DRAFT

DETAILED PROJECT REPORT/ ENVIRONMENTAL ASSESSMENT

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

April 2010

Prepared for

US Army Corps of Engineers®
Seattle District

Prepared by

ANCHOR QEA

DRAFT

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U.S. Army Corps of Engineers, Seattle District

Contract No. W912DW-07-D-I006

Task Order No. 0006

Prepared by

Anchor QEA, LLC

April 2010

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LIST OF ACRONYMS AND ABBREVIATIONS

Abbreviation	Definition
AAE	Average Annual Equivalent
ADA	American with Disabilities Act
AHS	Average Habitat Score
APE	area of potential effect
BE	Biological Evaluation
CE/ICA	cost effectiveness/incremental cost analysis
City	City of Burien
CPTED	Crime Prevention through Environmental Design
cy	cubic yards
CZMA	Coastal Zone Management Act
EA	Environmental Assessment
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act of 1973
ESC	Environmental Science Center
ESRP	Estuary and Salmon Restoration Program
FWCA	U.S. Fish and Wildlife Coordination Act
HEA	Habitat Equivalency Analysis
HPA	Hydraulic Project Approval
IPCC	Interagency Panel for Climate Change
IWR	Institute for Water Resources
LPP	Locally Preferred Plan
Management Measures Report	Management Measures for Protecting and Restoring the Puget Sound Nearshore, Technical Report 2009-1
MHHW	mean higher high water
MLLW	mean lower low water
mm	millimeters
MM	management measure
MTLB	Marine Technology Lab building

NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NEPA	National Environmental Policy Act
NER Plan	National Ecosystem Restoration Plan
NHPA	National Historic Preservation Act (as amended 2006)
NMFS	National Marine Fisheries Service
NRC	National Research Council
NRDA	Natural Resource Damage Assessment
NRHP	National Register of Historic Places
OMRR&R	operation, maintenance, repair, replacement and rehabilitation
P&G	Principles and Guidelines
PPA	project partnership agreement
Project	Seahurst North Shoreline Project
PSAW	Puget Sound and Adjacent Waters
PSNERP	Puget Sound Nearshore Ecosystem Restoration Project
SHPO	State Historic Preservation Officer
SIP	State Implementation Plan
SMP	Shoreline Master Program
SNAR	Strategic Needs Assessment Report
SPU	Seattle Public Utilities
SRFB	Salmon Recovery Funding Board
SWSSD	Southwest Suburban Sewer District
T-sheet	U.S. Coast and Geodetic Survey topographic sheet
USACE	U.S. Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
VE	Value Engineering
WDFW	Washington Department of Fish and Wildlife
WRDA	Water Resources Development Act of 2000
WRIA	Water Resource Inventory Area

1 INTRODUCTION

Seahurst Park's approximately 4,500 linear feet of shoreline include a mix of bulkheaded and unbulkheaded conditions stemming from park development in the early 1970s. This park development has negatively impacted the ecological functions of the park habitats. Specifically, shoreline armoring has displaced the park's natural intertidal and riparian habitats and disrupted beach stability and the sediment supply regime.

Seahurst Park is the largest park in the City of Burien and attracts residents, visitors, and school groups from the Puget Sound metropolitan area. The large open space at Seahurst Park provides residents and other visitors with beautiful vistas of the water, beaches, and upland forests. The park's north shoreline is home to the Marine Technology Lab building (MTLB) educational facility, which provides training for high school students in marine-related vocational skills. An environmental education center was completed in 2009 near the MTLB, called the Environmental Science Center (ESC), to provide a home for programs currently being held at the park for K-12 students and families by a non-profit organization called the Environmental Science Center Foundation.

