests that the channel encountered the erosion-resistant Pleistocene Terrace deposits that have been documented in borings by the State of Washington. The North Willapa Channel west of North Cove has widened and deepened, such that the increasing cross-sectional area of the channel results in weakening the current and thereby reducing current-induced erosion. The incident wave climate at Willapa Bay is severe, with storm wave heights exceeding 23 feet, but the ebb shoals extending north from Leadbetter Point substantially attenuate incident waves in the interior of the bay. The tide level modulates waves within the bay, with more wave energy penetrating the bay at high tide levels and less at low tide levels.

Rather than attempting to turn aside the advance of the North Willapa Channel, engineering solutions to protect the Shoalwater Reservation will need only to address the erosion and resulting flooding caused by locally generated storm waves which occur under elevated water conditions. Sophisticated wave studies, including the collection of field data and numerical modeling by CHL, concluded that these waves are relatively small by coastal engineering standards. However, storms with elevated water levels will continue to contribute to erosion of the barrier dune and flooding of tribal lands. As described in Section 2.2.3 of Appendix 1, changes in storm paths and frequency, as well as increased wave heights and altered wave directions during El Niños are likely factors that alter erosion patterns in Willapa Bay. Dramatic increases in shore damage have been attributed to significantly higher waves coincident with El Niños, as well as unusually high winter sea levels. Evidence has been found of repeated increases in monthly sea level on the order of 0.7 to 1.0 feet for several months during El Niño events. Graveyard Spit breaches and storm overwash into North Cove seems to be strongly dependent on processes promoted by El Niños.

Under future without project conditions, combined high tides and storm waves will flood the Shoalwater Reservation with increasing frequency and severity, as the barrier dune continues to erode. The eroded dune will increasingly be overwashed during storms with wind-driven waves and elevated water levels. Historically, the Graveyard Spit dune has protected the Shoalwater Reservation uplands from shoreline wave attack during extreme high tide storms. Erosion of the barrier dune exposes the Shoalwater Reservation uplands to shoreline erosion and increasing levels of flooding due to storm overwash of the eroded dune and resultant wave run-up and overtopping of the low-lying tribal uplands. What has until recently been only nuisance flooding (one foot of water on roads, parking lots and yards) and deposition of logs and debris (see photos on following page taken after the February 4, 2006 storm), is rapidly approaching serious flooding with damage to tribal facilities and potential for loss of life. Such storm events typically occur at night, resulting in additional concern about the potential for injury or loss of life. The eroded barrier dune offers diminishing wave protection to the Shoalwater Reservation.

Continued erosion and breaching of the barrier dune on Graveyard Spit, accompanied by deposition of dune sand in the North Cove embayment, will continue to aggrade the tidal flats in North Cove that were productive sites for clams and other shellfish. The result is the conversion of tribal tide flats to vegetated salt marsh. This conversion has been, and will continue to be, a significant environmental, societal and cultural loss to the Shoalwater Tribe. The 700 acre North Cove represents two-thirds of the Reservation. Due to storm overwash of the eroded barrier dune and the resulting infilling of North Cove with sand, the habitat in the cove will be completely transformed into high salt marsh, consisting of beachgrass, sedges and rushes, glasswort and other salt marsh succulents, as well as smooth cordgrass, an invasive non-native species. The end result will be the complete loss of the intertidal areas that once supported shellfish growing and harvesting upon which the Tribe has relied heavily, both historically and in recent times, as a subsistence food source. The loss of North Cove intertidal habitat will have profound adverse consequences and ramifications to this important subsistence food gathering by tribal members. In addition, tribal members will have far less success harvesting local native plant species for tribal crafts and ceremonial use. Loss of the Tribe's North Cove intertidal habitat would have a severe impact on the cultural heritage, traditions, and economic future of the Shoalwater Tribe.

Since the extreme maximum tides are always associated with low atmospheric pressure events, such elevated water levels are almost always accompanied by storm wave conditions. CHL used a numerical model to evaluate wave heights along the Tokeland shoreline for the future with- and without-dune conditions. Three storms were selected for simulation of storm wave conditions, including a storm that occurred at an extreme +13.61 feet MLLW tide on March 3, 1999 (the storm of record). The model results indicate that the March 3, 1999 storm probably generated waves at the Reservation shoreline that were approximately 1.5 feet high. This severe wind storm occurred at a very high tide, causing significant flooding of tribal uplands and facilities and associated shoreline erosion, and posed a significant threat to life and property.

The steady-state spectral wave (STWAVE) numerical model used in previous Willapa Bay studies was selected for the wave simulations. CHL used the STWAVE model to simulate the

March 3, 1999 storm assuming that the barrier dune was eroded to the elevation of the surrounding land (+8 feet MLLW). **Model results indicate that, without the protection of the barrier dune, high tide storm wave heights at the Shoalwater Reservation shoreline will more than double to as much as 3.3 feet.** Thus, as the barrier dune continues to erode, the result will be significantly greater wave run-up and overtopping of Reservation uplands with each successive extreme high tide storm event. Graveyard Spit will erode to the point that it will provide little if any wave attenuation, with the full force of the 3.3 feet storm-generated waves attacking the shoreline. In the process, the remaining North Cove intertidal habitat will be completely in-filled with sand and disappear. In short, loss of the Graveyard s dune will increase wave heights at the shoreline (increased storm damage) and increase overwash into North Cove. The effect of increased storm damage can be seen in photos below taken after a storm on February 4, 2006. The storm occurred during a +14.07 feet MLLW tide, further eroding the barrier dune. Note the extensive debris deposition and ponding of water due to wave run-up.

Logs and Debris Deposited by February 4, 2006 Coastal Storm

Damage and Debris from February 4, 2006 Coastal Storm

The March 3, 1999 storm caused severe flooding and resulted in the initiation of an emergency flood protection planning process. As a result, in March 2001, the Corps constructed a segment of riprap flood berm along 1,700 feet of the Reservation shoreline. While this flood berm segment has provided a significant measure of protection from direct wave attack to that portion of tribal uplands, the structure fails to address flooding caused by overtopping of the adjacent unprotected shoreline areas. Further, the flood berm assumes that Graveyard Spit provides some meaningful degree of storm wave attenuation. Portions of the shoreline that are not protected by flood berm will continue to be overtopped, causing flooding of all the low lying backshore areas with elevations lower than approximately +15 ft MLLW. **Figure 3.3** is a topographic survey that illustrates the extent of flooding of the upland portion of the Shoalwater Reservation that can be expected during storm events during which the tide elevation exceeds approximately +13 ft MLLW. High tides exceeding about +13 ft MLLW occurred 11 times in the last 32 years, including five times since 1999 (see events in bold/blue lettering on **Table 3.1**).

Even if the frequency of high tides remains constant, erosion and lowering of the dune profile will continue. The wave protection previously afforded by the barrier dune will further diminish, and serious flooding of Shoalwater Reservation uplands and adjoining lands will occur at increasingly frequent intervals. Equally important is the fact that infilling of North Cove with sand due to storm wave overwash of the eroded barrier dune will accelerate, resulting in total loss of the rich intertidal habitat of this portion of the Shoalwater Reservation.

Under the worst case scenario, flooding and erosion of the narrow strip of developable tribal uplands will reach a point where relocation of the Shoalwater Reservation will have to be considered. Not only would the financial costs be prohibitive (hundreds of millions of dollars), but the spiritual and cultural costs and impacts to the Shoalwater Tribe would be significant. Relocation of the Reservation would not be in the best interests of either the Federal Government or the Shoalwater Tribe.

On February 4, 2006, a severe storm with winds in excess of 88 miles per hour at an extreme high tide (+14.07 ft MLLW) caused significant flooding and damage. Without implementation of storm damage reduction measures, the Shoalwater Reservation is at increasing risk of severe coastal storm damage and flooding due to shoreline erosion.

Table 3.1 Toke Point Highest Tides, 1970 Through February 2006

TIDE ELEVATION (FEET, MLLW)	DATE
14.41	November 14, 1981
14.07	**February 4, 2006**
13.87	December 11, 1973
13.61	**March 3, 1999**
13.36	December 3, 1982
13.23	**December 1, 2001**
13.21	**January 2, 2003**
13.16	January 27, 1983
13.09	February 7, 1978
12.97	January 18, 1973
12.95	**January 29, 1999**

3.1.3 Specific Problems and Opportunities

- The barrier dune protecting the Shoalwater Reservation from wave attack and flooding has been severely eroded and breached by winter storm waves at extreme high tide. Shoreline erosion and flooding is increasing in frequency as the protection provided by the barrier dune is nullified due to severe erosion.
- A significant reduction in sediment (sand) supply in the littoral transport system has resulted in the gradual and progressive erosion, narrowing, and breaching of the Graveyard Spit barrier dune that has previously protected the Shoalwater Reservation lands from the ravages of winter storms.
- The narrow strip of Shoalwater Reservation uplands is increasingly vulnerable to significant shoreline erosion and serious flooding associated with storm-generated ocean waves, particularly during periods of extreme high tides.
- The productive subsistence shellfish growing and harvesting habitat of North Cove, representing 700 acres (61 percent) of the Shoalwater Reservation, is being lost to in-filling with sand due to storm waves overwashing the eroding barrier dune during storm events and depositing sand in the North Cove embayment.
- The Shoalwater Tribe is making significant investments in public infrastructure to better serve the needs of its people.
- Policy of Congress, the Administration, and the Corps is to support and assist Native American Tribes to the maximum extent possible within the framework of

law and regulation. Federal trust responsibilities require that some action be taken by the Federal government, though not necessarily the Corps, when reservation lands of federally recognized tribes are endangered.

- Measures to reduce coastal erosion and associated flood and coastal storm damage are both technically feasible and environmentally acceptable. The implementation of appropriate measures will significantly contribute to the Shoalwater Tribe's ongoing efforts to improve economic and social conditions for present and future generations of tribal members, by preventing further shoreline erosion and flooding of tribal uplands and preventing further degradation and loss of intertidal habitat in the North Cove embayment, which has provided important supplemental subsistence shellfish food supply.

3.2 Planning Objectives and Constraints

3.2.1 Planning Objectives

- Reduce coastal erosion so as to protect the Shoalwater Bay Indian Reservation from wave attack and flooding of tribal uplands and infrastructure during storms that coincide with elevated water levels.
- Protect the intertidal habitat of the North Cove embayment from further degradation due to storm wave overwash of the Graveyard Spit barrier dune, thereby providing the opportunity for restoration of the previously abundant Tribal subsistence shellfish beds and native plant species used for Tribal crafts and ceremonial use.
- Identify a plan that satisfies the criteria set forth in the authorizing legislation for this project, Section 545(b)(1) of WRDA 2000 (see paragraph 1.1 above).

3.2.2 Planning Constraints

- Avoid unanticipated, and potentially adverse, consequences to the hydrodynamics and ecology of Willapa Bay.
- Minimize environmental impacts and associated mitigation costs attributable to any alternative plan.
- Minimize adverse effects to the adjacent non-reservation community on the Tokeland Peninsula from any alternative plan.
- Avoid inducing flooding or storm wave attack to the Tokeland Peninsula non-reservation community..

3.3 Alternative Plans

3.3.1 Measures That Address Problems and Opportunities

A wide array of measures was considered to address identified problems and opportunities, as well as planning objectives and constraints. Before initiating any engineering work on alternative measures and plans, a major effort was expended to understand the geology, geomorphology, and hydraulics of Willapa Bay and the Willapa Bay entrance (see Paragraph 3.1.2). These comprehensive studies and associated numerical modeling led to some unexpected findings that paved the way for a straightforward engineering solution that is technically feasible, cost effective, environmentally acceptable, and will improve the economic and social conditions of the Shoalwater Tribe. Measures were formulated in concert with the findings of the comprehensive studies and associated numerical modeling conducted by the Corps' Seattle District in cooperation with the Coastal and Hydraulics Laboratory at ERDC, the U.S. Geological Survey's Coastal and Marine Geology Program, and Washington Department of Ecology's Coastal and Marine Geology Program. Measures to address problems and opportunities were formulated in close coordination with the Shoalwater Bay Tribal Council, and with significant input from affected Federal, state and local resource and regulatory agencies and the affected Tokeland Peninsula community. Collectively, alternative plans represent a reasonable range of alternatives under NEPA. A range of measures, in addition to the no-action alternative, was formulated and evaluated. The measures and alternative plans evaluated as part of this study are listed in **Table 3.2**. Each measure and alternative plan is described below.

Table 3.2 Alternative Plans Evaluated and Screened

Type of Measure	Alternative Number	Name of Alternative
No Action	Alternative 1	No Action
Floodplain Fill	Alternative 2	Fill Floodplain
Hydraulic Modification		
	Alternative 3a	Toke Point Training Dike
	Alternative 3b	North Channel Training Dike
	Alternative 3c	Ellen Sands Training Dike
	Alternative 3d	SR-105 Training Dike Extension
Protective Structures		
	Alternative 4	Sea Dike
	Alternative 5	Shoreline Revetment
	Alternative 6	Barrier Dune Restoration
	Alternative 7	Barrier Dune Restoration with Flood Berm Extension

3.3.1.1 No Action

Alternative 1, the No Action alternative, assumes that no measures will be undertaken to address the ongoing erosion of the barrier dune located on Graveyard Spit, which fronts the Tokeland peninsula. This alternative also recognizes that, although the northern migration of the North Willapa Channel has halted seaward of the Shoalwater Reservation, tidal currents and, to a greater extent, storm waves will continue to lower and narrow the barrier dune which has afforded protection to the Shoalwater Reservation and Tokeland Peninsula (see **Figures 3.1 and 3.2**). Material that is eroded from the dune will continue to be carried into the inter-tidal area behind the dunes, eventually filling in what remains of North Cove. Lowering of the dune will expose the Shoalwater Reservation shoreline to increasing levels of flooding due to wave overtopping during periods of high tide storms.

The level of wave protection currently provided by the eroded barrier dune system was evaluated at the Coastal and Hydraulics Laboratory. Since extreme maximum tides are always associated with low atmospheric pressure events, storm extreme tides are almost always accompanied by storm wave conditions. A numerical model was used to evaluate wave heights along the Tokeland Peninsula shoreline for the with and without dune conditions for a storm and extreme +13.61 feet MLLW tide that occurred on March 3, 1999. The model results indicate that the 1999 storm probably generated waves at the Tokeland Peninsula shoreline that were approximately 1.5 feet high. The numerical model was used to simulate the same storm assuming that the dune was eroded to the elevation of the surrounding land (+8 feet MLLW).

Model results indicate that, without the protection of the barrier dune, wave heights at the Shoalwater Reservation shoreline will more than double to as much as 3.3 feet. **Figure 3.3** is a topographic survey that illustrates the extent of flooding that can be expected during storm events when the tide elevation exceeds approximately +13 feet MLLW. High tides exceeding about +13 feet MLLW occurred 10 times in the last 30 years, and tides at or above +13 feet MLLW have occurred four times in the last five years. Even if the frequency of extreme high tides remains constant, lowering and narrowing of the barrier dune due to erosion will continue. The wave protection once afforded by the dune will continue to diminish, and flooding of the Shoalwater Reservation and adjoining lands due to storm wave overtopping during periods of high tides will occur at increasingly frequent intervals.

3.3.1.2 Floodplain Fill

Filling the Shoalwater Reservation floodplain (Alternative 2), would raise the elevation of low-lying Shoalwater Reservation lands above flood elevation. Filling the floodplain would prevent flooding due to storm wave overtopping during periods of high tides. Fill material would be imported and all structures and infrastructure would be raised accordingly. The reservation shoreline would be armored, to prevent wave attack and associated erosion. The small upland portion of the Shoalwater Reservation would, in effect, become like an island, rising above the surrounding landscape.

3.3.1.3 Hydraulic Modification of the Entrance to Willapa Bay

For many years, modifying the tidal ebb flow in Willapa Bay has been suggested as a way to turn back the clock and arrest, if not reverse, the northward migration of the main (northernmost) Willapa channel and the resultant erosion of the North Cove shoreline. The idea of redirecting the ebb flow of the Willapa entrance was an appealing concept for reducing the threat posed by the encroaching northernmost channel. The Shoalwater Tribe proposed that training structures, or dikes, be investigated as a possible remedy for controlling the extreme erosion along the North Cove shoreline. The purpose for these structures would be to deflect the high current away from the shore, or to divert the flow in the North Channel such that it opens and maintains the Middle Channel to the open ocean.

Four representative training structure locations (Alternatives 3a, 3b, 3c, and 3d) were modeled by the Coastal and Hydraulics Laboratory at ERDC (see **Appendix 1, Section 3.1**, for detailed modeling discussion). The four locations were selected for analysis because they are the closest to tribal lands, thereby having the greatest potential to deflect the current away from the shoreline. The ADvanced CIRCulation (ADCIRC) numerical model was chosen by the Coastal and Hydraulics Laboratory to simulate the long-wave hydrodynamic processes in Willapa Bay. The ADCIRC modal can accurately replicate tidally-driven currents and wave run-up levels induced by winter storms. The dimensions and orientation of the structures were adjusted until an obvious change in the flow regime of the northernmost Willapa Channel, if any, occurred.