In order to address a wide range of community and environmental issues, a master planning process began in late 2001 and was completed in 2002 and approved by City Council. The City of Burien (City) and Seattle District of the U.S. Army Corps of Engineers (USACE) began discussions about partnering on shoreline restoration at the southern portion of the park prior to the master planning process, and USACE remained engaged with the City during the master planning process. A state Salmon Recovery Funding Board (SRFB) "Bulkhead Alternatives Analysis" was combined with the overall park master planning process and supported more in-depth investigation of the shoreline.

The Master Plan was developed with extensive public involvement and resulted in an integrated approach to shoreline habitat restoration, recreation improvements, and environmental education support facilities. Improvements in these three areas were identified at the north and south portions of the park's shoreline. Preservation of existing natural habitats along the park's shoreline and upland areas is also a key component of the Master Plan.

Implementation of the Master Plan began with the south shoreline portion of the park. Restoration of the south shoreline was a high priority for the City and USACE. The failing gabion bulkheads in this portion of the park were unsafe to beach users and negatively impacted shoreline habitat for federally listed threatened species such as Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), and forage fish such as Pacific sand lance (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus*), which are key food resources for listed salmon (Anchor 2002). The City and USACE subsequently entered into a project partnership agreement (PPA) to restore the southern 1,400 linear feet of the park shoreline. Federal funding came from the Puget Sound and Adjacent Waters (PSAW) program in 2004 and construction began late that year, ending in early 2005.

The restoration began by removing a gabion bulkhead with riprap toe protection and restoring a natural sand and gravel beach. The City subsequently completed two other construction contracts in 2006 and 2008 with additional state SRFB, Aquatic Lands Enhancement Account, and Land and Water Conservation funding. The 2006 SRFB construction contract restored native riparian and backshore vegetation, "daylighted" a small stream, and mitigated minimal wetland impacts from yet-to-be-constructed trail relocation. The 2008 park facilities upgrades and relocations included completion of trails and pathways, beach access stairs and ramps, picnic facilities, and replacement of the park restroom. Extensive physical and biological monitoring of the south shoreline started prior to 2004 and is continuing. Monitoring has demonstrated that the restoration is performing well and that targeted habitats and species are colonizing and using the south shoreline (Johannessen 2009; Toft 2009; see Appendix F)

Because the south shoreline is completed, the City and USACE focus has shifted to the north shoreline and seawall. In 2008, the City initiated its own feasibility study and convened a stakeholder group including USACE and other organizations with interest in the north shoreline portion of the park, to initiate discussion of a feasibility study to evaluate alternative plans. In addition, a public meeting and a meeting with permit agencies were held to get additional input on the alternatives and evaluation criteria. The City completed its feasibility report in 2009 (Anchor QEA 2009). That report was used extensively in the development of this Integrated Feasibility Study and Environmental Assessment.

1.1 Authorization

The proposed Project is authorized by Section 544 of the Water Resources Development Act of 2000 (Public Law 106-541, December 11, 2000), which authorizes implementation of critical restoration projects in the watersheds that drain directly into Puget Sound. Section 544 states:

> ***SEC. 544. PUGET SOUND AND ADJACENT WATERS RESTORATION, WASHINGTON.***
>
> *(a) DEFINITION OF CRITICAL RESTORATION PROJECT.—In this section, the term "critical restoration project" means a project that will produce, consistent with Federal programs, projects, and activities, immediate and substantial ecosystem restoration, preservation, and protection benefits.*
>
> *(b) CRITICAL RESTORATION PROJECTS.—The Secretary may participate in critical restoration projects in the area of Puget Sound, Washington, and adjacent waters, including—*
>
> *(1) the watersheds that drain directly into Puget Sound;*
> *(2) Admiralty Inlet;*
> *(3) Hood Canal;*
> *(4) Rosario Strait; and*
> *(5) the Strait of Juan de Fuca to Cape Flattery.*
>
> *(c) PROJECT SELECTION.—*
>
> *(1) IN GENERAL.—The Secretary may identify critical restoration projects in the area described in subsection (b) based on—*
>
> *(A) studies to determine the feasibility of carrying out the critical restoration projects; and*
> *(B) analyses conducted before the date of enactment of this Act by non-Federal interests.*
>
> *(2) CRITERIA AND PROCEDURES FOR REVIEW AND APPROVAL.—*
>
> *(A) IN GENERAL.—In consultation with the Secretary of Commerce, the Secretary of the Interior, the Governor of the State of Washington, tribal governments, and the heads of other appropriate Federal, State, and local agencies, the Secretary may develop criteria and procedures for prioritizing projects identified under paragraph (1).*
> *(B) CONSISTENCY WITH FISH RESTORATION GOALS.—The criteria and procedures developed under subparagraph (A)*

shall be consistent with fish restoration goals of the National Marine Fisheries Service and the State of Washington.

(C) USE OF EXISTING STUDIES AND PLANS.—In carrying out subparagraph (A), the Secretary shall use, to the maximum extent practicable, studies and plans in existence on the date of enactment of this Act to identify project needs and priorities.

(3) LOCAL PARTICIPATION.—In prioritizing projects for implementation under this section, the Secretary shall consult with, and consider the priorities of, public and private entities that are active in watershed planning and ecosystem restoration in Puget Sound watersheds, including—

(A) the Salmon Recovery Funding Board;

(B) the Northwest Straits Commission;

(C) the Hood Canal Coordinating Council;

(D) county watershed planning councils; and

(E) salmon enhancement groups.

(d) IMPLEMENTATION.—The Secretary may carry out projects identified under subsection (c) after entering into an agreement with an appropriate non-Federal interest in accordance with section 221 of the Flood Control Act of 1970 (42 U.S.C. 1962d–5b) and this section.

(e) COST SHARING.—

(1) IN GENERAL.—Before carrying out any project under this section, the Secretary shall enter into a binding agreement with the non-Federal interest that shall require the non-Federal interest—

(A) to pay 35 percent of the total costs of the project;

(B) to provide any land, easements, rights-of-way, dredged material disposal areas and relocations necessary to carry out the project;

(C) to pay 100 percent of the operation, maintenance, repair, replacement, and rehabilitation costs associated with the project; and

(D) to hold the United States harmless from any claim or damage that may arise from carrying out the project, except any claim or damage that may arise from the negligence of the Federal Government or a contractor of the Federal Government.

(2) CREDIT.—

(A) IN GENERAL.—The Secretary shall credit the non-Federal interest for the value of any land, easement, rightof-way,

dredged material disposal area, or relocation provided for carrying out the project.
(B) FORM.—The non-Federal interest may provide up to 50 percent of the non-Federal share in the form of services, materials, supplies, or other in-kind contributions.
(f) AUTHORIZATION OF APPROPRIATIONS.—There is authorized to be appropriated to carry out this section $40,000,000, of which not more than $5,000,000 may be used to carry out any 1 critical restoration project.

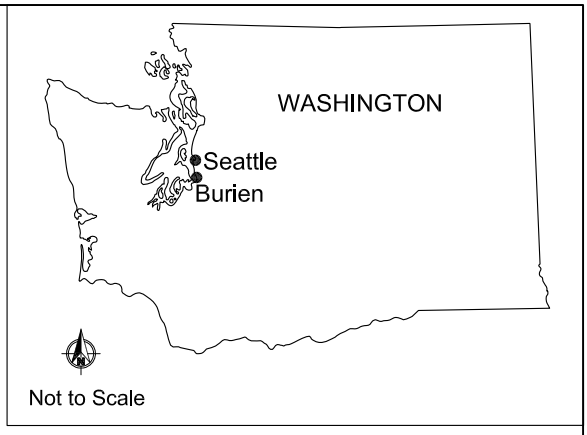
USACE Headquarters developed implementation guidance for this authority in December 2003 and amended that guidance in October 2006. This guidance is provided as Appendix A.