3.3.1.4 Protective Structures

Comprehensive studies, including sophisticated computer modeling by the Coastal and Hydraulics Laboratory at ERDC, have found that the erosion processes, driven by channel migration, are undergoing a profound change. The northward migration of the Willapa Channel has stabilized, sparing the eroded dune on Graveyard Spit. Thus, engineering solutions will not have to attempt to turn aside the advance of the Willapa Channel, but will only have to address the continued erosion of the dune and the flooding caused by storm generated waves which overtop the dune and attack the Shoalwater Reservation shoreline. Wave studies, including the collection of field data and numerical modeling, determined that while these waves were capable of continuing to erode the dune and cause flooding, they are relatively small by coastal engineering standards. The protective structures generally described below were formulated and designed to address the wave induced flooding that takes place during storm events that coincide with high tides.

a. Sea Dike. Alternative 4, sea dike, is a large armor stone structure to replace the wave protection that was once afforded by the now deteriorated barrier dune system on Graveyard Spit. The sea dike would be constructed along the crest of the deteriorated barrier dune. Sand would have to be excavated to make way for the dike armor stone, and the excavated sand would be re-graded over the stone and planted with native vegetation. The sea dike itself would be designed to prevent overtopping by storm waves and thus prevent further habitat loss in North Cove as well as protect Reservation uplands from wave attack, shoreline erosion, and flooding.

b. Shoreline Revetment. Alternative 5, shoreline revetment, is a riprap and armor rock structure along the existing shoreline to protect Reservation uplands and thus provide protection from coastal flooding due to wave run-up and overtopping during periods of high tides. The revetment is porous, allowing water to filter through after the wave energy has been dissipated. The revetment is designed for wave conditions that would result as the existing barrier dune erodes and lowers to the elevation of the surrounding intertidal area, (approximately +8 feet MLLW). The structure would tie into high ground at both ends, so as to prevent back flooding of the Shoalwater Reservation caused by wave overtopping. Structures of this design have been used successfully along the Washington coast, at Grays Harbor in particular. Revetment stone would be brought to the construction site by truck, and access to the site would be along the structure itself. Sand would have to be excavated to make way for the revetment stone. The excavated sand would be re-graded over the revetment and planted with native vegetation. A revetment would protect Reservation uplands only, no protection would be afforded to the North Cove portion of the Reservation.

c. Barrier Dune Restoration. Erosion and lowering of the barrier dune that extends southward on the remnants of Graveyard Spit is exposing the Shoalwater Reservation and the Tokeland Peninsula shoreline to increased flooding from storm waves during periods of extreme high tides. Alternative 6, dune restoration alternative, would rebuild and maintain the now deteriorated dune system with sand dredged from the adjacent Willapa Bay entrance and channel. Like the sea dike, the dune would be constructed along the crest of the existing deteriorated barrier dune. The dredged sand would be graded and planted with native vegetation to stabilize the restored dune, thereby extending the periodic nourishment interval.

d. Barrier Dune Restoration with Flood Berm Extension. As described in Paragraph 2.2.2, a 1,700 foot-long riprap flood berm was constructed by the Corps of Engineers in March 2001 along a small portion of the Shoalwater Reservation shoreline. Extending the existing riprap flood berm along the shoreline could significantly extend the interval between periodic nourishment cycles of a restored barrier dune on Graveyard Spit. A low profile flood berm, however, is not feasible as a stand-alone alternative, unlike the shoreline revetment described above. Rather, a flood berm would only work in conjunction with barrier dune restoration, to provide a complete solution to the coastal erosion problems confronting the Shoalwater Tribe. If, for any reason, the barrier dune were to seriously erode and/or be breached, an extended flood berm would provide secondary protection from storm wave run-up, overtopping, and flooding of the shoreline of the Shoalwater Reservation until nourishment of the barrier dune could be accomplished. The flood berm is a porous structure constructed of graded riprap, to allow water to filter through after the wave energy has been dissipated. The 1,700-foot-long flood berm segment constructed by Corps in 2001 has been very effective in this regard.

3.3.2 Screening of Alternative Plans

Alternative plans were evaluated and screened in consideration of five discrete criteria listed below. Criteria 1 through 4 represent standard evaluation criteria typically utilized in

evaluating Corps of Engineers water resources projects. In addition, criteria 1, and criteria 3 through 5 are specified in the project authorization (see Paragraph 1.1 of this report):

1) ***Effectiveness***: Is it technically feasible (i.e., is it feasible from an engineering standpoint).
2) ***Completeness***: Is it a complete solution to the identified problem(s).
3) ***Efficiency***: Is it a cost effective means of providing erosion protection.
4) ***Acceptability***: Is it environmentally acceptable and, thus, capable of being implemented from a regulatory standpoint.
5) ***Social effects***: Will it improve the economic and social conditions of the Shoalwater Bay Indian Tribe.

Table 3.3 summarizes the results of the screening-level evaluation of alternative plans. A discussion and summary of the screening-level evaluation for each alternative follows.

3.3.2.1 Alternative 1, No Action

Alternative Description. Under the No Action alternative, no project would be implemented. The no action alternative would result in an increasing threat and frequency of flood and coastal storm damage to Shoalwater Reservation lands and infrastructure. Further loss of Graveyard Spit barrier dune elevation will exacerbate flooding and storm damage to low-lying tribal uplands. Material that is eroded from the dunes will continue to be carried into the intertidal area behind the dunes, eventually filling in what remains of North Cove. Continued lowering of the barrier dunes will expose the Shoalwater Reservation to increasing levels of flooding due to overwash of the dunes during periods of high tide storms, with resulting overtopping of the shoreline and flooding of low-lying tribal uplands.

Discussion and Summary. The No Action alternative will not reduce the shoreline erosion threat to the Shoalwater Reservation uplands, nor halt loss of North Cove habitat. It does not address any of the five evaluation criteria in the project authorizing legislation. However, this alternative was carried forward for comparative purposes per NEPA guidelines.

3.3.2.2 Alternative 2, Fill Floodplain

Alternative Description. This alternative would raise the elevation of low-lying Shoalwater Reservation uplands above flood elevation by filling the floodplain.

Discussion and Summary. Raising the elevation of Tribal uplands and structures would prevent flooding due to storm wave run-up and overtopping of Shoalwater Reservation uplands during periods of high tides. Filling the floodplain would not, however, address the loss of 700 acres of Tribal shellfish habitat in North Cove resulting from infilling of North cove with sand due to storm waves overwashing the remnants of the Graveyard Spit barrier dune. In simplest terms, this alternative fails to address the coastal erosion problems confronting the Shoalwater Tribe, and thus fails to satisfy the criteria set forth in the project authorization.

Table 3.3 Summary of Preliminary Screening-level Alternatives Evaluation

Alternative	Preliminary Screening Results					Carry Forward for Further Evaluation?
	Effectiveness	Completeness	Efficiency	Environmental Acceptability	Social Effects	
Alternative 1, No Action	Does not address identified problems	Does not address identified problems	Not applicable	No induced environmental impacts	Not acceptable to the Shoalwater Tribe; No action will result in more frequent and increasingly serious erosion and flooding due to storm events at high tide, as well as complete loss of subsistence shellfish habitat in North Cove	**Yes, per NEPA guidelines**
Alternative 2, Fill Floodplain	**Technically feasible** means of addressing identified problems	Not a complete solution; would protect only Reservation uplands, but not North Cove intertidal habitat	Not evaluated; very expensive and thus unlikely to be cost effective	Unlikely; mitigation required for filling of reservation uplands and alterative of natural drainage patterns.	Not acceptable to the Shoalwater Tribe; filling floodplain and raising structures protects only tribal uplands. Complete loss of subsistence shellfish habitat in North Cove	No
Alternative 3a, Toke Point Training Dike	**Not technically feasible;** would have little, if any, beneficial effect in addressing identified problems	Not a complete solution; additional measures required to fully address identified problems	----------	----------	----------	No
Alternative 3b, North Channel Training Dike	**Not technically feasible;** would have little, if any, beneficial effect in addressing identified problems, with potential for serious unintended adverse effects in Willapa Bay	Not a complete solution; additional measures required to fully address identified problems	----------	----------	----------	No
Alternative 3c, Ellen Sands Training Dike	**Not technically feasible;** would have little, if any, beneficial effect in addressing identified problems, with potential for serious unintended adverse effects in Willapa Bay	Not a complete solution; additional measures required to fully address identified problems	----------	----------	----------	No
Alternative 3d, SR-105 Training Dike	**Not technically feasible;** would have little, if any, beneficial effect in addressing identified problems, with potential for high maintenance costs	Not a complete solution; additional measures required to fully address identified problems	----------	----------	----------	No
Alternative 4, Sea Dike	**Technically feasible** means of addressing identified problems	**Would provide a complete solution** to identified problems	Unlikely to be cost effective; very high construction costs	Unlikely; mitigation required due to placement of very large armor stone; potential for unintended redirection of currents and disruption of sediment flow in and near the project area	Not favored by the Shoalwater Tribe; incompatible with interior of Willapa Bay which has no jetties or similar massive rock structures	**Yes**
Alternative 5, Shoreline Revetment	**Addresses only problems associated with tribal uplands**; does not address North Cove intertidal habitat which represents 67 percent of Reservation	Not a complete solution; would protect only tribal uplands, but not North Cove intertidal habitat	Not evaluated	Likely; would require some mitigation due to placement of armor stone below mean higher high water line along shoreline	Not acceptable to the Shoalwater Tribe; protects only tribal uplands, while creating a visual barrier and physical obstacle to North Cove. Complete loss of subsistence shellfish habitat in North Cove	No
Alternative 6, Barrier Dune Restoration	**Technically feasible** means of addressing identified problems	**Would provide a complete solution** to identified problems	Likely to be cost effective	Yes;	Acceptable to the Shoalwater Tribe, if required frequent nourishment of barrier dune can be assured at all times, thereby avoiding substantial risk of flood damage and shoreline erosion to reservation lands	**Yes**
Alternative 7, Barrier Dune Restoration with Flood Berm Extension	**Technically feasible** means of addressing identified problems	**Would provide a complete solution** to identified problems	Likely to be cost effective	Yes	Favored by the Shoalwater Tribe as best combination of measures to provide the necessary level of protection to tribal lands	**Yes**

3.3.2.3 Alternative 3a, Toke Point Training Dike

Alternative Description. Alternative 3a is located west of the Shoalwater Reservation at Toke Point, and would extend as much as 2,050 feet into the northernmost Willapa channel (see **Figure 3.4** for training dike locations). The structure would be constructed of very large armor rock, and would have the appearance of a jetty projecting from shore. The intended function of the training dike is to deflect the high current away from the shore, thereby reducing or preventing further erosion of Graveyard Spit and its barrier dune system.

Discussion and Summary. Alternatives 3a, 3b, 3c, and 3d were evaluated with the ADCIRC numerical model by the Coastal and Hydraulics Laboratory at ERDC. The dimensions and orientation of the training dikes were adjusted until an obvious change in the flow regime of the northernmost Willapa Channel occurred. This investigation found that flow modifications caused by a training structure are localized, and if a structure is constructed, it must be in close proximity to North Cove to have an impact on the current. Furthermore, the structure must be massive in size to divert or deflect the strong current away for the shoreline. And finally, historical measurements show that the rate of shoreline erosion has decreased over the past decade, suggesting that the bathymetry in the Willapa Bay system is reaching an equilibrium condition. Potentially, constructing one or more training structures may change this condition, resulting in an unintended adverse effect on the rate of shoreline, spit and/or island erosion.

Alternative 3a was found to have a minimal impact, at best, on current in the vicinity of the Shoalwater Reservation, and therefore would have minimal impact on preventing erosion along Graveyard Spit and North Cove. Alternative 3a is not technically feasible, nor would it be a complete solution to identified problems. Computer modeling was not able to verify any beneficial effect in reducing the flood and coastal storm damage threat to the Shoalwater Reservation. It was further determined that even if hydraulic modification were technically feasible, additional measures, including protective structures such as those measures described in the following paragraphs, would still be required to reduce storm wave overtopping of the eroded barrier dune and flooding of the Shoalwater Reservation during periods of high tides. For these reasons, this alternative was not carried forward for further evaluation.

3.3.2.4 Alternative 3b, North Channel Training Dike

Alternative Description. This alternative would extend directly across North Cove and Graveyard spit and into the northernmost Willapa Channel (see **Figure 3.4** for location). The structure length is 12,800 feet and extends 7,800 feet into the channel.

Discussion and Summary. Modeling indicates that the structure reduces the peak ebb current along the western extent of Graveyard Spit, and, to a lesser extent, at the eastern end of the spit. Current velocity along the eastern end of Graveyard Spit is reduced during flood tide, whereas a small reduction in current is found to the west. Two consequences, however, are the creation of a gyre (a circular or spiraling current) on the lee-side of the structure, and

impediment of sediment transported along the shore. Although the gyre is weaker than the main current, the spiraling gyre will still suspend the sediment along the shore, and transport it into deeper water. With the structure preventing movement of sediment along the shore, the area being eroded by the gyre is not replenished, leading to a loss in land. This same process can be see by comparing aerial photographs of the shore before and after the SR-105 dike was constructed. For these reasons, as well as those stated for alternative 3a, this alternative was not carried forward for further evaluation.

3.3.2.5 Alternative 3c, Ellen Sands Training Dike

Alternative Description. This alternative is located along the northern reach of the Nachotta Channel (see **Figure 3.4** for location), and is oriented so that the ebb current is deflected in a westerly trajectory, away from the Shoalwater Reservation shoreline. The structure has an overall length of 16,200 feet, and extends 950 feet into the northern reach of the Nahcotta Channel. A further extension lengthened the dike to 19,000 feet, with only a minimal effect in the vicinity of North Cove.

Discussion and Summary. Initial modeling showed strong current flowing around the eastward end of the dike, raising the potential for the strong current to scour a new channel across the Ellen Sands and also to undermine the foundation of the structure. Consequently, subsequent testing was conducted with the structure extending across low-lying Ellen Sands to high ground. The structure has an overall length of 16,200 feet, and extends 950 feet into the channel. At this length, the dike would have minimal impact on current along Graveyard Spit. The dike was extended such that it extended completely across the channel and terminated on a sandbar. Total length for this dike was 19,000 feet. This increased length still showed a minimal effect in the vicinity of Graveyard Spit and North Cove. For the same reasons stated for alternative 3a, this alternative was not carried forward for further evaluation.

3.3.2.6 Alternative 3d, SR-105 Training Dike

Alternative Description. This alternative training dike is located at the same position as the SR-105 dike (see **Figure 3.4** for location). The structure extends 2,350 feet into the North Channel, or approximately to the center of the channel thalweg. A second experiment lengthened the dike to 3,000 feet. The structure would be constructed of very large armor rock, and would have the appearance of a jetty projecting from shore. The intended function of the training dike is to deflect the high current away from the shore, thereby reducing or preventing further erosion of Graveyard Spit and its barrier dune system.

Discussion and Summary. The structure at this location reduces the peak flood current velocity along the western extent of the North Cove area, but a minimal change in current is noted along the eastern end of Graveyard Spit. Because the dike resides to the west of North Cove and Graveyard Spit, current in the vicinity of the Shoalwater Reservation was not affected

during the ebb flow. Increased current caused by reducing the conveyance of water flowing past the dike is expected to induce the formation of a scour hole at the toe of the dike, requiring regular maintenance to prevent the dike from slumping into the scour hole. For the same reasons stated for alternative 3a, this alternative was not carried forward for further evaluation.

3.3.2.7 Alternative 4, Sea Dike

Alternative Description. The sea dike is a 12,500-foot-long rock structure located on Graveyard Spit that is intended to replace the wave protection that was once afforded by the now eroded dune system on the Spit. To prevent storm wave overtopping, the structure has a top elevation of +20 feet MLLW, a top width of 14 feet, and a side slope of 1V on 2H (**Figure 3.5**). The dike requires approximately 213,000 tons of underlayer rock and quarry stone and 203,000 tons of armor stone, and is constructed along the crest of the eroded barrier dune. Approximately 200,000 CY of sand is excavated to make way for the dike stone. The excavated sand is re-graded over the dike, and planted with native vegetation to stabilize the sand.

The dike stone is brought to the construction site by truck. Access to the site requires construction of a 1-mile-long haul road from SR-105. The haul road will be removed at the completion of construction. While the sea dike itself is designed to resist erosion by waves and currents, the sand covering the rock on the seaward side of the dike will erode, and will require replacement on a periodic basis. The maintenance requirement for the sand covering the seaward face of the dike is assumed to be 100,000 CY at two-year-intervals. Replacement of 50 percent of the dike armor stone will be required at 25-year intervals.

Discussion and Summary. The sea dike alignment is fixed at the time of construction, and cannot easily accommodate even a minor change in the channel location. The sea dike alternative assumes, based on analysis and interpretation of available data, that the northward migration of the Willapa channel has halted seaward of the Shoalwater Reservation. The fact that the dike alignment is fixed at the time of construction, and can't easily accommodate even a minor change in the channel location, is a major disadvantage of this alternative. Any further channel encroachment would undermine and ultimately destroy the dike. This is a major disadvantage to the long-term integrity and efficient function of this alternative, and does not provide any opportunity for adaptive management. Given this caveat, the sea dike is technically feasible and could provide a complete solution; it was carried forward for further evaluation.

3.3.2.8 Alternative 5, Shoreline Revetment

Alternative Description. The shoreline revetment alternative consists of constructing an 8,470-foot-long rock structure that is intended to provide protection to tribal uplands from coastal flooding due to wave run-up and overtopping during periods of high tides. The revetment is designed for wave conditions that would result once the barrier dune erodes and lowers to the elevation of the surrounding inter-tidal area (approximately +8 feet MLLW). The revetment has a top elevation of +21feet MLLW, a top width of 8 feet, and a side slope of 1V on 1.5H (**Figure 3.6**). Construction of the revetment requires placing approximately 55,000 tons of

graded riprap and 64,000 tons of armor stone along the existing shoreline. The revetment is a porous structure designed to dissipate wave energy, and the graded riprap is the underlayer/filter material for the overlying armor stone. The graded riprap and revetment stone are brought to the construction site by truck, and access to the site is along the structure itself. Approximately 24,000 CY of sand is excavated to make way for the revetment stone. The excavated sand, along with approximately 40,000 CY of imported sand, is re-graded to cover the rock on the seaward side of the revetment. The graded sand is then planted with native vegetation.

Discussion and Summary. The revetment protects only the upland portion of the Shoalwater Reservation. Thus, alternative 5 abandons any attempt to restore the existing barrier dune system on Graveyard Spit and does not address the filling of North Cove. Material that is eroded from the barrier dune will continue to be carried into the inter-tidal area behind the dune, eventually filling in what remains of North Cove and resulting in a total loss of shallow intertidal habitat within this portion of the Shoalwater Reservation. In order to afford the level of upland flood and coastal erosion protection required, the revetment would create a significant visual and physical barrier to the Shoalwater Tribe and adjacent community alike.