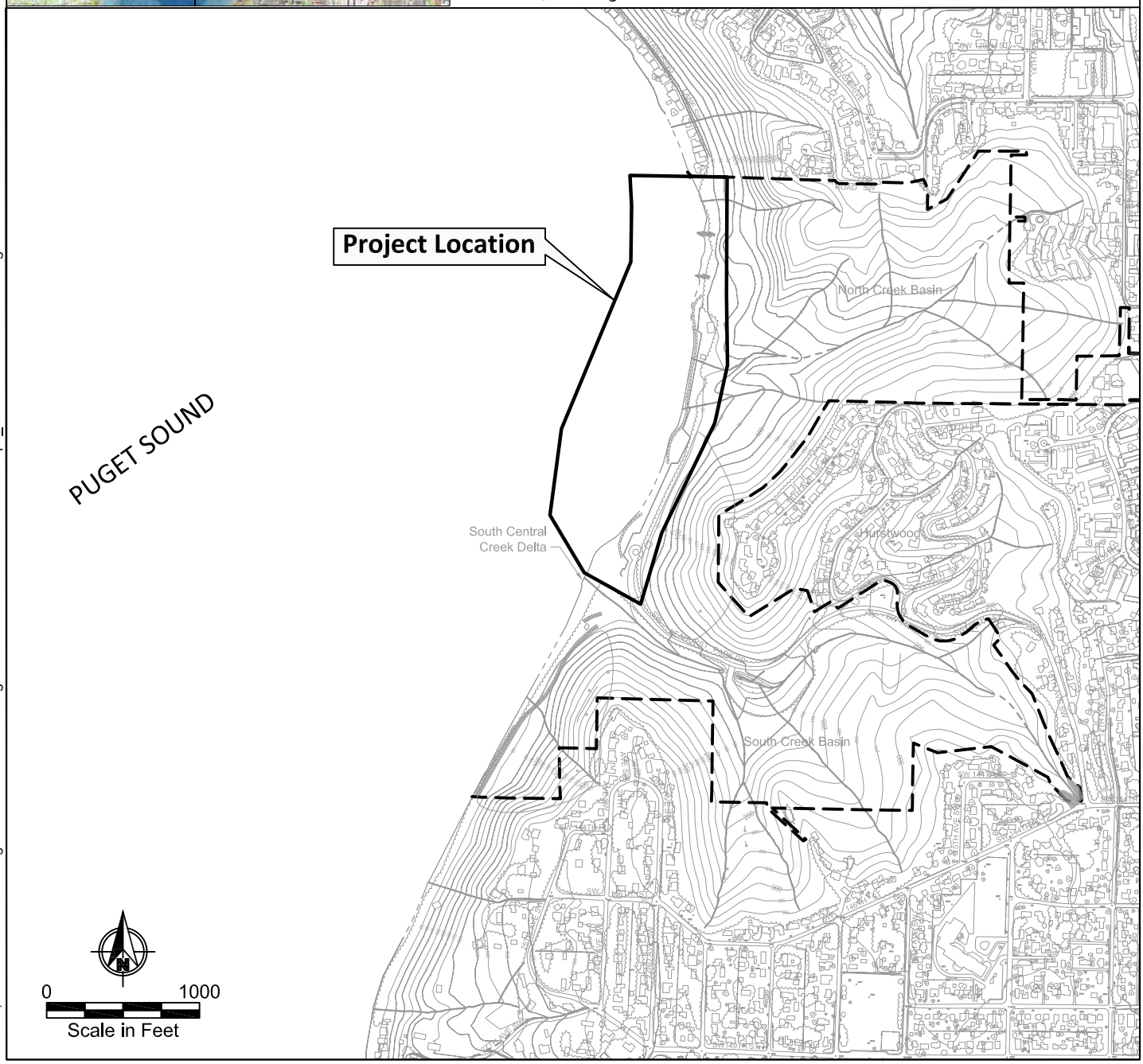
The project sponsor is the City of Burien, King County, Washington. The City's authority to participate in this effort stems from the 2002 Seahurst Park Master Plan that included an integrated approach to shoreline habitat restoration at Seahurst Park.

1.2 Project Area

Seahurst Park is located on the eastern side of the South Central Puget Sound shoreline in the City of Burien (City), and King County, Washington (see Figure 1). The 152-acre park includes approximately 4,500 linear feet of shoreline and is the largest public shoreline park between Seattle and Tacoma. The Project Area includes approximately the northern two-thirds of the park shoreline. The Project Area extends from the South Central Creek to the north park boundary and from an approximate elevation of 0.0 feet mean lower low water (MLLW) to the lower slopes of the forested bluffs, elevation +29 feet MLLW (see Figure 2). The shoreline within the Project Area is 2,865 linear feet. 72 percent, or 2,075 linear feet, of this length is armored with concrete seawall, rock riprap, or both. However, in three locations, perched beaches are armored waterward of the concrete seawall. For the purpose of describing alternatives, the percent armor removal is calculated for the seawall and perched beach lengths separately, as one or the other is removed in some alternatives. See Section 3.5.2 for an explanation of how the armor removal lengths were determined for the alternative descriptions.

Note: Base map prepared from Terrain Navigator Pro USGS 7.5 minute quadrangle map(s) of Seattle South and Burien, Washington.





Mar 19, 2010 9:36am bberminghamK:\Jobs\070202-Puget Sound Nearshore\07020201\Corps_FS\07020201-RP-001.dwg FIG 1

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Figure 1
Project Location Map
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

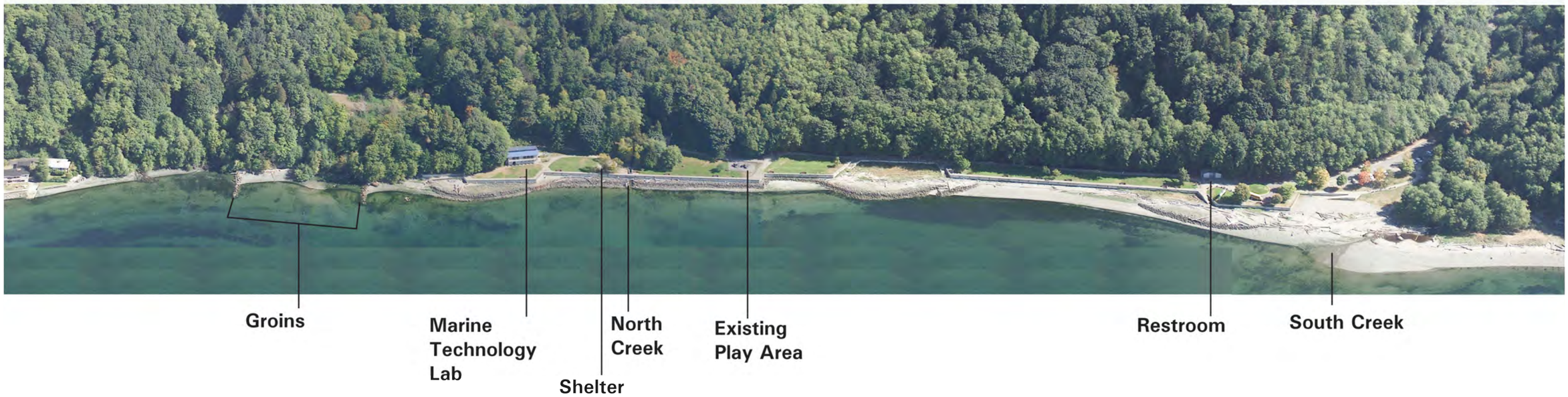

PHOTO OF SEAHURST PARK NORTH SHORELINE

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Figure 2
Aerial Photo of Park Showing Phase II Shoreline Restoration Area
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

1.3 Purpose and Need

This report serves two purposes. It functions as a feasibility report to lay out the costs, benefits and practical considerations associated with the proposed project, and it functions as an environmental assessment to fulfill the federal government's obligations under the National Environmental Policy Act (NEPA). As an environmental assessment, this document will be posted for a public comment period of no less than 30 days. Public comments on the proposed action are solicited and will be responded to. If the Corps determines that the project will have no significant effects, then a Finding of No Significant Impact document will be prepared, concluding the environmental review process.