Though technically feasible, the revetment does not provide a complete solution to identified problems and fails to fully meet the criteria specified in the project authorization. A revetment would provide protection only to the upland portion of the Shoalwater Reservation. The physical and visual barrier created by the revetment is not acceptable to either the Shoalwater Tribe or its neighbors. For these reasons, the revetment alternative was not carried forward for further evaluation.

3.3.2.9 Alternative 6, Barrier Dune Restoration

Alternative Description. The dune restoration alternative is intended to rebuild the now eroded dune system on Graveyard Spit with sand dredged from the adjacent Willapa Bay entrance and channel. The restored dune is 12,500-feet-long, with a top elevation of +25 feet MLLW, a top width of 20 feet, and a side slope of 1V on 5H (**Figure 3.7**). Like the sea dike, the restored dune is constructed along the crest of the existing deteriorated dune. The initial dune restoration requires approximately 600,000 CY of sand dredged from the entrance to Willapa Bay. The dredged sand is graded and planted with native vegetation to stabilize the sand and thereby extend the interval between periodic nourishment needed to replace eroded sand.

Discussion and Summary. Under this alternative, the restored barrier dune will provide the only protection to the Shoalwater Reservation from storm waves. Therefore, maintaining the dune to its design dimensions will be critical; the dune cannot be allowed to erode to a point that waves could overtop the structure, placing the Shoalwater Reservation at substantial risk of flood damage and shoreline erosion. The dune is not intended to address any further channel migration or even erosion (or accretion) of the lower beach, below +6 feet MLLW. Accordingly, the dune alignment can easily be readjusted to the most effective alignment on Graveyard Spit when periodic nourishment is required. Alternative 6 is technically feasible, and, if the barrier dune is effectively maintained at all times, offers a complete solution to identified problems.

This alternative offers few, if any, environmental obstacles, and is very acceptable to state, federal and local resources agencies and the Shoalwater Tribe. For these reasons, the barrier dune restoration alternative was carried forward for further evaluation.

3.3.2.10 Alternative 7, Barrier Dune Restoration with Flood Berm Extension

Alternative Description. The barrier dune restoration and flood berm extension alternative combines restoration of the eroded Graveyard Spit barrier dune system with the extension of an existing riprap flood berm along the affected shoreline (**Figure 3.8**). The barrier dune restoration element in this alternative is identical to that described in alternative 6 immediately above.

The flood berm extension, as initially designed, has a combined length of 8,470 feet long, with a top elevation of +17 feet MLLW, a top width of 16 feet, and a side slope of 1V on 1.5H. The flood berm generally follows the same alignment as the shoreline revetment (alternative 5). A 1,700-foot-long section of flood berm was constructed in 2001 under the Corps' Flood Control and Coastal Emergency (FC&CE) authority. Under alternative 7, the existing riprap flood berm is extended northward 4,000 feet and southward 2,770 feet for a total length of 8,470 feet, providing a continuous protective structure along the shoreline. The flood berm requires approximately 60,000 tons of graded riprap and 29,000 tons of core material which serves as the underlayer/filter for the overlying riprap. The flood berm is intentionally porous; allowing water to filter through after the wave energy is dissipated. Excavated sand and soil is re-graded over the face of the riprap flood berm and planted with native vegetation.

Discussion and Summary. The restored barrier dune in alternative 7 will provide primary protection to the entire Shoalwater Reservation from storm waves. The added presence of the flood berm, however, allows considerable erosion of the barrier dune before periodic nourishment of the dune is required. The flood berm feature will ensure that tribal uplands are protected from wave run-up and flooding if the eroded barrier dune is breached or overtopped prior to periodic nourishment being performed. However, the backup protection provided by the flood berm allows considerable flexibility in the periodic nourishment schedule for the dune restoration. This flexibility alleviates concerns regarding availability and timing of funding for periodic nourishment, scheduling and availability of relatively scarce dredging equipment on the west coast, and adverse weather conditions impinging on our ability to perform periodic nourishment in a timely manner. Alternative 7 is technically feasible and offers a complete solution to identified problems. This alternative offers few, if any, environmental obstacles, and is very acceptable to state, federal and local resources agencies and the Shoalwater Tribe. For these reasons, the barrier dune restoration with flood berm extension alternative was carried forward for further evaluation.

3.4 Presentation and Evaluation of Final Array of Alternative Plans

Three alternative plans, in addition to the No Action alternative, survived the screening-level alternatives evaluation and were carried forward for further development and evaluation. The three plans in the final array of alternative plans are: sea dike, barrier dune restoration, and barrier dune restoration with flood berm extension. An in-progress review with HQUSACE and Northwestern Division staff was held in November 2004, at which time the screening of alternative plans was reviewed. It was agreed that only these three technically feasible plans could logically be carried forward for further evaluation, based on careful consideration of identified planning objectives and constraints, including project criteria set forth in the project authorization (Section 545 of WRDA 2000, Public Law 106-541).

For each alternative plan in the final array, the preliminary design was refined as appropriate, and cost estimates in M-CACES format for both construction and periodic maintenance were prepared. A life cycle cost economic evaluation was performed, to determine cost effectiveness relative to other plans. Further environmental and social evaluation was also performed, including conducting two community meetings with the tribal and non-tribal community. Meetings were also conducted with the local, state and Federal resource and regulatory agencies. The degree of environmental acceptability of each plan in the final array was assessed, as well as the nature of social effects of each plan on the Shoalwater Bay Indian Tribe and the adjacent non-Indian community. Each plan is described and the results of a detailed evaluation are presented in the following paragraphs.

3.4.1 Alternative 4, Sea Dike

The sea dike is a 12,500-foot-long rock structure that is intended to replace the wave protection that was once afforded by the now deteriorated dune system. The structure has a top elevation of +20 feet MLLW, a top width of 14 feet, and a side slope of 1V on 2H (see **Figure 3.5**). The dike requires approximately 213,000 tons of underlayer and quarry stone, and 203,000 tons of armor stone, and is constructed along the crest of the deteriorated dune. The dike stone is brought to the construction site by truck. Access to the site to construct the dike thus requires construction of a one-mile-long haul road from SR-105. The haul road will be removed at the completion of dike construction. Approximately 200,000 CY of sand is excavated to make way for the dike stone. The excavated sand is re-graded over the dike, and planted with native dune grass.

While the sea dike itself is designed to resist erosion by waves and currents, the sand covering the rock on the seaward side of the dike will erode over time, and will thus require periodic replacement. The maintenance requirement for the sand covering the seaward face of the dike is assumed to be 100,000 CY at two-year intervals. Replacement of 50 percent of the dike armor stone will be required at 25-year intervals.

The sea dike would be a fixed location hard structure in a dynamic marine environment, affording no opportunity for adaptive management. The sea dike alternative assumes that the northward migration of the Willapa channel has halted seaward of the Shoalwater Reservation. The fact that the dike alignment is fixed at the time of construction, and can't easily accommodate even a minor change in the channel location, is a major disadvantage of this

alternative. Since the dike is not intended to address any channel migration, further channel encroachment could undermine and destroy the dike, significantly increasing maintenance costs. Its initial construction and life cycle cost is highest of the three technically feasible alternative plans. Equally important, the armor rock sea dike is not environmentally acceptable to state or federal resource agencies, and thus not supported by the Shoalwater Bay Tribe. There is concern that potential for unintended redirection of currents and disruption of sediment flow in and near the project area. From an esthetic standpoint, the sea dike would loom as a detached breakwater, very much out of place in Willapa Bay, and offers no environmental attributes.

3.4.2 Alternative 6, Barrier Dune Restoration

As described in previous paragraphs, erosion and lowering of the barrier dune that extends southward on Graveyard Spit is exposing the Shoalwater Reservation and the Tokeland Peninsula shoreline to increased flooding from storm wave run-up and overtopping associated with low pressure storm events which coincide with extreme high tides. The barrier dune restoration alternative is intended to rebuild and maintain the severely eroded dune system with sand dredged from the adjacent Willapa Bay entrance and channel. The restored dune is 12,500-feet-long, with a top elevation of +25 feet MLLW, a top width of 20 feet, and a side slope of 1V on 5H (see **Figure 3.7**). Like the sea dike, the dune is constructed along the crest of the now deteriorated barrier dune. The initial dune restoration requires approximately 600,000 CY of sand dredged from the entrance to Willapa Bay. The dredged sand is graded and planted with native dune grass, to extend the periodic nourishment interval by stabilizing the sand from wind erosion. This sand stabilization technique has been proven effective at Grays Harbor, just 12 miles to the north along the Washington coast.

Although the migration of the Willapa channel has halted, other littoral process will not be altered. Erosion by storm waves and currents will continue, and the restored barrier dune will require maintenance on a regular basis to avoid compromising flood and coastal storm damage protection to the Shoalwater Reservation. The cost of mobilizing a large dredge to the project site is a major consideration, and the lowest life-cycle cost for this alternative plan is obtained by maximizing the internal between required periodic nourishment. For this reason, the initial dune restoration dimensions maximize the volume of sand that is placed within the available plan area of the existing spit during both initial construction and subsequent periodic nourishment.

Periodic nourishment requirements for the dune restoration were estimated by using topographic surveys of the dune to compute the sand loss that occurred between 2000 and 2002. Based on the 2000-2002 erosion rates, the annual loss of sand from the dune (above +6 feet MLLW) is estimated to be 50,000 CY/year. For both initial construction and periodic nourishment, the sand probably will be pumped from a borrow site by a large pipeline dredge. A potential borrow site is located approximately 4,000 feet from the project site, on the north side of the Willapa Bay channel. A similar construction process was successfully carried out by the Washington State Department of Transportation in 1998 for the SR-105 Emergency Stabilization Project. For the SR-105 project, some 350,000 CY of dredged sand was pumped approximately 7,000 feet. Thus, constructability is not in question for the dune restoration

The restored barrier dune would provide the only protection to the Shoalwater Reservation from storm waves. Therefore, maintaining the restored dune to its design dimensions is critical, and the dune cannot be allowed to erode to a point that storm waves could overtop the structure and place the Shoalwater Reservation at substantial risk of flood damage due to wave run-up and overtopping the shoreline. For this reason, the periodic nourishment requirement is 250,000 CY at frequent five-year-intervals. Like the sea dike, the dune restoration alternative assumes that the northward migration of the Willapa channel has halted seaward of the Shoalwater Reservation. The dune is not intended to address any further channel migration or even erosion (or accretion) of the lower beach, below +6 feet MLLW. However, the dune alignment on the spit can, and will, be readjusted to the most effective location each time periodic nourishment is required.

Over the last ten years, the erosion of the barrier dune has profoundly affected the channel that flows into North Cove. **Figure 4.8** shows that, in 1994, the dune formed a continuous barrier separating North Cove from Willapa Bay and a single, well-defined channel entered the southern end of the cove. The natural tidal flow in this channel was strong enough to scour away sand that was being carried southward on the ocean side of the spit. In 1995, erosion of the dune resulted in the formation of a breach. This additional entrance and exit for tidal flows, combined with the reduction in the cove volume due to infilling, resulted in a diminished flow through the channel. The tidal flow through the North Cove channel was no longer strong enough to resist the southward encroachment of the spit, and the channel began migrating to the southeast, toward the Tokeland Peninsula shoreline. The result is erosion of the shoreline due to tidal flow.

In 2003, a second breach developed in the spit, decreasing the North Cove tidal channel flow even further. The 2004 aerial photograph (**Figure 3.2**) clearly shows that the migrating channel is now eroding the southern Tokeland Peninsula shoreline. Restoration of the barrier dune will close the breaches, resulting in an increase in the flow – to pre-breach levels – through the North Cove tidal channel. The increased flow would likely exacerbate the channel-caused erosion along the Tokeland Peninsula shoreline. This problem will be addressed by relocating the North Cove channel 1,000 feet westward, to the approximate location and configuration it occupied in 1994. Relocation of the channel will require excavating approximately 100,000 CY of sand. The excavated sand will be relocated to the area presently occupied by the existing channel (see **Figure 3.7**). The plan areas (below MHHW) for the relocated channel and for the fill were adjusted to balance each other so that there will be no net change in intertidal area.

3.4.3 Alternative 7, Barrier Dune Restoration with Flood Berm Extension

The dune restoration and flood berm extension alternative combines restoration of the deteriorated barrier dune system with an extension of a shoreline flood berm that was constructed in 2001 by the Corps to protect a small portion of the Shoalwater Reservation shoreline. **The dune restoration portion of alternative 7 is identical to the alternative 6 dune restoration described above in paragraph 3.4.2.** In addition, the 2001 flood berm is extended along the shoreline northward 4,000 feet and southward 2,770 feet (see **Figure 3.8**). When the 4,000-foot-long north flood berm extension and 2,770-foot-long south flood berm

extension are combined with the existing 1,700-foot-long flood berm, a continuous shoreline protective structure with a total length of 8,470 feet is formed.

The 4,000-foot-long northward extension of the flood berm utilizes a design that is similar to the existing flood berm and past experience of the Corps at Grays Harbor to the north. The flood berm is constructed of graded riprap with a top elevation of +17 feet MLLW, a top width of 16 feet, and a side slope of 1V on 1.5H. The north flood berm extension requires approximately 35,000 tons of graded riprap and 14,000 tons of core (i.e., underlayer/filter) material. The initial gradation for both the riprap and underlayer/filter material was calculated using the Corps' Automated Coastal Engineering System (ACES). They were slightly altered based on the Corps' Seattle District office past experience and constructability. The core material serves as the underlayer/filter for the overlying riprap. The flood berm is intentionally porous, allowing water to filter through after the wave energy is dissipated. It is not intended, nor required, to be a levee that keeps elevated water levels from flooding interior lowlands. Nor will it be subjected to continuous or even frequent wave attack. Wave attack, when it occurs, will be over a 3-4 hour period, perhaps once or twice annually, and only if the barrier dune is sufficiently eroded prior to renourishment. All construction materials are brought to the construction site by truck, and access to the site is along the structure itself. Approximately 15,000 CY of sand and soil is excavated to make way for construction of the flood berm. The excavated sand and soil is re-graded over the flood berm and planted with native vegetation as an environmental and esthetic feature.

The 2,770-foot-long south flood berm extension utilizes the same design as the north flood berm extension. It is constructed of graded riprap with a top elevation of +17 feet MLLW, a top width of 16 feet, and a side slope of 1V on 1.5H. The south flood berm extension requires approximately 25,000 tons of graded riprap and 15,000 tons of underlayer/filter material. Approximately 10,000 CY of sand and soil is excavated to make way for the underlayer/filter material and riprap. All construction materials for the southward extension are brought to the construction site by truck, and access to the site is along the structure itself. The excavated sand and soil is re-graded over the face of the flood berm and planted with native vegetation as an environmental and esthetic feature.

The restored barrier dune will provide primary protection from storm waves, but the extension of the flood berm allows considerable erosion of the barrier dune before periodic nourishment is required. Periodic nourishment of the barrier dune is 500,000 CY of sand at 10-year-intervals. Maintenance of the flood berm will require replacement of 10 - 25 percent of the riprap at 25-year intervals, and replacement of 5,000 CY of the sand and soil covering the seaward face of the riprap flood berm extension at 25-year-intervals. The backup protection provided by the flood berm allows significant flexibility in the periodic nourishment schedule for the barrier dune restoration, allowing the periodic nourishment interval to double to at least 10 years verses every five years if the barrier dune restoration-only alternative were implemented. This flexibility alleviates concerns regarding availability and timing of funding for periodic nourishment of the barrier dune, scheduling and availability of relatively scarce dredging equipment, and the short four-month-long dredging window (July through October) within which dredging equipment can safely operate in the severe wave climate at Willapa Bay. Thus,

if the barrier dune has eroded to the point that it is overtopped and/or breached during a winter storm event, the flood berm alleviates concern about shoreline erosion and wave run-up and overtopping during the time period (minimum of 6 months, and likely longer) until periodic nourishment of the dune can be accomplished.

3.5 Trade-off Analysis

The results of trade-off analysis are presented in **Table 3-4** below. Items considered in the analysis include construction cost and life cycle cost analysis, maintenance intervals, compatibility of plans with the Corps of Engineers Environmental Operating Principles, public acceptability, and the views of the Shoalwater Bay Indian Tribe.

A detailed cost estimate was developed for each of the three plans that comprise the final array of alternative plans. Cost estimates were developed using the Corps Micro-Computer Aided Cost Estimating System (M-CACES) software. An economic evaluation was performed on the three plans, using a life-cycle cost analysis approach. For the following reasons, a life-cycle cost analysis approach was used to evaluate alternative plans:

- The project authorization exempts the project from any requirement for economic justification, as confirmed by Headquarters Counsel. The Federal government has a trust responsibility toward the Shoalwater Tribe. An appropriate basis for decision-making is to determine cost effectiveness from an annualized life-cycle cost basis.

- The three alternative plans (sea dike, barrier dune restoration, and barrier dune restoration with flood berm extension) provide a comparable level of benefit to the Shoalwater Tribe. That is, they each afford effective flood and coastal storm damage reduction to all Shoalwater Reservation lands, both intertidal and uplands.

The economic decision criteria for alternative plans was quantified using a life-cycle cost analysis which includes all upfront capital costs, interest during construction, plus all future costs for operation and maintenance and replacement expected to be incurred over the 50-year period of analysis. Costs for each alternative reflect a constant price level (October 2006). Future costs were converted to present worth value by discounting from their expected year of expenditure to project year one, using the latest Federal discount rate (4 7/8 percent). The sums of all upfront and discounted future costs were annualized over the 50-year period of analysis.