Shoreline alterations and shoreline development have contributed to the marked decline of the Puget Sound ecosystem. Among the most common modifications to the nearshore is the installation of shoreline armoring (e.g., bulkheads and revetments), which disconnects coastal bluffs and riparian habitats from the intertidal zone and often encroaches into the intertidal zone, thereby reducing aquatic habitat. Along the eastern shoreline of South Central Puget Sound, shoreline armoring is present in more than 60 percent of the shoreline (Anchor 2004). Seahurst Park is situated near the "up-drift" end of the longest net shore drift or "drift cell[1]" in South Central Puget Sound (Schwartz et al. 1991). In fact, the drift cell extends north more than 10 miles to Duwamish Head in Seattle. In the drift cell in which Seahurst Park is located, more than 87 percent of the shoreline is armored and more than 70 percent of the armoring extends into the intertidal zone (Anchor 2004). The extensive shoreline armoring in the drift cell has severely reduced sediment supplies into the nearshore system.

[1] The drift cell concept has been employed in coastal studies to represent a sediment transport sector from source to deposition along a coast. The term drift cell refers to the closed or nearly closed system of sediment transport along the shoreline (Johannessen 1992). An idealized drift cell is composed of an erosional site, such as a bluff, that provides the source of sediment; a zone of transport, where sediment is deposited and transported alongshore; and an area of deposition (Jacobsen and Schwartz 1981). Within a drift cell, sediment is suspended by waves or currents and transported along the shoreline in a repetitious cycle of suspension and deposition. The direction of the transport of sediment is determined by the dominant direction of the waves and currents in that cell. Although wave and current direction varies frequently, over time most drift cells show net transport in one direction or the other. The net directional movement of sediment is called net-shore drift (Johannessen and MacLennan 2007).

The alterations to Puget Sound and its nearshore environments have directly reduced the amount of nearshore habitat and otherwise impaired the natural processes that create and sustain habitats. Restoration of Puget Sound shorelines has been a priority of ecosystem-based restoration planning, such as the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) underway by the Seattle District of the USACE and Washington Department of Fish and Wildlife (WDFW).

In Seahurst Park, restoration is needed because extensive shoreline armoring present in the park has interrupted natural sediment transport processes and significantly degraded habitat function within and beyond the park boundaries. A seawall and riprap occur along approximately 2,075 linear feet of the Project Area, preventing coastal bluff sediment supplies from reaching the intertidal zone, thereby reducing the amount of beach sediment. The structures also alter wave energy dissipation along the shoreline and cause more long-shore and cross-shore (offshore) transport of sediment than would occur naturally.

The purpose of this feasibility study of the Seahurst North Shoreline Project (Project) is to evaluate opportunities to restore natural marine nearshore processes and select a preferred alternative that provides the optimal combination of shoreline habitat restoration, park facilities, and support for ongoing educational programs. This report presents the evaluation method and results, and through these results outlines a preferred alternative design for the north shoreline. The purpose includes:

- Compiling new and existing information supporting the feasibility study and design
- Developing alternative plans ranging from full restoration of the shoreline to leaving the seawall and providing beach nourishment, in addition to a No Action alternative
- Conducting the feasibility evaluation of the alternatives using developed evaluation criteria
- Selecting a preferred alternative based on the results of the feasibility evaluation
- Preparing an (integrated) Environmental Assessment (EA) as required by NEPA

1.4 Previous Studies

A number of studies and reports contributed to the Project analysis. Some of these studies cover the entire park or park shoreline, some focus on the south portion, some focus on the Project Area, and some provide useful guidance for nearshore restoration projects on Puget Sound. The earliest reports that were used included studies initiated in anticipation of the seawall's construction. Dr. Eugene Richey's beach characterization report contributes pre-seawall sediment information about the park (Richey 1970). In 1971, Shannon & Wilson Inc. (Shannon & Wilson) prepared a subsurface investigation report for their test pit and boring investigations along the proposed north seawall alignment (Shannon & Wilson 1971). Shannon & Wilson provided a later subsurface investigation report in 2003 in concert with the ESC building design in the Project Area (Shannon & Wilson 2003).

The Master Plan information, SEPA Checklist, and Phase I (South Shoreline) monitoring reports by Anchor staff (Anchor 2002, 2005a, 2005b, 2005c) and Coastal Geologic Services (CGS 2004, 2005, 2007, 2008a) also contributed substantial background information. The Master-Plan-related documents from 2002 and the SEPA Checklist from 2005 cover the entire park and shoreline, and the subsequent documents cover only the south shoreline. In addition, biological monitoring of the south shoreline restoration by the University of Washington Wetland Ecosystem Team has documented pre- and post-restoration biological conditions, particularly of juvenile salmon prey organisms (Toft 2009). Selected Seahurst Phase I monitoring reports can be found in Appendix F.

In 2009, the *Seahurst Park North Seawall Feasibility Study* was completed for the City of Burien (Anchor QEA 2009). This report evaluated several alternatives, included additional information gathering, and recommended a preferred alternative. The Seattle District of the USACE participated in the preparation and review of this document. However, that report did not meet all the USACE requirements (including a complete plan formulation methodology, cost effectiveness/incremental cost analysis [CE/ICA], or identification of a National Ecosystem Restoration (NER) Plan). This report builds on the previous analyses.

General technical documents pertaining to Puget Sound nearshore restoration were prepared through PSNERP or its member agencies, primarily the Seattle District USACE and WDFW. Restoration of the Seahurst Park shoreline can address one or more of the priority restoration

recommendations that PSNERP identified in its Strategic Needs Assessment Report (SNAR; Schlenger et al. In Review). PSNERP also developed an important guidance document titled *Management Measures for Protecting and Restoring the Puget Sound Nearshore, Technical Report 2009-1* (Management Measures Report; Clancy et al. 2009). Management measures presented in that PSNERP document were used to craft the alternative plans for the Project. The Management Measures Report is described in more detail in Section 3.4, Description of Management Measures, of this report. PSNERP also provides sea-level rise estimates based on the methods described in USACE Circular EC 1165-2-211: *Water Resource Policies and Authorities Incorporating Sea-Level Change Considerations in Civil Works Programs*. The sea-level rise estimates were used in this detailed project report. More general guidance on Puget Sound salmon recovery planning efforts is provided in reports such as the *Shared Strategy Puget Sound Salmon Recovery Plan* (Shared Strategy 2007) and the regional *WRIA 9 Salmon Habitat Plan* (Green/Duwamish and Central Puget Sound Watershed WRIA 9 Steering Committee 2005).

1.5 Planning Process

The *Economic and Environmental Principles and Guidelines for Water Resources Planning and Related Land Resources Implementation Studies* (1983) guides the USACE planning process. These principles are intended to ensure proper and consistent planning by federal agencies in the formulation and evaluation of implementation studies for water and related land resources.

The guidance for conducting civil works planning studies (Engineering Regulation [ER] 1105-2-100) requires the systematic formulation of alternative plans that contribute to the federal objective. To ensure that sound decisions are made with respect to development of alternatives and ultimately with respect to plan selection, the plan formulation process requires a systematic and repeatable approach. Alternatives for proposed actions are formulated in consideration of Project Area problems and opportunities as well as study goals, objectives, and constraints with respect to four criteria, which are defined as:

- *Completeness* is the extent to which a given alternative plan provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects.