Table 3.4 Trade-off Analysis for Final Array of Alternative Plans

Alternative	Initial Construction (Present Value)	Total Annualized Cost	Required Periodic Nourishment and Maintenance Intervals	Environmental Operating Principles	Public Acceptability	Views of Shoalwater Bay Indian Tribe
Alternative 4, Sea Dike	$22,172,000	$2,091,000	Armor stone: 25 years Sand cover: 2 years	Massive rock structure not environmentally compatible with natural system in Willapa Bay. Hard structure does not lend itself to adaptive management.	Not acceptable to state and Federal resource agencies. Very extensive mitigation required to gain permits.	Tribal leadership does not support this alternative, for the same reasons cited by state and Federal resource agencies (see **Public Acceptability**).
Alternative 6, Barrier Dune Restoration	$9,754,000	$1,276,000	Periodic Nourishment: 5 years Planting: 5 years	Dune requires periodic nourishment at five year intervals, followed by replanting of native vegetation to stabilize sand.	Dune restoration is very acceptable to state and Federal resource agencies. Soft solution lends itself to adaptive management. No adverse environmental impact and thus no mitigation required.	Tribal leadership shares concern that the dune could erode, prior to estimated five year periodic nourishment, to the point that storm waves overtop the structure and flood tribal uplands.
Alternative 7, Barrier Dune Restoration with Flood Berm Extension	$13,961,000	$1,282,000	Dune Restoration: Periodic nourishment: 10 years Planting: 10 years Flood Berm Extension: Berm riprap: 25 years Sand/soil cover: 25 years Planting: 25 years	Flood berm extension in combination with dune restoration will extend the dune periodic nourishment interval to 10 years minimum. Flood berm extension blends with the environment, as has existing flood berm.	Very acceptable to state and Federal resource agencies. Soft solution for dune lends itself to adaptive management. Flood berm also is acceptable, and is sited almost entirely above MHHW. No adverse environmental impact and thus no mitigation required.	Tribal leadership strongly supports this alternative plan. The flood berm extension provides a second line of defense against upland flooding should the dune erode, prior to estimated 10 year periodic nourishment, to the point that storm waves overtop the structure.

- **Alternative 4, Sea Dike.** Initial construction of the sea dike would require two years, with dike armor stone maintenance occurring after 25-years. Sand cover maintenance would be required every two years. The total annualized, life-cycle cost of Alternative 4 is $2,091,000 (see **Table 3.5**).

- **Alternative 6, Barrier Dune Restoration.** Initial construction would occur seasonally over a 2-year period. Periodic nourishment is expected to be required every five years, including replanting of stabilizing vegetation. The total annualized, life-cycle cost for Alternative 6 is $1,276,000 (see **Table 3.5**).

- **Alternative 7, Barrier Dune Restoration with Flood Berm Extension.** Initial construction of the flood berm extension will occur over a two year period, followed by construction of barrier dune restoration over a two year period. Maintenance of the flood berm includes riprap replacement at year 25. Periodic nourishment of the barrier dune restoration is expected to be required at ten-year intervals, including replanting of stabilizing vegetation. The total annualized, life-cycle cost for Alternative 7 is $1,282,000 (see **Table 3.5**).

As shown below in **Table 3.5**, the total annualized cost difference between Alternative 6 and Alternative 7 is very minor, with Alternative 7 being slightly more expensive ($6,000) than Alternative 6 from an annualized life cycle basis.

Table 3.5 Summary Cost Data for Final Array of Alternative Plans

Alternative	Initial Construction (Net Present Value) [1/]	O&M and/or Periodic Nourishment (Net Present Value)	Annualized Initial Construction Cost	Annualized O&M and/or Periodic Nourishment Cost	Total Annualized Cost (Rounded)
Alternative 7, Barrier Dune Restoration with Flood Berm Extension	$12,239,692	$293,199 (O&M) $11,334,604 (periodic nourishment)	$657,544	$624,672	**$1,282,000**
Alternative 6, Barrier Dune Restoration	$9,129,654	$14,622,217 (periodic nourishment)	$490,466	$785,539	**$1,276,000**
Alternative 4, Sea Dike	$21,107,425	$3,090,891 (O&M)	$1,133,939	$956,715	**$2,091,000**

[1/] Includes interest during construction

3.6 Selection of the Final Plan

Alternative 7, barrier dune restoration with flood berm extension, has been tentatively identified as the final plan. This plan was selected after careful consideration of the criteria specified in the project authorization, planning objectives and constraints, views of the Shoalwater Bay Indian Tribe, input from the adjacent non-Indian community, and the views of local, state and Federal resource and regulatory agencies who have collectively provided valuable input throughout the project planning process.

3.6.1 Rationale for Selection

Alternative 7, barrier dune restoration with flood berm extension, is identified as the most appropriate long term solution to the shoreline erosion and coastal storm damage problems affecting the Shoalwater Bay Indian Reservation. This plan is the most cost effective means of providing erosion and coastal storm damage protection, is environmentally acceptable and technically feasible, and will improve the economic and social conditions of the Shoalwater Tribe. Alternative 7 provides a complete solution to identified flood and coastal storm damage problems and concerns facing the Shoalwater Bay Indian Tribe and their Reservation.

Alternative 7 is the only plan that meets all criteria specified in the project authorization, and, thus, best satisfies planning objectives and evaluation criteria. In a perfect world, the restored barrier dune would never be allowed to deteriorate to a point that storm waves could overtop the structure and allow wave run-up and flooding of the Shoalwater Reservation shoreline. The flood berm extension is a second line of defense in the event that required periodic nourishment of the barrier dune cannot be scheduled and performed in a timely manner. The flood berm alleviates real concerns regarding future availability and timing of funding for periodic nourishment, scheduling and availability of scarce dredging equipment, and the short four-month-long dredging window within which the required dredging equipment can safely operate in the severe wave climate of Willapa Bay. The inclusion of the flood berm extension also doubles the interval (every 10 years rather than 5 years) for required periodic nourishment.

3.6.2 Risks and Uncertainties

Few, if any, risks and uncertainties appear to be associated with the selected alternative plan (alternative 7). Risks and uncertainties appear to be associated more so with the alternative plans that were not selected than with the dune restoration with flood berm extension alternative. The comprehensive technical studies conducted as part of the interagency collaborative planning process for this project have confirmed that a modest engineering solution is both a technically feasible and cost effective means to reestablish the storm protection provided by the barrier dune system on Graveyard Spit. After 1985, Graveyard Spit stabilized in position, but the barrier dune lowered and narrowed, and consequently became prone to storm overwash. The littoral drift of sand that previously nourished and maintained the dunes was interrupted, resulting in the narrowing and eventual breaching of the protective dunes. During storm events, high tides and

storm surge are not the issue, but rather the storm wave run-up and overtopping associated with low pressure storm events which coincide with extreme high tides. Uncertainty about the ability to perform necessary periodic nourishment of the restored barrier dune on Graveyard Spit in a timely manner following an unanticipated severe storm at high tide or series of storms led to a determination that extension of the shoreline flood berm should be a component of the selected plan. The selected plan presents little, if any, risk to either the Shoalwater Tribe or the Tokeland Peninsula community, or to the ecosystem of Willapa Bay.

The barrier dune restoration and shoreline flood berm extension on and near the Shoalwater Bay Indian Reservation is not a major action and will not result in significant impacts on the human environment. Environmental impacts associated with the proposed action include minor short-term impacts to water quality due to turbidity increase, minor short-term impacts to air quality and noise levels, minor short-term stresses to aquatic organisms due to turbidity increases, burial of small areas of benthos along with attendant plants and animals, and minor short-term impacts to the esthetics of the area during construction.

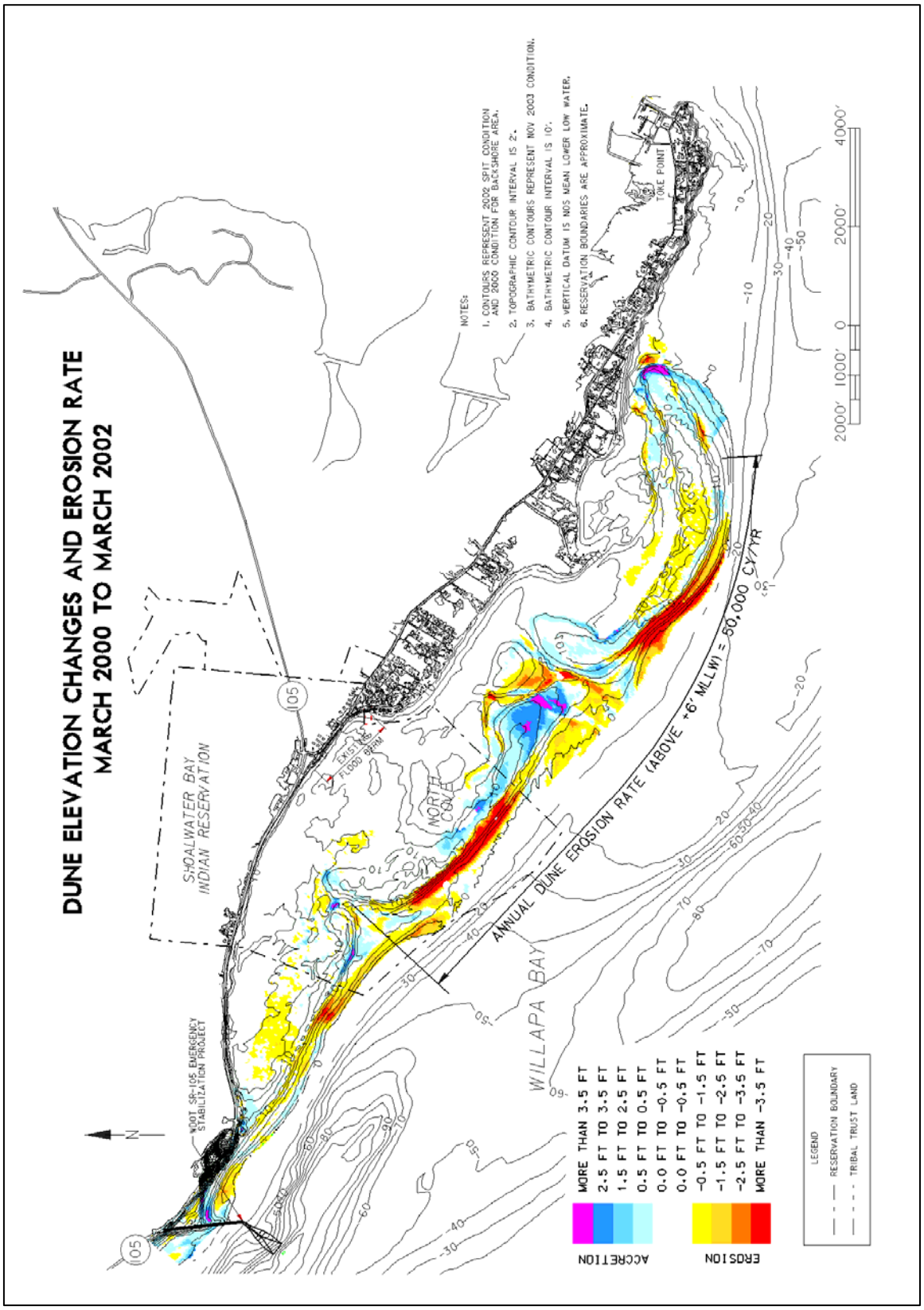


Figure 3.1 Barrier Dune Elevation Changes and Erosion Rate

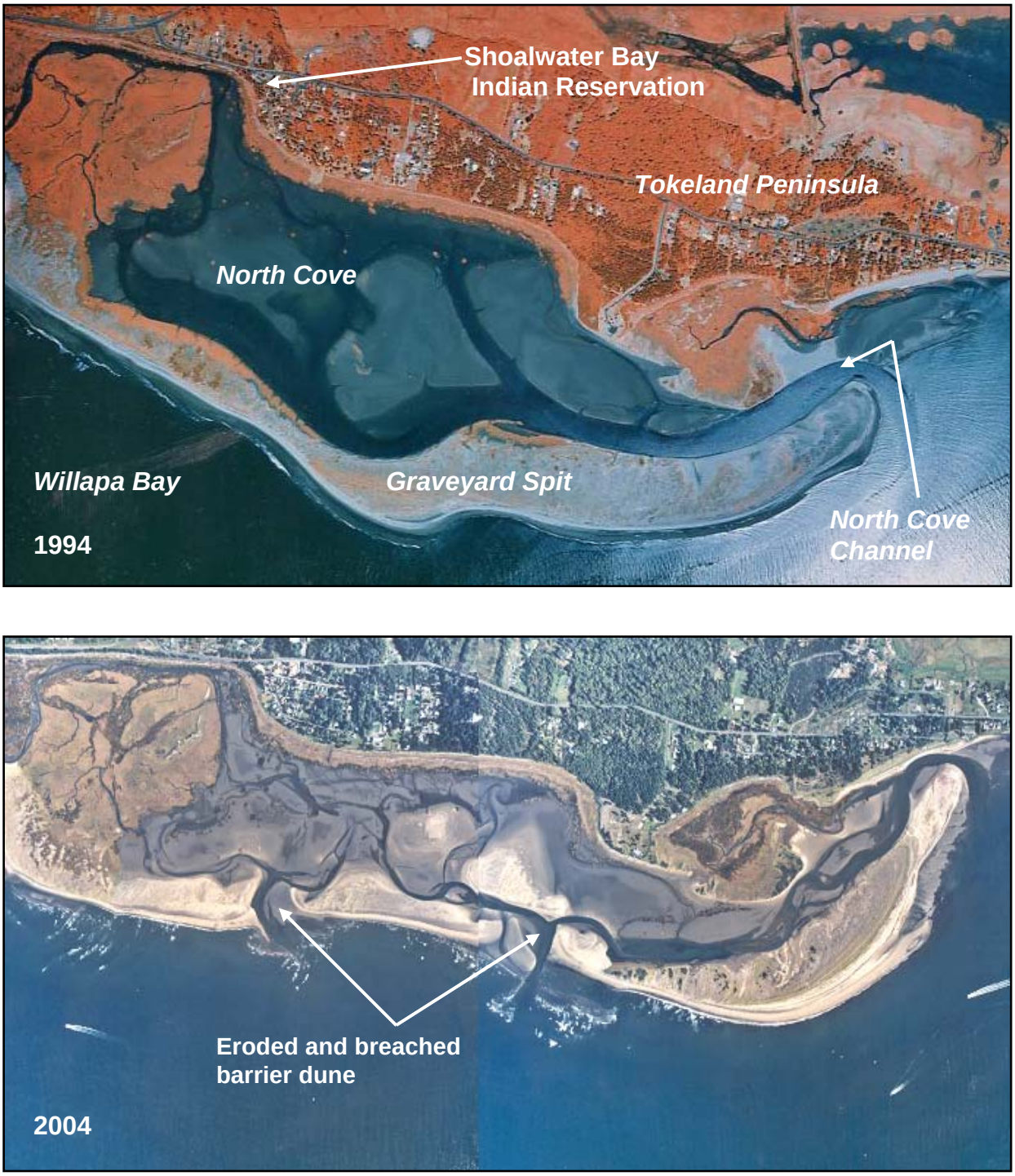


Figure 3.2 Barrier Dune Condition, September 1994 and August 2004

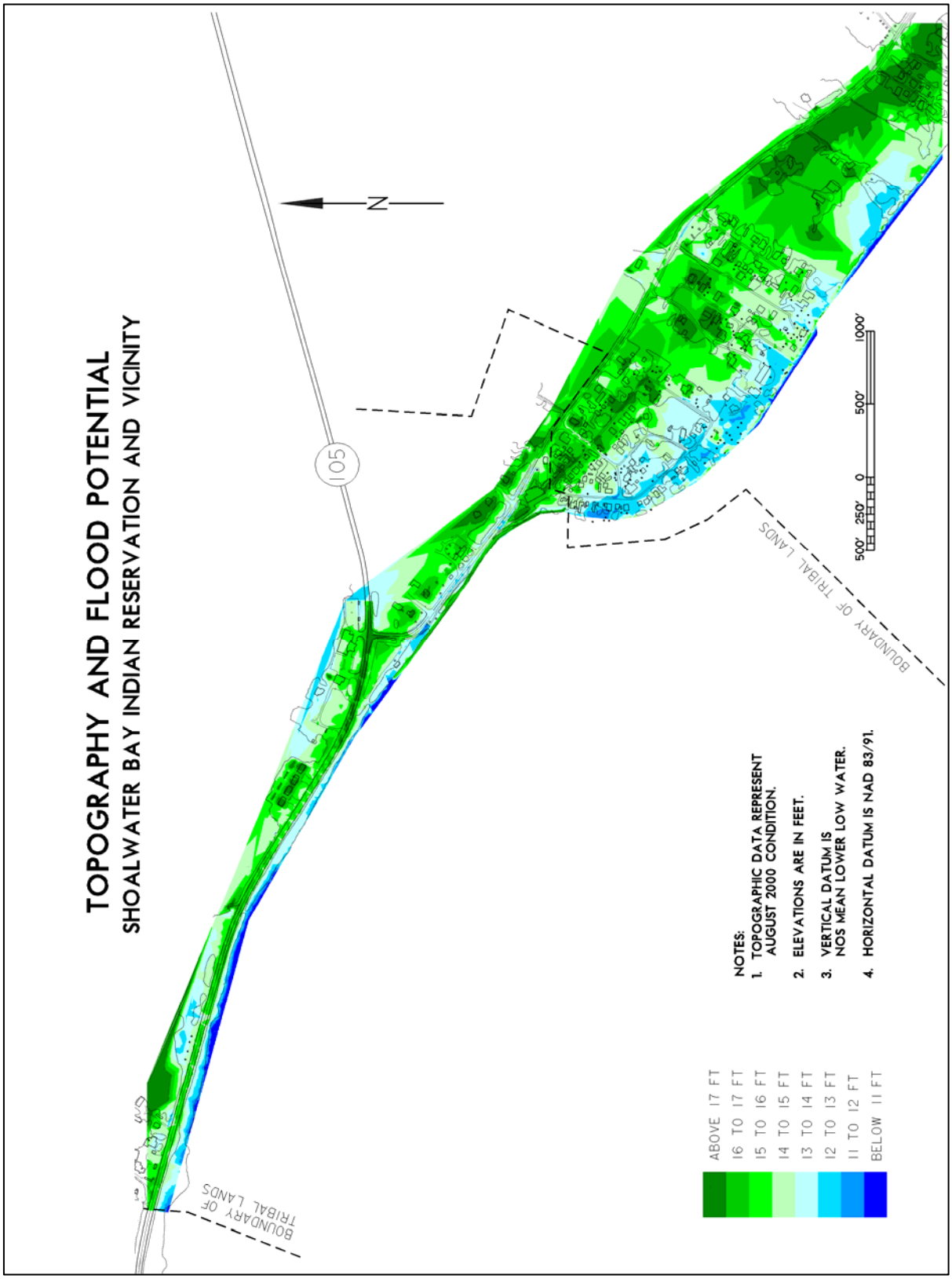


Figure 3.3 Tokeland Peninsula, Topography and Flood Potential

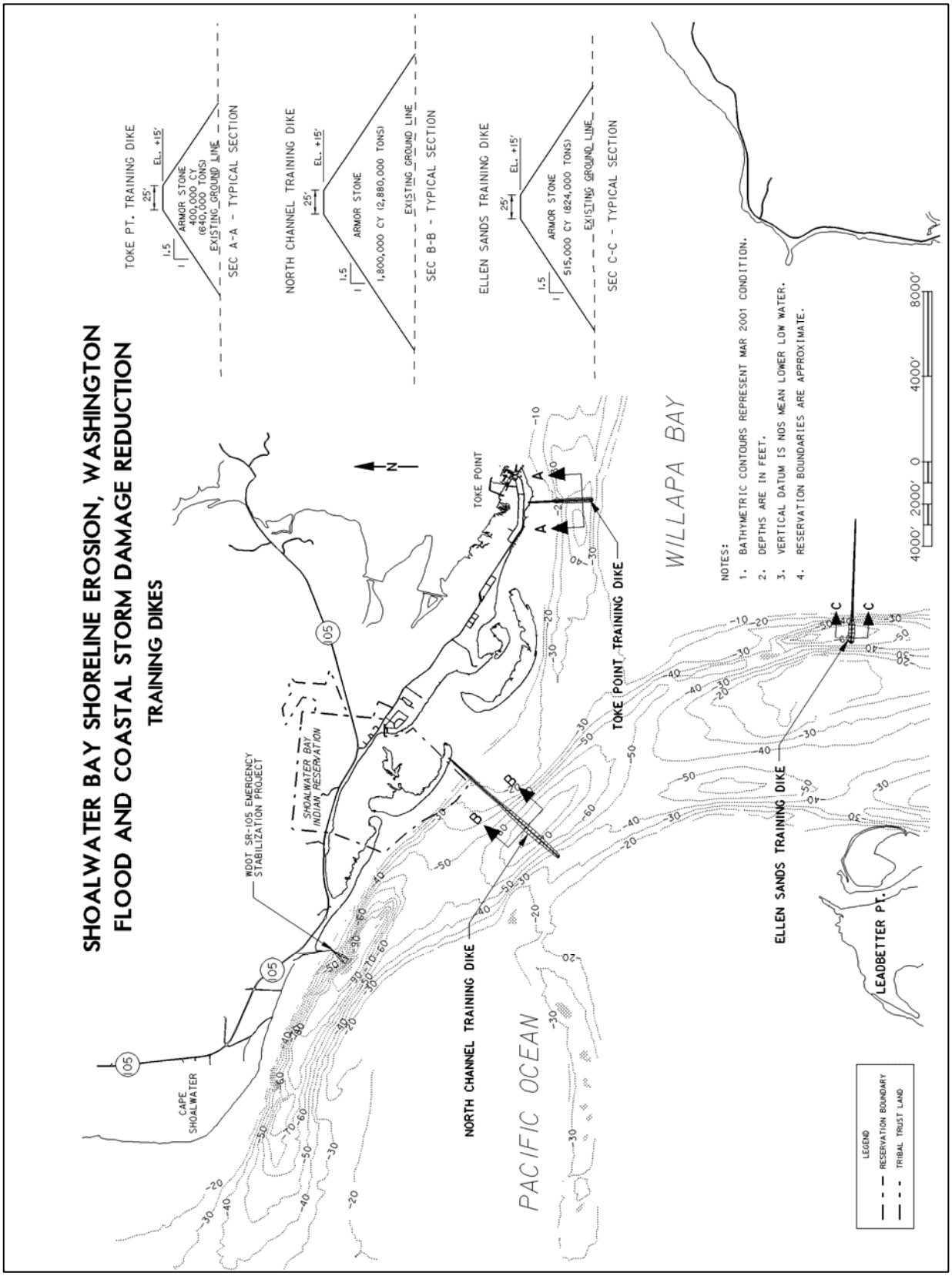


Figure 3.4 Training Dike Locations, Plan and Sections

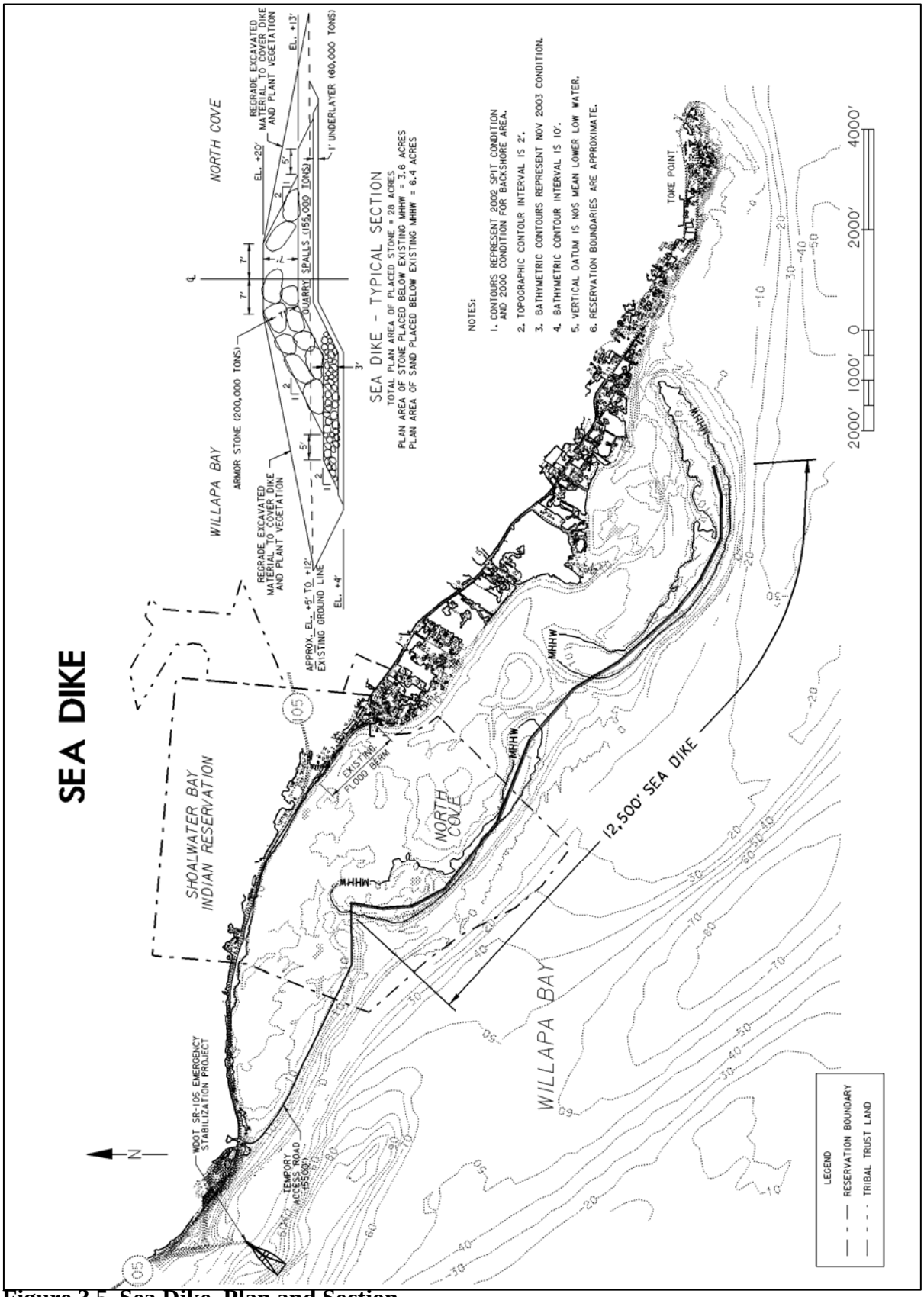


Figure 3.5 Sea Dike, Plan and Section

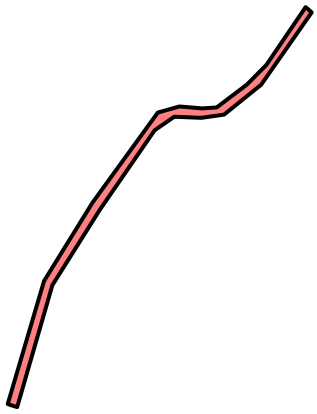


Figure 3.6 Shoreline Revetment, Plan and Section

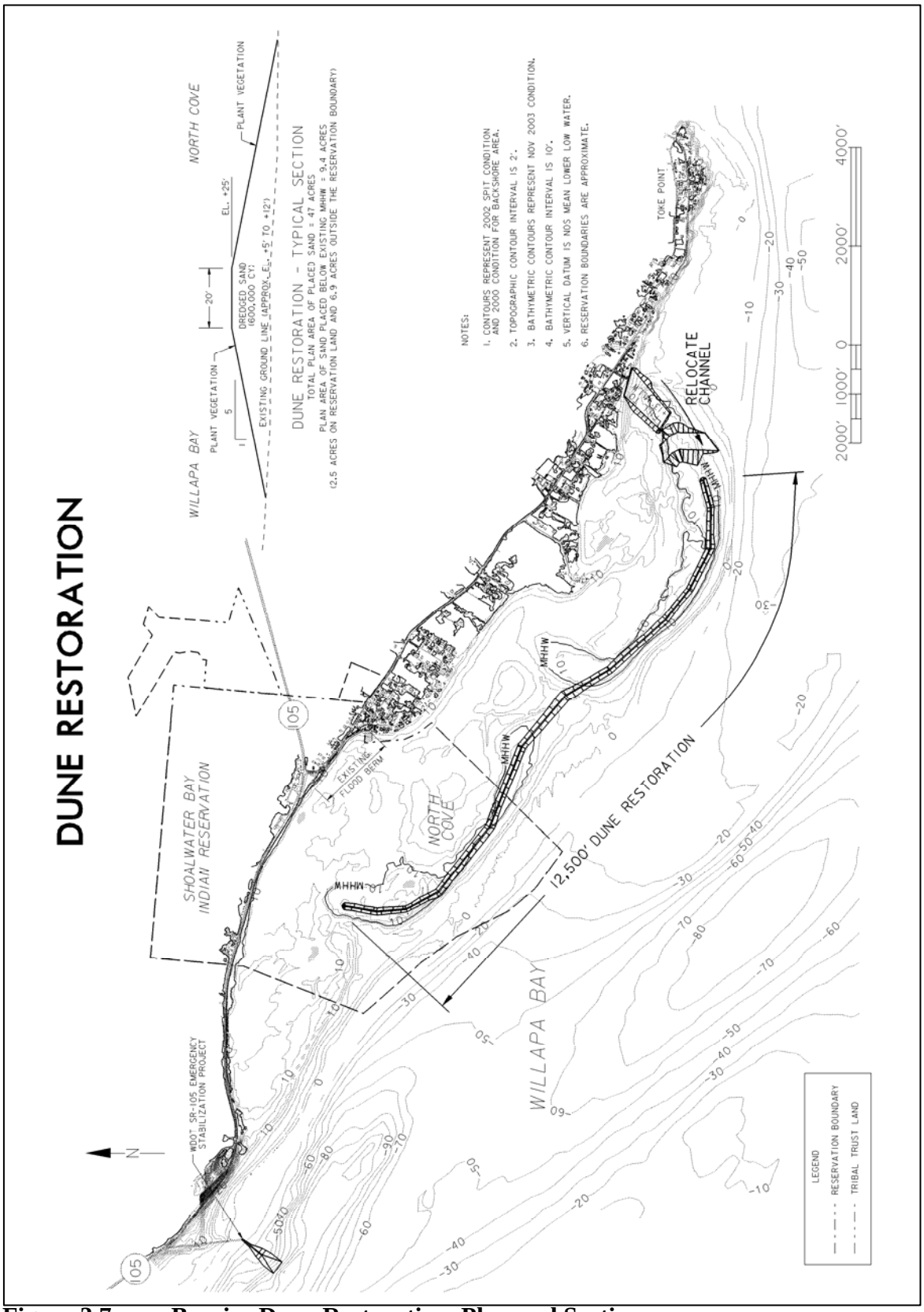


Figure 3.7 Barrier Dune Restoration, Plan and Section

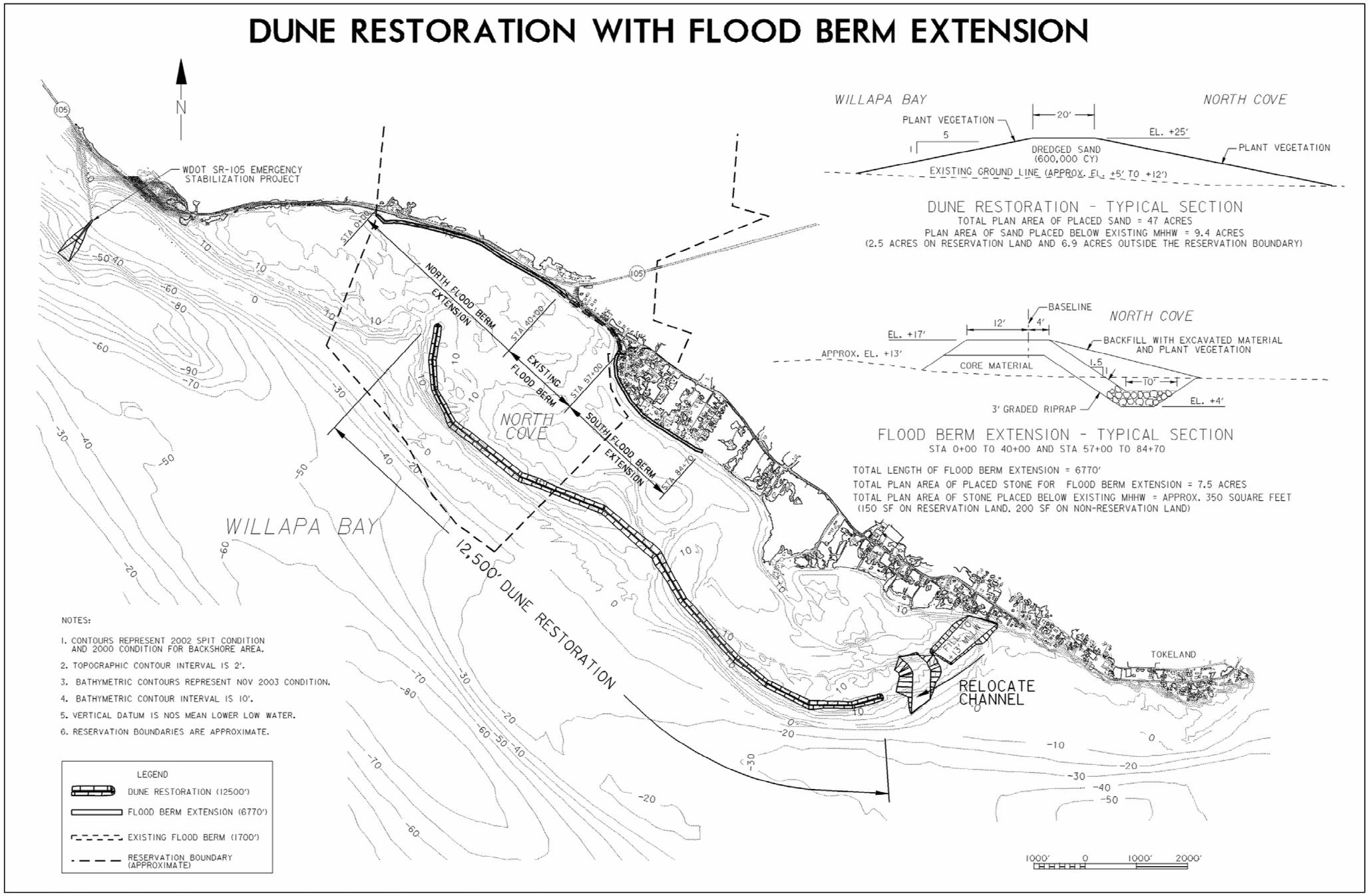


Figure 3.8 Barrier Dune Restoration with Flood Berm Extension, Plan and Sections

SECTION 4: DESCRIPTION OF SELECTED PLAN

4.1 Plan Components

The selected plan is **Alternative 7, barrier dune restoration with flood berm extension**. Alternative 7 has three components which are separately described below. This plan combines restoration of the deteriorated barrier dune system on Graveyard Spit with a northward and southward extension of the existing shoreline flood berm segment which was constructed in 2001 by the Corps of Engineers.

4.1.1 Barrier Dune Restoration

Barrier dune restoration will restore the eroded and breached dune system on Graveyard spit with sand dredged from the adjacent Willapa Bay entrance and channel. The restored dune is 12,500-feet-long, with a top elevation of +25 feet MLLW, a top width of 20 feet, and a side slope of 1V on 5H (see **Figure 3.8**). The dune restoration will be constructed along the crest of the existing eroded and breached dune. The restored barrier dune will require dredging approximately 600,000 CY of sand from the entrance to Willapa Bay. The dredged sand will be graded and planted with native dune grass, to extend the periodic nourishment interval by stabilizing the sand from wind erosion.

Dune restoration dimensions maximize the volume of sand that can be placed within the available plan area of the existing eroded dune on Graveyard Spit. The design objective was to restore the barrier dune to its approximate former height (as recently as 1990), and thereby accomplish planning objectives for this project. The restored dune will again provide the primary storm wave protection to the entire Shoalwater Reservation, including intertidal habitat in the North Cove embayment and tribal uplands. Storm waves cannot be allowed to overtop and subsequently breach the restored dune. In addition, the cost of periodic nourishment necessitates that the interval between nourishment be as long as possible. The cost of mobilizing a large dredge to the project site is a major consideration, and the lowest life-cycle cost for this alternative plan is obtained by maximizing the nourishment interval. Natural erosion of the dune is to be expected. However, the inclusion of the flood berm (see **Paragraph 4.1.2** below) permits greater dune erosion before periodic nourishment of the dune is required to maintain the intended level of storm damage reduction to protect the Shoalwater Reservation.

For both initial construction and periodic nourishment, the sand probably will be pumped from a nearby aquatic borrow site in Willapa Bay by a large pipeline dredge. A potential borrow site has been evaluated in detail (**reference Chapter 5 of Appendix 1**), and is located approximately 4,000 feet from the project site, on the north side of the Willapa Bay channel (see **Figure 4.1**). A similar construction process for dredged sand placement in Willapa Bay was successfully carried out by the Washington State Department of Transportation in 1998 for the

SR-105 Emergency Stabilization Project to the west of Graveyard Spit. For that project, some 350,000 CY of dredged sand for a shoreline beach fill was pumped by hydraulic dredge approximately 7,000 feet. The SR-105 borrow site is located on the south side of the Willapa North Channel, to the west of the proposed primary borrow site identified for the barrier dune restoration. A secondary sand borrow site is located on the south side of the Willapa North Channel.

An ancillary feature of the barrier dune restoration is to realign the North Cove tidal channel at the southern end of the cove 1,000 feet westward to the approximate location it occupied in 1994 (see **Figure 3.2 and 3.8**). In 1994, the Graveyard Spit dune formed a continuous barrier separating North Cove from Willapa Bay and a single, well-defined, tidal channel entered the southern end of the cove. Relocation of the channel to its former position will require excavating 100,000 CY of sand, with the excavated sand relocated to the area presently occupied by the existing tidal channel. The plan areas (below MHHW) for both the relocated channel and the fill will be adjusted to balance each other so that there will be no net change in intertidal area. Erosion of the barrier dune has profoundly affected the natural tidal channel into and out of North Cove. Prior to the barrier dune being severely eroded and breached, the tidal flow in this channel was strong enough to scour away sand that was being carried southward on the ocean side of Graveyard Spit. As erosion resulted in the formation of breaches in the barrier dune, the additional entrance and exit of North Cove tidal flows, combined with the reduction in the cove volume due to infilling, resulted in a diminished flow through the channel. As the flow through the North Cove channel diminished, it was no longer strong enough to resist the southward encroachment of the spit, and the channel began migrating to the southeast, causing erosion along the Tokeland Peninsula shoreline. Rehabilitation of the barrier dune will close the breaches, resulting in an increase in the flow through the channel.

4.1.2 Flood Berm Extension

The existing flood berm is extended southward 2,770 feet and northward 4,000 feet (see **Figures 3.8 and 4.2**). When the south flood berm extension and north flood berm extension are combined with the existing 1,700-foot-long flood berm (constructed by the Corps in 2001), a continuous shoreline protective structure with a total length of 8,470 feet is formed.

The purpose of the flood berm is to provide backup protection to tribal uplands from wave run-up and overtopping during periods of high tide storms in those situations where the primary protection provided by the barrier dune has been compromised due to severe erosion and periodic renourishment has, for whatever reasons, not yet been performed. The flood berm allows considerable erosion of the barrier dune to occur before renourishment is required. The flood berm is a porous structure, allowing water to filter through after the wave energy is dissipated. It is not intended, nor required, to be an impervious levee that keeps elevated water levels from flooding interior lowlands. Nor will it be subjected to continuous or even frequent wave attack. Wave attack, when it occurs, will be over a 3-4 hour period, perhaps once or twice annually, and only in the rare circumstance that the barrier dune is sufficiently eroded and has not been renourished with sand.

The flood berm extension utilizes a design that is similar to the existing flood berm. The flood berm extension is constructed of graded riprap with a top elevation of +17 feet MLLW, a top width of 16 feet, and a side slope of 1V on 1.5H. The flood berm design assumes that the barrier dune is in the deteriorated condition that was used in the "without dune" wave simulations by CHL. The riprap gradation was determined using the Corps Automated Coastal Engineering System (ACES v 1.07f). Assuming a +13.61 foot tide, a structure toe elevation of +8 feet MLLW (5.6 foot toe depth), and 2 foot (0.6 meter) incident wave height, the ACES *Rubble Mound Revetment Design* application computed that the rock should be graded with a minimum weight of 19.87 pounds, a maximum weight of 635.74 pounds, and 50% by weight greater than 158.94 pounds. The specified gradation will be rounded to a minimum weight of 10 pounds, a maximum weight of 500 pounds, and 50% by weight less than 200 pounds. The riprap "layer thickness" computed by ACES is 1.98 feet, but for reasons of constructability, and to minimize the potential for the piping of fines, the layer thickness was increased to 3 feet. The underlayer/ filter material (flood berm core material) gradation computed by ACES has a minimum weight of 0.05 pounds, a maximum weight of 1.67 pounds, with 50% by weight greater than 0.29 pounds. Based on past experience and to maximize quarry yield, this gradation was revised to a minimum weight of 0.1 pounds, a maximum weight of 10 pounds, with 50% by weight less than 1 pound. The ACES *Wave Run-up and Overtopping* application was used to compute the wave run-up to be 3.7 feet. Combined with a +13.61 foot tide, the maximum run-up elevation is calculated +17.31 feet MLLW. A design elevation of +17 feet MLLW was selected. Since the flood berm itself will be used for construction and maintenance access, the berm top width is 16 feet.

The 4,000-foot-long north flood berm is constructed along the shoreline and parallel to SR-105, extending from the Shoalwater Reservation boundary (station 0+00) to the north end of the existing flood berm (station 40+00) (see **Figures 4.3 and 4.4**). Construction requires approximately 35,000 tons of graded riprap and 14,000 tons of core material. All construction materials are brought to the construction site by truck, and access to the site is along the structure itself. Approximately 15,000 CY of sand and soil is excavated to make way for the core material and riprap. The excavated sand and soil is re-graded over the face of the flood berm and planted with native vegetation as an environmental and stabilizing feature for the sand and soil.

The 2,770-foot-long southward extension of the flood berm is constructed along the shoreline south of the existing flood berm. It extends from station 57+00 to high ground at station 84+70 (see **Figures 4.4 and 4.5**). Construction requires approximately 25,000 tons of graded riprap and 15,000 tons of core material. All construction materials for the south extension are brought to the construction site by truck, and access to the site is along the existing flood berm and the new structure itself. Approximately 10,000 CY of sand and soil is excavated to make way for the core material and riprap. The excavated sand is re-graded over the face of the flood berm and planted with native vegetation as an environmental and stabilizing feature for the sand and soil.

4.2 Estimated Cost of Selected Plan

A detailed cost estimate was developed for the selected plan. The cost estimate was developed using the Corps of Engineers Micro Computer Aided Cost Estimating System (M-CACES) software. The initial construction cost estimate (net present value) for Alternative 7 is $12,240,000. The total annualized cost for Alternative 7, as shown on **Table 3.5**, is $1,282,000. The estimate includes contingency of 15 percent, interest during construction, operation and maintenance costs for the flood berm, and periodic nourishment for the barrier dune restoration. As specified in the project authorization, the Shoalwater Tribe will provide all project lands necessary for implementation of the project.

4.3 Design and Construction Considerations

Project design was heavily influenced by the findings of the comprehensive investigation of coastal processes at Willapa Bay and by the extensive Northwest experience with similar coastal structures and construction techniques. The comprehensive interagency investigation of coastal processes provided a verifiable basis for the conclusion that modest coastal engineering solutions are an appropriate response to the storm damage and coastal erosion problems confronting the Shoalwater Tribe. The findings of the Coastal Hydraulics Laboratory and the U.S. Geological Survey teams provided the basis for the conclusion that modest coastal engineering solutions are technically feasible and cost effective means to protect the Shoalwater Reservation from future flooding and shoreline erosion associated with extreme high tide storm events. In addition, the design of project features is based on proven construction techniques used by the Corps and other agencies along the coast of the state of Washington.

The restored barrier dune will provide primary protection from storm wave overtopping during periods of extreme high tides. The extension of the flood berm will allow considerable erosion of the barrier dune before periodic nourishment with dredged sand is required. The backup protection provided by the flood berm allows considerable flexibility in the periodic nourishment interval for the dune restoration, allowing the interval to increase to at least 10 years verses every five years if the dune restoration-only alternative (Alternative 6) is implemented. This flexibility alleviates concerns regarding availability and timing of funding for periodic nourishment, scheduling and availability of relatively scarce dredging equipment, and the short four-month-long dredging environmental window (July 15 through October 15) within which dredging equipment can safely operate in the severe wave climate at Willapa Bay.

Based on anticipated appropriation of funding, and due to the short dredging season for barrier dune restoration, the project will be constructed over a four-year period. Construction contracts for each project element will be awarded when all required real estate acquisitions for that element have been certified and construction funding is available. The preferred sequence of construction, as concurred in by the Shoalwater Tribal Council, is as follows:

- **FY 2007 construction season:** North flood berm extension
- **FY 2008 construction season:** South flood berm extension
- **FY 2009 - 2010 construction seasons:** Barrier dune restoration

4.4 Real Estate Requirements

4.4.1 Project Authorization

In accordance with Section 545(b)(2) of WRDA 2000 (Public Law 106-541), the Shoalwater Tribe is responsible for all lands, easements, rights-of-way and dredged material disposal areas (hereinafter "project lands") necessary for implementation of the project. Relocations, if any, are not identified as a responsibility of the Shoalwater Tribe and, therefore, would be a Federal responsibility. There are no known relocations associated with the project. The complete text of Section 545(b)(2) of WRDA 2000 is as follows:

> ***(2) LANDS, EASEMENTS, AND RIGHTS-OF-WAY. - As a condition of the project, described in paragraph (1), the Shoalwater Bay Tribe shall provide lands, easements, rights-of-way, and dredged material disposal areas necessary for implementation of the project.***

4.4.2 Obligations of the Corps and Shoalwater Tribe

The Corps, in consultation with the Shoalwater Tribe, will determine the project lands required for the construction and the operation and maintenance (O&M) of the project. The Corps will supply the Shoalwater Tribe with legal descriptions, maps, and other written information as appropriate for the project lands the Corps determines the Shoalwater Tribe must provide. Information provided to the Shoalwater Tribe by the Corps will be in detail sufficient to enable the Tribe to fulfill its obligations to provide project lands.

Prior to the issuance of the solicitation for each Government contract for construction of the project, or prior to the Government incurring any financial obligations for construction of a portion of the project using the Government's own forces, the Shoalwater Tribe will provide all project lands the Corps determines are necessary for the work associated with each construction contract and will provide the Corps with authorization for entry thereto. Furthermore, prior to the end of the period of construction of the project, the Shoalwater Tribe will provide all project lands required for construction, operation, and maintenance of the project and will provide the Corps with authorization for entry thereto. For so long as the project remains authorized, the Shoalwater Tribe will ensure the project lands that are determined by the Corps to be necessary for the project are retained by the Shoalwater Tribe for uses compatible with the authorized purposes of the project.

The Shoalwater Tribe will comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (Public Law 91-646), as amended by Title IV of the Surface Transportation and Uniform Relocation Assistance Act of 1987 (Public Law 100-17), and the Uniform Regulations contained in 49 C.F.R. Part 24, in acquiring project lands, and will inform all affected persons of applicable benefits, policies, and procedures in connection with said Act.

4.4.3 North Flood Berm

The north flood berm extension element of the project is located entirely within the boundary of the Shoalwater Reservation. The Shoalwater Tribe will provide without cost to the Corps all project lands, consistent with existing easements and rights-of-way, required for construction, operation, and maintenance of the north flood berm extension. A temporary work area/contractor staging area and a permanent construction/maintenance access from SR-105 to the flood berm will be provided. Project lands certification by the Corps will include the north flood berm and that portion of the existing flood berm that is within the Shoalwater Reservation boundary.

4.4.4 South Flood Berm

The south flood berm extension element of the project will extend beyond the Shoalwater Reservation boundary to the east and south. Lands required for the south flood berm are currently in private and public ownership (State of Washington Department of Natural Resources). The Shoalwater Tribe will acquire from landowners and provide without cost to the Corps all project lands, consistent with existing easements and rights-of-way, required for construction, operation, and maintenance of the south flood berm extension. The required project lands comprise 27 private owners, plus two public rights-of-way. A temporary work area/contractor staging area and a permanent construction/ maintenance access easement located within the Shoalwater Reservation boundary will also be provided without cost to the Corps.

4.4.5 Barrier Dune Restoration

The barrier dune restoration on Graveyard Spit is partially located within the boundary of the Shoalwater Reservation. Approximately one-third the length of the Graveyard Spit barrier dune is within the Reservation boundary; the remaining length is currently in private and public ownership (State of Washington Department of Natural Resources). The Shoalwater Tribe will acquire and provide without cost to the Corps all required project lands, consistent with existing easements and rights-of-way, required for construction, operation, and maintenance of the barrier dune restoration.

4.4.6 Additional Real Estate Information

In March 2005, an environmental evaluation to identify the existence and extent of any hazardous substances that may exist in, on, or under anticipated project lands was conducted by the Corps. Nothing was discovered that would indicate any contamination due to hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (hereinafter "CERCLA"), 42 U.S.C. Sections 9601-9675 (reference **Appendix 3, Environmental Assessment, Paragraph 3.38**).

4.5 Operations and Maintenance Considerations

The Corps of Engineers will be responsible for all operation and maintenance activities associated with the completed project to protect the Shoalwater Reservation. An Operation and Maintenance Manual will be developed following completion of project construction.

4.5.1 Barrier Dune Restoration

Maintenance requirements for the barrier dune restoration were estimated by using topographic surveys of the dune to compute the sand loss that occurred between 2000 and 2002. Based on these rates, the annual loss of sand from the dune (above +6 feet MLLW) is estimated to be 50,000 CY/year. Review of more recent data confirms this annual rate of erosion.

Periodic nourishment requirements for the barrier dune restoration are assumed to be 500,000 CY of sand replacement at 10-year intervals, followed by replanting of native vegetation to stabilize the dune from wind-blown erosion. The backup protection provided by the flood berm allows significant flexibility in the nourishment schedule for the barrier dune. The flood berm allows the nourishment interval for the barrier dune to extend to at least 10 years, verses five years if the barrier dune is constructed in the absence of the flood berm. Sand for maintenance of the dune will be pumped from a borrow site by a large pipeline dredge or similar equipment. A potential borrow site is located approximately 4,000 feet from the project site, on the north side of the Willapa North Channel (see **Figure 4.1**).

4.5.2 Flood Berm Extension

Maintenance requirements for the flood berm are assumed to be replacement of 10 - 25 percent of the flood berm riprap at 25-year intervals, as well as replacement of 5,000 CY of the sand and soil covering the seaward face of the riprap flood berm extension. Riprap replacement at year 25 may be significantly less than this estimate, particularly if there is little settlement over time. Based on our field experience with the quality of rock specified, very little if any deterioration due to freeze-thaw cycles or abrasion is anticipated.

4.6 Plan Accomplishments

Restoration of the barrier dune on Graveyard Spit, coupled with extension of the existing shoreline flood berm, will protect the Shoalwater Bay Indian Reservation from the damaging and disastrous effects of coastal erosion. Restoration of the barrier dune and the extension of the flood berm will prevent flooding of the Reservation uplands due to wave run-up and overtopping during storm events occurring at extreme high tide. The flood berm will also prevent further erosion of the shoreline. Tribal infrastructure and housing, and essential public facilities which serve the needs of tribal members, will no longer be subject to flooding and damage due to coastal storms that coincide with elevated water conditions. Restoration of the barrier dune will also prevent storm over-wash and the resultant in-filling and associated degradation and loss of intertidal habitat in the North Cove embayment. This will afford the opportunity for restoration of the 700 acres of degraded Shoalwater Reservation intertidal habitat and tide flats in North Cove upon which the Shoalwater Tribe relied heavily for subsistence shellfish growing and gathering, as well as harvesting of local native plant species for tribal crafts and ceremonial use.

4.7 Summary of Environmental and Other Social Effects

4.7.1 Environmental Effects

An Environmental Assessment (EA) to evaluate the environmental effects of the proposed project was prepared by the Corps. As the Federal Action Agency for this project, the Corps is required by the National Environmental Policy Act (NEPA) (40 CFR § 1500 et. seq.) to assess the effects to the human environment of proposed agency actions, determine the significance of those effects, and coordinate with other agencies, Tribes, and the interested public in that assessment. The Corps has implemented NEPA through the Corps' ER 200-2-2 regulation. The EA was prepared according to that regulation, and the guidance presented in the Corps' Planning Guidance Notebook, ER 1105-2-100. The EA was prepared specifically to determine if this project warrants the preparation of an Environmental Impact Statement.

Based on the analysis, the EA concludes that the proposed dune restoration and flood berm extension project is not a major federal action significantly affecting the quality of the human environment, and therefore does not require preparation of an Environmental Impact Statement. The barrier dune restoration and shoreline flood berm extension on and near the Shoalwater Bay Indian Reservation is not a major action and will not result in significant impacts on the human environment. Environmental impacts associated with the proposed project include minor short-term impacts to water quality due to turbidity increase, minor short-term impacts to air quality and noise levels, minor short-term stresses to aquatic organisms due to turbidity increases, burial of small areas of benthos along with attendant plants and animals, and minor short-term impacts to the esthetics of the area during construction.

Nineteen species protected by the Endangered Species Act of 1973, as amended, and one candidate species are potentially found in the vicinity of Shoalwater Bay Erosion Project (see **Table 4.1** below). In accordance with Section 7(a)(2) of the Act, Federally funded, constructed, permitted, or licensed projects must take into consideration impacts to Federally listed and proposed threatened or endangered species. In order to satisfy the requirements of the Act, the Corps will consult with the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) regarding the effects of the proposed action on listed species. The Corps has prepared a biological evaluation (BE) to determine the effects of the project and propose conservation measures for species affected by the proposed action. The effect determinations described in the Corps BE can be found in **Table 4.2** below. No construction would occur by the Corps until the Services concur with the determinations made in the BE.

Table 4.1 Threatened, Endangered, and Candidate Species and Critical Habitat

Species	Listing Status	Critical Habitat
Bald Eagle *Haliaeetus leucocephalus*	Threatened	None
Brown Pelican *Pelecanus occidentalis*	Endangered	None
Marbled Murrelet *Brachyramphus marmoratus*	Threatened	Designated (none in project area)
Western snowy plover *Charadrius alexandrinus nivosus*	Threatened	Proposed
Northern spotted owl *Strix occidentalis caurina*	Threatened	Designated (none in project area)
Short-tailed albatross *Phoebastria albatrus*	Endangered	None
Streaked horned lark *Eremophilia alpestris strigata*	Candidate	N/A
Coastal-Puget Sound Bull Trout *Salvelinus confluentus*	Threatened	Designated (none in project area)
Leatherback Sea Turtle *Dermochelys coriacea*	Endangered	Designated (none in project area)
Loggerhead Sea Turtle *Caretta caretta*	Threatened	None
Green Sea Turtle *Chelonia mydas*	Threatened	Designated (none in project area)
Olive Ridley Sea Turtle *Lepidochelys olivacea*	Threatened	None
Oregon silverspot butterfly *Speyeria zerene hippolyta*	Endangered	Designated (none in project area)

Species	Listing Status	Critical Habitat
Steller sea lion *Eumetopias jubatus*	Threatened	Designated (none in project area)
Humpback whale *Megoptera novaeangliae*	Endangered	None
Sperm whale *Physeter catodon*	Endangered	None
Sei whale *Balaenoptera borealis*	Endangered	None
Fin whale *Balaenoptera physalus*	Endangered	None
Blue whale *Balaenoptera musculus*	Endangered	None
Southern resident killer whale *Orcinus orca*	Endangered	Proposed

Table 4.2 Effect Determination Summary

Species	Effect Determination	Critical Habitat Determination
Bald Eagle	Not likely to adversely affect	Not applicable
Brown Pelican	Not likely to adversely affect	Not applicable
Marbled Murrelet	Not likely to adversely affect	No effect
Western Snowy Plover	Not likely to adversely affect	No effect on proposed critical habitat
Northern Spotted Owl	No effect	No effect
Short-tailed Albatross	No effect	Not applicable
Streaked Horned Lark	Not likely to adversely affect	Not applicable
Coastal-Puget Sound Bull Trout	Not likely to adversely affect	No effect
Green Sturgeon	Not likely to adversely affect	Not applicable
Leatherback, Loggerhead, Green, and Olive Ridley Sea Turtles	No effect	Not applicable
Oregon Silverspot Butterfly	No effect	No effect
Steller Sea Lion	Not likely to adversely affect	No effect
Humpback Whale	Not likely to adversely affect	Not applicable
Sperm, Sei, Fin, and Blue Whales	No effect	Not applicable
Southern Resident Killer Whale	Not likely to adversely affect	No effect on proposed critical habitat

A Fish and Wildlife Coordination Act Report (CAR) dated August 2006 presents the conclusions of the U.S. Fish and Wildlife Service (Service) on the effects of the proposed project. The CAR was provided pursuant to the Fish and Wildlife Coordination Act (48 Stat. 401, as amended 16 U.S.C. 661, *et seq*.) and fulfills section 2(b) of this Act. The Service's conclusions, shown on page 15 of the CAR, are as follows:

> *"The Corps has determined that the use of soft structures (i.e., the restoration of the dune) in combination with the extension of the existing flood berm would likely be sufficient to achieve the goals of the project. The Corps has attempted to minimize impact to Willapa Bay through the incorporation of certain measures in the project design, specifically: 1) the use of soft materials (i.e., sand) instead of hard structures in the bay, 2) native vegetation plantings for dune stabilization, and 3) the placement and maintenance of sand and plantings on the existing flood berm and its extension. If the Corps proceeds with project implementation, we recommend that the Corps select their preferred alternative with the proposed measures to minimize impacts to habitat and species.*
>
> *We support the goals of the proposed restoration project in regard to the protection of Tribal lands and resources, and give our support on the presented components of the preferred alternative, pending the satisfactory inclusion of appropriate conservation measures to minimize impacts to fish and wildlife and their habitats during construction."*

4.7.2 Other Social Effects

Alternative 7, barrier dune restoration with flood berm extension, will provide a complete solution to identified coastal storm damage problems and concerns facing the Shoalwater Bay Indian Tribe and their Reservation. Accordingly, this plan holds the greatest promise of improving the economic and social conditions of the Shoalwater Tribe.

Restoration of the barrier dune on Graveyard Spit will provide the opportunity for ecosystem restoration of the North Cove embayment, thereby enabling the restoration of its previously abundant Tribal subsistence shellfish resources. The restored barrier dune will prevent storm waves from over-washing the dune and infilling the embayment with sand. This will thus prevent further degradation and loss of the intertidal habitat and tide flats of the North Cove embayment. Restoration of the ecosystem of the North Cove embayment to return the shellfish habitat will thus encourage its use again as a subsistence resource for the Tribal community. The Shoalwater Tribe relied heavily, both historically and in recent times, on the diversity and productivity of the 700 acres of intertidal habitat and tide flats in the North Cove embayment. Barrier dune restoration will enable the Shoalwater Tribe to take steps necessary to restore the ecosystem of North Cove, thereby restoring subsistence shellfish beds. The Tribe grew and harvested shellfish in North Cove, on which, along with ocean fisheries, they relied heavily for subsistence food supply. In addition, tribal members harvested local native plant species from the North Cove embayment for tribal crafts and ceremonial use. Protection of the North Cove embayment from further habitat degradation and loss will have a positive effect on the Tribe's cultural and religious traditions.

The growing threat of winter storm flooding and damage to tribal uplands and facilities will be eliminated by restoration of the barrier dune and completion of the shoreline flood berm. The Shoalwater Tribe has a very small upland land base, and there are no alternative sites upon which to develop needed Tribal facilities and housing. Construction of the proposed project will provide needed assurance to the Shoalwater Tribe that their tribal facilities and housing are safe from winter coastal erosion and associated storm damage, and that the small tribal population is no longer at risk due to storm-induced flooding. In addition, the Tribe will not be isolated due to flooding and closure of SR-105 which traverses the Shoalwater Reservation.

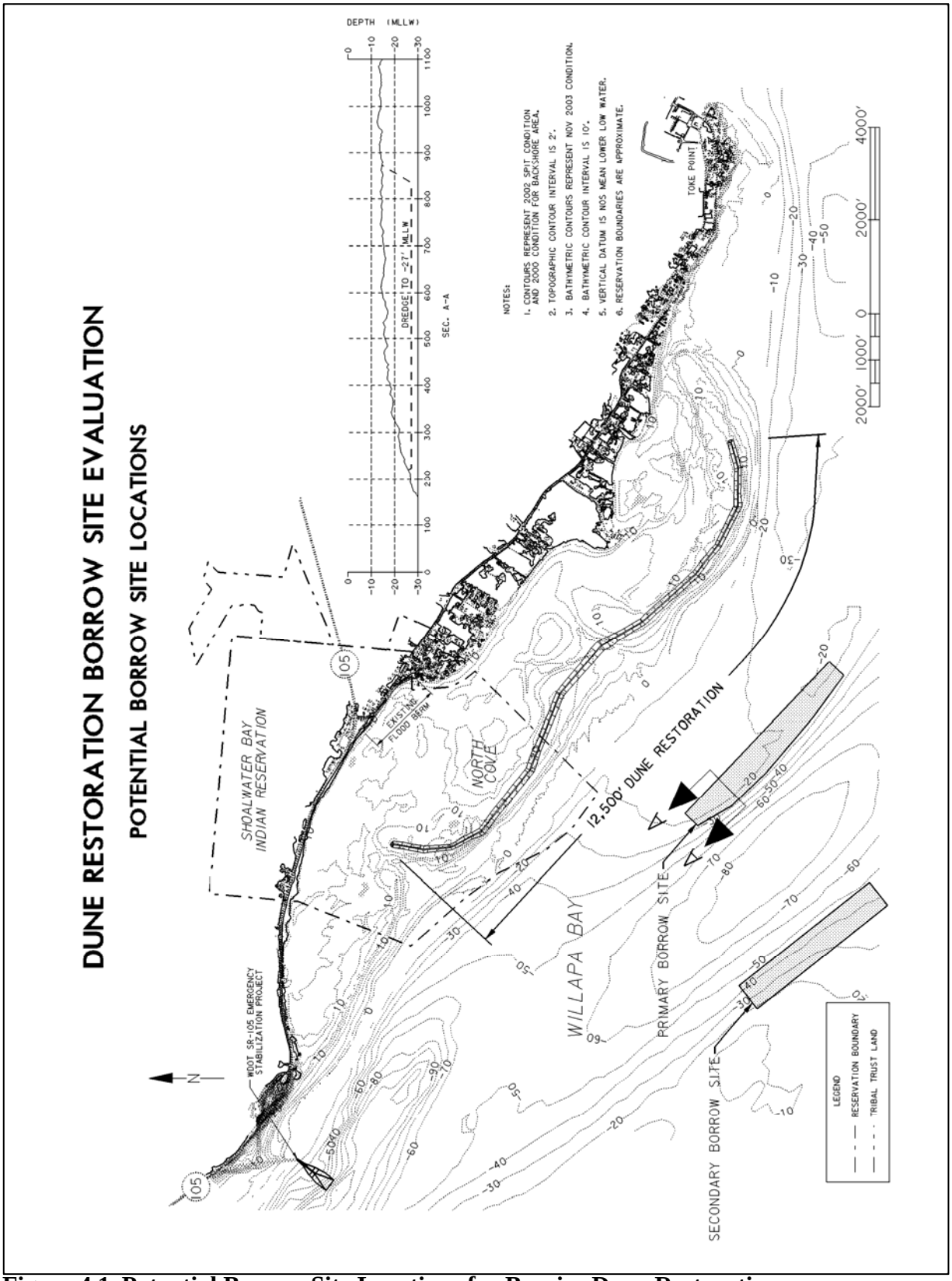


Figure 4.1 Potential Borrow Site Locations for Barrier Dune Restoration

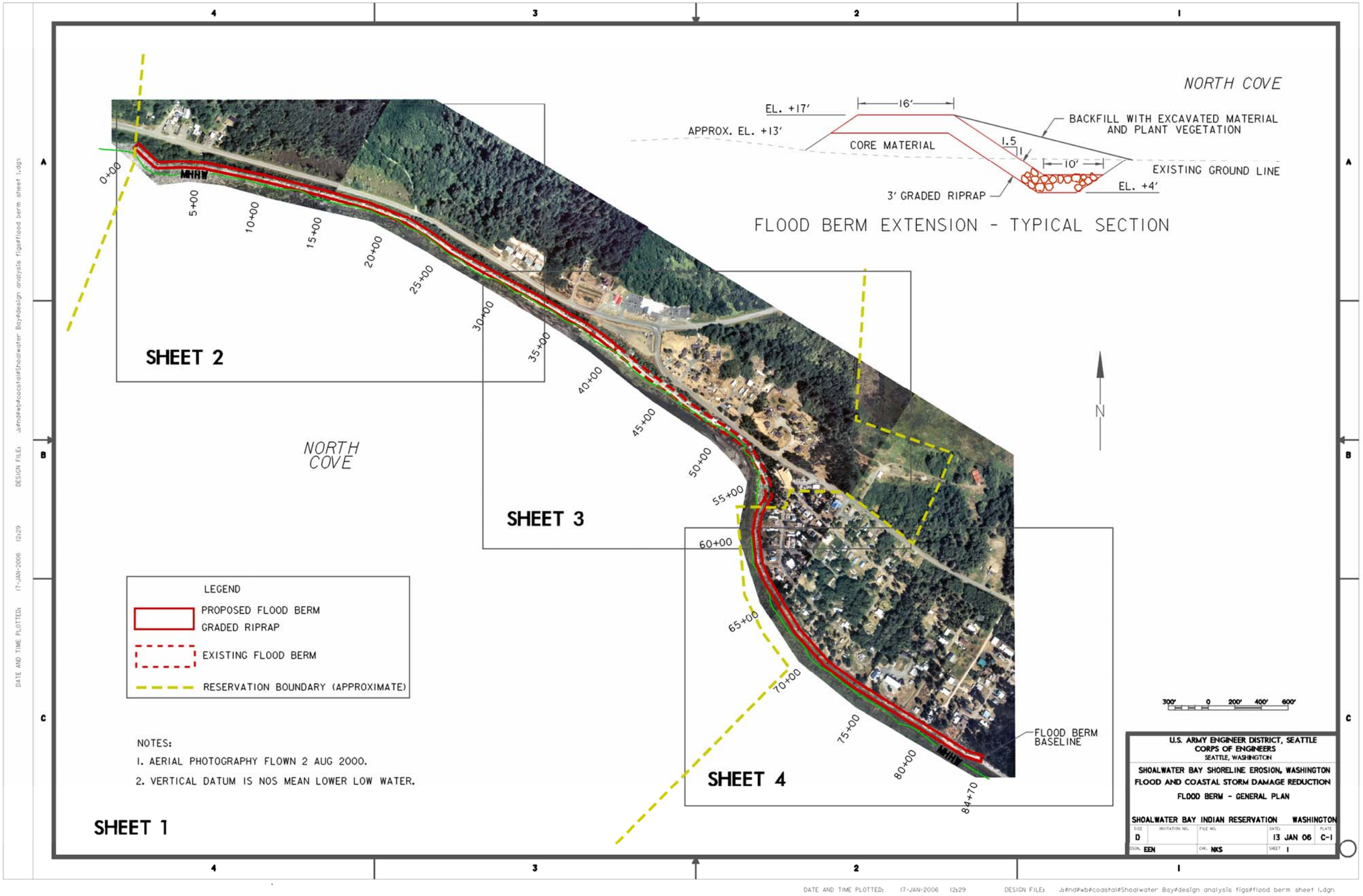


Figure 4.2 Flood Berm Extension, General Plan and Typical Sections

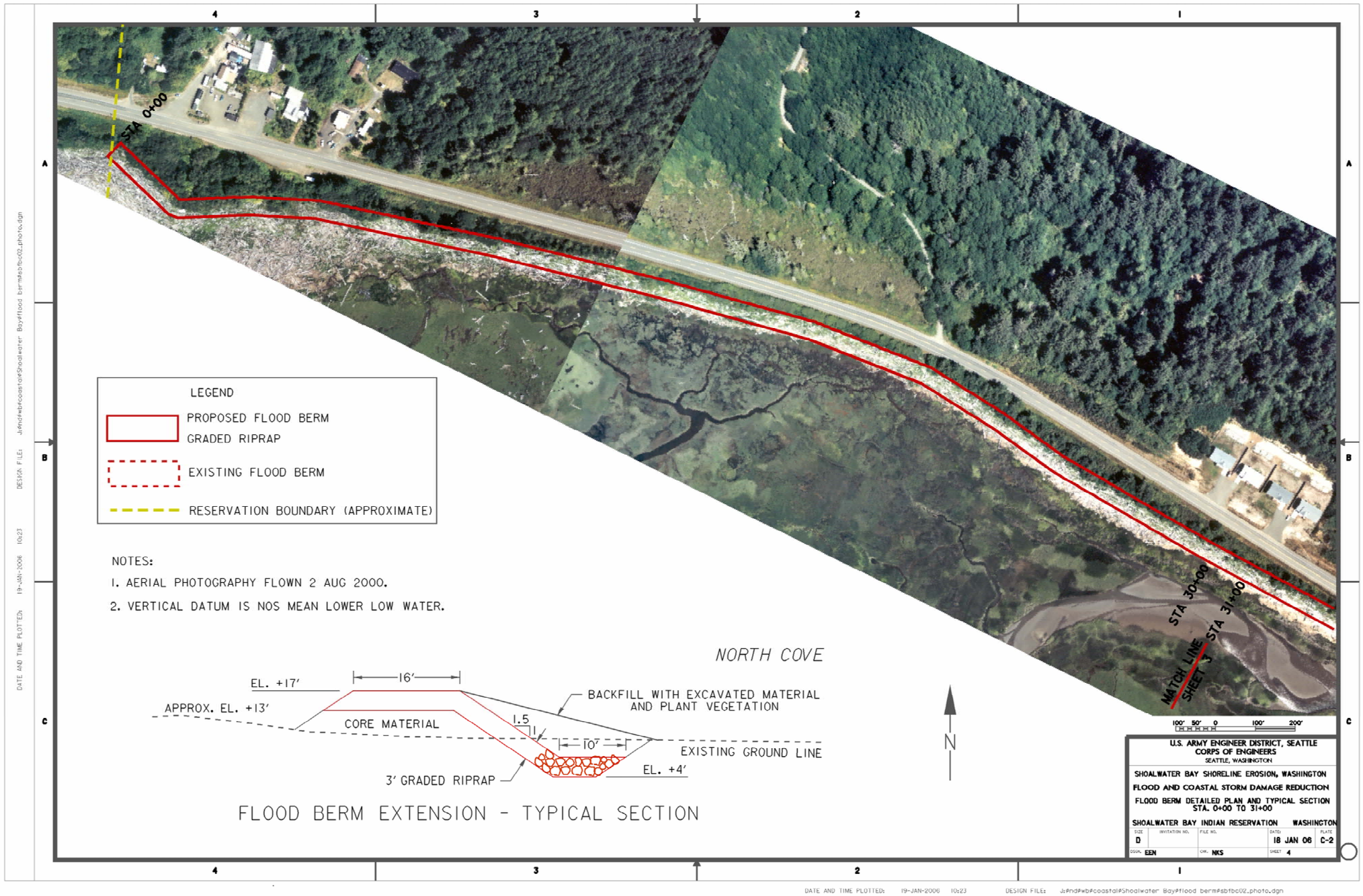
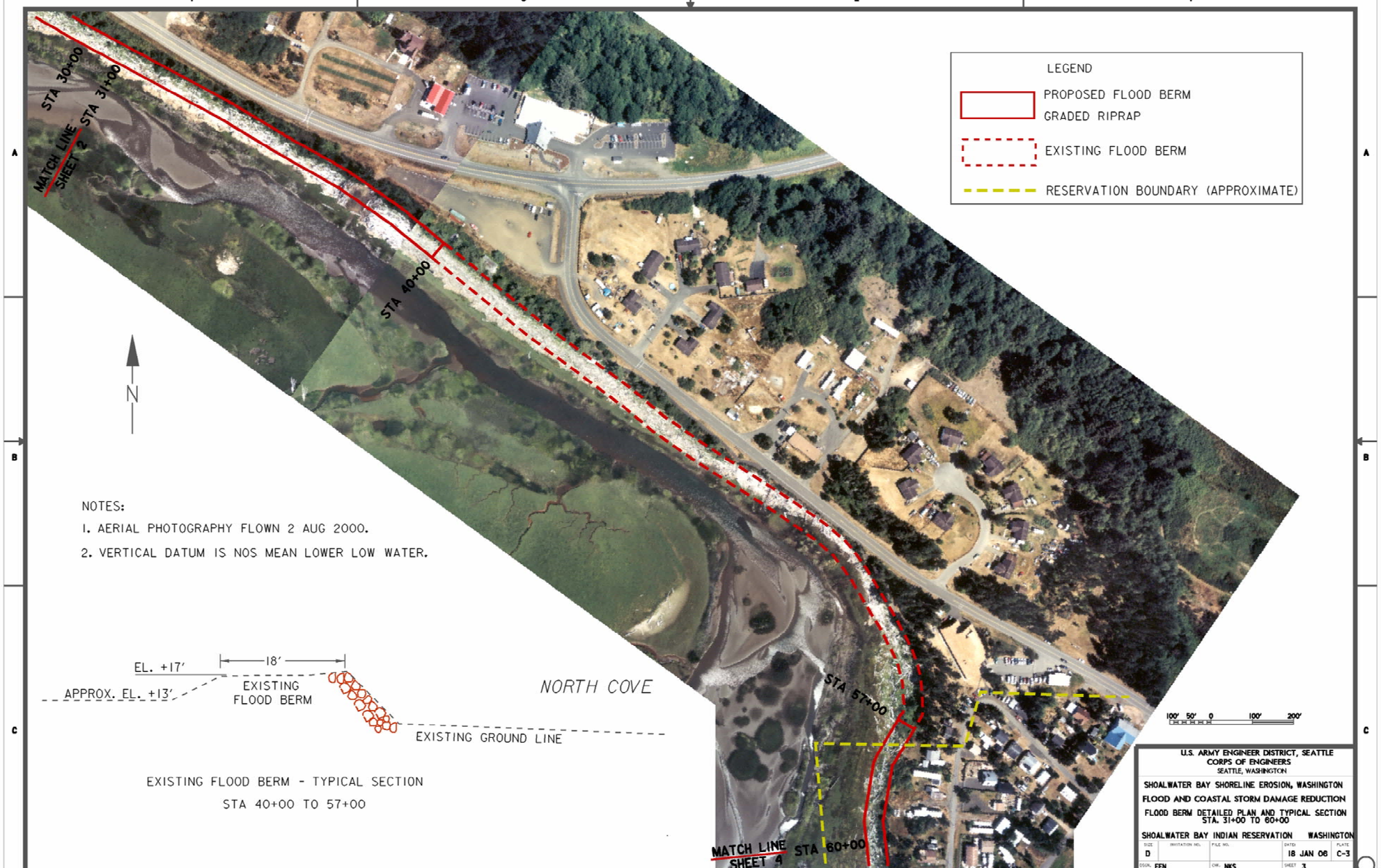


Figure 4.3 Flood Berm Detailed Plan and Typical Section, Station 0+00 to 31+00


LEGEND
PROPOSED FLOOD BERM
GRADED RIPRAP
EXISTING FLOOD BERM
RESERVATION BOUNDARY (APPROXIMATE)
STA 30+00
STA 31+00
MATCH LINE
SHEET 2
STA 40+00
STA 57+00
MATCH LINE
SHEET 4
STA 60+00
N
NORTH COVE
100' 50' 0 100' 200'
NOTES:
1. AERIAL PHOTOGRAPHY FLOWN 2 AUG 2000.
2. VERTICAL DATUM IS NOS MEAN LOWER LOW WATER.
EL. +17'
18'
APPROX. EL. +13'
EXISTING
FLOOD BERM
EXISTING GROUND LINE
EXISTING FLOOD BERM - TYPICAL SECTION
STA 40+00 TO 57+00
U.S. ARMY ENGINEER DISTRICT, SEATTLE
CORPS OF ENGINEERS
SEATTLE, WASHINGTON
SHOALWATER BAY SHORELINE EROSION, WASHINGTON
FLOOD AND COASTAL STORM DAMAGE REDUCTION
FLOOD BERM DETAILED PLAN AND TYPICAL SECTION
STA. 31+00 TO 60+00
SHOALWATER BAY INDIAN RESERVATION WASHINGTON
SIZE D
INVITATION NO.
FILE NO.
DATE 18 JAN 06
PLATE C-3
DSGN. EEN
CHK. NKS
SHEET 3

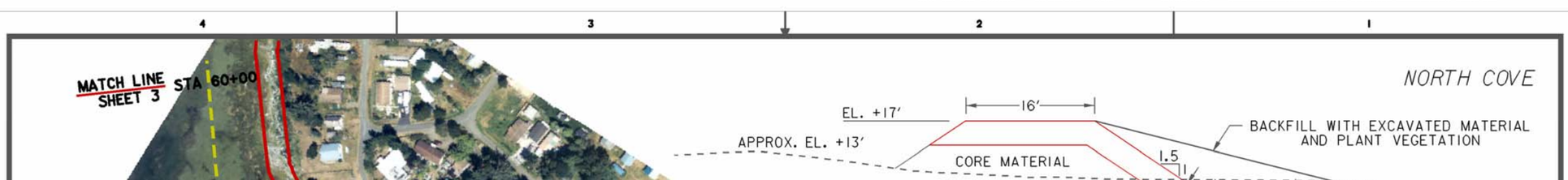

MATCH LINE
SHEET 3
STA 60+00
NORTH COVE
EL. +17'
16'
APPROX. EL. +13'
CORE MATERIAL
1.5
1
BACKFILL WITH EXCAVATED MATERIAL
AND PLANT VEGETATION

Figure 4.5 Flood Berm Detailed Plan and Typical Section, Station 60+00 to 84+70

SECTION 5: PLAN IMPLEMENTATION

5.1 Plan Responsibilities

Federal and non-Federal responsibilities for implementing the approved plan are summarized below. These responsibilities are derived from the project authorization, Section 545 of the Water Resources Development Act of 2000 (Public Law 106-541).

5.1.1 Federal Responsibilities

In accordance with the project authorization, the project will be constructed, operated, and maintained at 100 percent Federal expense. The Federal government will complete the preconstruction engineering and design (PED) phase (detailed construction plans and specifications), and advertise and administer construction contracts following project approval. The Federal government will determine the all lands, easements, rights-of-way and dredged material disposal areas (hereinafter "project lands") required for the construction, operation, and maintenance of the project. The Federal government will supply the Shoalwater Tribe with legal descriptions, maps, and other written information as appropriate in sufficient detail to enable the Shoalwater Tribe to acquire and provide required project lands.

5.1.2 Non-Federal Responsibilities

As specified in the project authorization, the Shoalwater Tribe will provide all project lands necessary for implementation of the project. The Shoalwater Tribe is not required to provide Project Lands until after the Memorandum of Agreement between the Federal government and the Shoalwater Tribe is executed (see **Paragraph 5.2** below).

5.2 Memorandum of Agreement

Based on extensive discussions between Seattle District, Northwestern Division, and Headquarters Office of Counsel regarding the authorizing language for this project, it was determined that a Memorandum of Agreement (MOA) will be entered into between the Department of the Army and the Shoalwater Bay Indian Tribe regarding the provision of lands for the project. An MOA has been prepared and will be executed following approval of the project. The MOA contains the following articles: (1) obligations of the Government and the Shoalwater Tribe; (2) dispute resolution; (3) Federal and state laws; (4) relationship of parties; (5) officials not to benefit; (6) hazardous substances; (7) notices; (8) waiver of immunity; (9) termination or suspension; and (10) amendment. The MOA will be formally submitted for final approval following approval of the project for construction.

5.3 Views of the Shoalwater Bay Indian Tribe

(To be summarized based on letter to be provided at end of public comment period)

SECTION 6: COORDINATION, PUBLIC VIEWS, AND COMMENTS

6.1 Public Involvement Overview

Public involvement activities were related to developing public information on the study and obtaining public input during the study process. The public involvement/outreach strategy consisted of a series of (1) workshops and a public meeting; (2) workshop and meeting notices, news releases, radio announcements, and public information packets; and (3) speaking engagements at community organizations by Corps and Shoalwater Tribe personnel. The study also included extensive coordination and review throughout the study process by agencies at the Federal, state, and local governmental level, special interest groups, and the general public. Those entities most directly involved in providing input and review included Shoalwater Bay Indian Tribe, Washington Department of Ecology, Washington Department of Fish and Wildlife, Washington Department of Transportation, Washington Department of Natural Resources, Washington Department of Archaeology and Historic Preservation, U.S. Fish and Wildlife Service, U.S. Geological Survey, Pacific County, and Dexter By The Sea homeowners. The Corps and the Shoalwater Tribe jointly conducted workshops and the public meeting and participated in community outreach engagements.

6.2 Public Meeting (not yet held)

(Summary information to be developed following public meeting)

6.3 Dexter Development Company, Inc. Property Owners Meeting on July 22, 2006

The Dexter Development Company, Inc. property owners association held their annual property owners meeting on Saturday, July 22, 2006 at the Shoalwater Bay Indian Tribal Center. The meeting was attended by approximately 45 Dexter By The Sea property owners. The Shoalwater Tribe's project manager was invited to make a presentation on project status, and discussed real estate easements that the Shoalwater Tribe will need to acquire from some 26 Dexter property owners for construction of the south flood berm extension.

6.4 Dexter Development Company, Inc. Property Owners Meeting on July 16, 2005

The Dexter Development Company, Inc. property owners association held their annual property owners meeting on Saturday, July 16, 2005 at the Shoalwater Bay Indian Tribal Center.

The meeting was attended by approximately 35 Dexter By The Sea property owners. The Corps project manager was invited to make a presentation on the status of project formulation and evaluation. Also attending was the Shoalwater Bay Tribal Council Chair and the Shoalwater Tribe's project manager. The project status handout was electronically distributed to all property owners via the Dexter website. Material covered in the presentation included results of technical studies, formulation and evaluation of alternative plans, and description of the dune restoration/flood berm extension plan that appears to best satisfy criteria set forth in the project authorization. There was a 45 minute question and answer period.

Strong support for the project was expressed by Dexter property owners, based on recognition that both tribal and non-tribal residents of the area would directly benefit from construction of the project. A portion of the flood berm extension would extend along the shoreline, beyond the Shoalwater Reservation boundary, requiring a perpetual easement be acquired from affected Dexter property owners. The general process of acquiring the easements was described. A summary of the meeting was written up in the Dexter electronic newsletter that is available to all property owners.

6.5 Dexter Development Company, Inc. Property Owners Meeting on July 17, 2004

The Dexter Development Company, Inc. property owners association held their annual property owners meeting on Saturday, July 17, 2004 at the Shoalwater Bay Indian Tribal Center. The meeting was attended by 31 Dexter By The Sea property owners. The Shoalwater Tribe's project manager was invited to make a presentation on project status.

6.6 Resource Interagency Meeting on May 16, 2004

A resource interagency meeting was held on May 16, 2004 at the Shoalwater Bay Indian Tribal Center. Purpose of the meeting was to discuss environmental aspects and avoidance/ mitigation measures associated with Shoalwater project alternatives. The meeting agenda included a description of the three technically feasible alternatives (sea dike, dune restoration, and dune restoration with flood berm extension), design considerations (construction techniques, project footprint below MHHW, maintenance intervals, borrow sources, beneficial use of dredged material), and environmental considerations associated with the technically feasible alternatives.

The meeting was attended by representatives from the Corps' Seattle District and the following Federal, State and local agencies: U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Washington Department of Ecology, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Washington Department of Transportation, Pacific County, and Shoalwater Bay Tribal Council.

6.7 Community Meeting/Workshop on May 12, 2004

A community meeting/workshop was held on May 12, 2004 at the Shoalwater Bay Indian Tribal Center. Purpose of the meeting was to provide the public with detailed information, and to have a dialogue with the public, on the technical study findings and alternatives formulation for the proposed project.

Approximately 40 members of the Shoalwater Tribe and the Dexter and Tokeland community attended the meeting. Technical study team members making presentations at the meeting included research scientists from the Corps' Coastal and Hydraulics Laboratory, U.S. Geological Survey's Coastal and Marine Geology Program, Washington Department of Ecology's Coastal Monitoring and Analysis Program, and the Corps' Seattle District. State and Federal regulatory agencies represented at the meeting included U.S. Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Washington Department of Ecology, and U. S. Environmental Protection Agency.

Topics covered included: (1) project authorization; (2) findings and conclusions of technical studies just completed (tides and tidal currents, wave climate and wave generation, prediction of future shoreline and channel location, design and evaluation of hydraulic modification structures, and design and evaluation of protective structures). Following the formal presentations, the technical study team members mingled and engaged the audience in discussion and to answer questions about the technical studies and the alternative plans under consideration.

6.8 Agency Coordination Kick-off Meeting on August 20, 2002

A regulatory and resource agency coordination kickoff meeting was conducted by the Corps at the Tribal Center on August 20, 2002. Attendees included representatives from the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Port of Willapa Harbor, Washington Department of Ecology, Washington Department of Fish and Wildlife, and Shoalwater Bay Tribal Council. The meeting included a discussion of the scope of the intended study by the Corps' interagency study team, brainstorming of alternative measures to be evaluated to address the storm damage and erosion of tribal lands, and environmental considerations.

6.9 Community Meeting/Workshop on June 18, 2002

A community meeting/workshop was held on June 18, 2002 at the Shoalwater Indian Tribal Center. Participating in the meeting were 17 members of the interagency study team assembled by the Corps of Engineers to evaluate the coastal erosion problems and formulate alternative plans for detailed engineering, environmental, and economic evaluation. Agency representatives included the Corps' Seattle District office, the Corps' Coastal and Hydraulics Laboratory, the U.S. Geological Survey, and Washington Department of Ecology. The workshop was attended by 51 members of the local community, both Tribal members and non-Tribal residents of the Tokeland

Peninsula. The study team made a short presentation on the scope of the technical studies that were being considered to be conducted over the next two years. The majority of meeting was devoted to informal discussions with members of the local community in an effort to better understand the coastal erosion and storm damage issues from the perspective of the people who actually live on and adjacent to the Shoalwater Reservation. The exchange of information and views was very useful in finalizing the scopes of work of the interagency study team.

6.10 Community Meeting/Workshop on September 23, 1999

A community meeting/workshop was held by the Corps on September 23, 1999 at the Shoalwater Indian Tribal Center, following a meeting between the Tribal Council and the Seattle District Engineer and Northwestern Division Deputy Commander. This meeting was held prior to enactment of legislation authorizing the project. The meeting was held as an opportunity for tribal and non-tribal residents of the area to describe and express concerns about the storm damage and coastal erosion issue. Eleven members of the local community participated in the meeting.

SECTION 7: FINDINGS AND CONCLUSIONS

7.1 Findings

In accordance with Section 545 of the Water Resources Development Act of 2000 (Public Law 106-541), an investigation of the coastal processes at Willapa Bay, Washington, to determine the feasibility of providing coastal erosion protection for the tribal reservation of the Shoalwater Bay Indian Tribe has been completed. The collaborative interagency investigation conclusively demonstrated that modest engineering solutions are technically feasible to protect the Shoalwater Bay Indian Reservation from coastal erosion resulting from storm events and flooding that coincides with extreme high tides. The storm-generated waves that have eroded the barrier dune on Graveyard Spit, and which result in shoreline erosion and flooding of the Shoalwater Bay Indian Reservation, are small by coastal engineering standards. Without action, the Shoalwater Reservation will be increasingly vulnerable to severe shoreline erosion and very serious and damaging flooding associated with these waves, particularly during periods of extreme high tides.

A wide array of alternative plans were formulated and evaluated against identified problems and opportunities, and planning objectives and criteria. Six plans that are neither technically feasible nor environmentally acceptable were screened out. Three alternative plans, plus the No Action alternative, were carried forward for further evaluation: sea dike (Alternative 4), barrier dune restoration (Alternative 6), and barrier dune restoration with flood berm extension (Alternative 7). Each plan provides a complete solution. The sea dike alternative was found to have the highest initial construction and annualized cost, and is not environmentally acceptable. The barrier dune restoration alternative meets all criteria specified in the project authorization, but requires frequent (every 5 years) periodic nourishment to ensure that the necessary level of coastal storm damage reduction for the Shoalwater Reservation is never compromised.

7.2 Conclusions

Barrier dune restoration with flood berm extension (Alternative 7) has been determined to be the most appropriate long-term solution to the shoreline erosion and coastal storm damage problems affecting the Shoalwater Bay Indian Reservation. Alternative 7 is the best technical solution to identified water resource needs and problems. With an initial construction cost of $12,240,000 and an annualized cost of $1,282,000, Alternative 7 best satisfies planning objectives and criteria, and meets all criteria specified in the WRDA 2000 Section 545 project authorization. This plan is a cost-effective means of providing coastal erosion protection, is environmentally acceptable, and is technically feasible. By reducing shoreline erosion and related coastal storm damage problems, the plan will also improve the economic and social conditions of the Shoalwater Bay Indian Tribe. Alternative 7 will protect tribal uplands from storm-related shoreline erosion and flooding, as well as prevent further degradation of the 700-acre North Cove embayment subsistence intertidal habitat.

Date: _____

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MICHAEL MCCORMICK
Colonel, Corps of Engineers
Commanding

End of Post-Authorization Decision Document

Shoalwater Bay Shoreline Erosion, Washington