- *Effectiveness* is the extent to which an alternative plan alleviates the specified problems and achieves the specified opportunities
- *Efficiency* is the extent to which an alternative plan provides the most cost-effective means of alleviating the specified problems and realizing the specified opportunities, consistent with protecting the nation's environment
- *Acceptability* is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public, and compatibility with existing laws, regulations, and public policies

The planning process consists of 6 interdependent and iterative steps: 1) define Project Area problems and opportunities; 2) inventory and forecast resources in the Project Area; 3) generate alternative plans; 4) evaluate alternative plans; 5) compare alternative plans; and 6) select a preferred alternative plan.

The first step includes identification of the Project Area problems and opportunities. For ecosystem restoration projects such as Seahurst Park, problems and opportunities are developed to address the federal objective of the NER Plan. Goals, objectives, and constraints consistent with the NER goal are developed to solve the problems and achieve the opportunities. The alternative plan that reasonably maximizes ecosystem restoration benefits compared to costs, consistent with the federal objective, shall be identified as the NER Plan.

The second step consists of the inventory and forecasting of resources within the Project Area. This step documents the quantity and quality of a particular resource that currently exists within the Project Area (i.e., identification of existing conditions) and forecasts predicted changes to resources over a 50-year period of analysis, assuming no actions are taken to address the problems in the Project Area.

The third step in the planning process is to generate alternative solutions. Alternative plans are formulated across a range of potential scales to demonstrate the relative effectiveness of various approaches at varying scales. Alternative plans are made up of management measures.

In the fourth step, alternative plans are evaluated for their potential results in addressing the specific problems, needs, and objectives of the study. The measure of output is expressed by the difference in amount or effect of a resource between the No Action alternative conditions and those predicted to occur with each alternative plan in place. This difference is referred to as the benefit of the alternative. This evaluation focuses on ecosystem benefits, which are measured in metrics that reflect the quantities (counts), areal extent, length, productivity, and value of habitats that are restored or maintained.

The fifth step involves comparing alternative plans to each other using the benefit outputs and costs of the alternatives.

The sixth step is the selection of the plan that best meets the study objectives and the four criteria of completeness, effectiveness, efficiency, and acceptability. Using this six-step planning process, a Preferred Plan is identified, which is then subjected to technical policy review and public comment. The selected plan must be shown to be cost-effective and justified to achieve the desired level of output.

1.6 Report Organization

This report consists of a feasibility report with an integrated EA and appendices. Major headings within this report marked with an asterisk (*) are the EA sections required for NEPA compliance. The report provides an overview of the study effort and summarizes information found in the appendices. The appendices provide detailed supporting information for all the investigations and tasks conducted under this and pertinent subsequent studies.

The main report is divided into eight sections including: 1) Introduction, 2) Existing and Future Without Project Conditions, 3) Plan Formulation, 4) Description of the Preferred Plan, 5) Environmental Effects of the Preferred Plan, 6) Coordination and Compliance, and 7) References.

2 EXISTING AND FUTURE WITHOUT PROJECT CONDITIONS (AFFECTED ENVIRONMENT)*

The park consists primarily of second growth forest, with steep coastal bluffs, two ravines with larger perennial streams, and multiple smaller stream drainages. The bluffs are unstable in many locations and prone to small and relatively frequent landslides. In some cases, particularly at the north and south ends of the park, these bluffs are connected to the nearshore due to restoration or lack of past development. The park and the undeveloped shore and bluffs south of it are important sediment sources for beaches extending to the north for approximately 10 miles to Alki Beach and Duwamish Head in Seattle. Sediment supply is a key habitat-forming process along Puget Sound, and the primary sediment source for Puget Sound is unstable coastal bluffs (Johannessen and MacLennan 2007). Shorelines down-drift (north) of the park are primarily bulkheaded and there are limited opportunities to supply sediment to this segment of the Puget Sound shoreline.

In addition, the park's nearly 1 mile of shoreline includes many important intertidal, subtidal, and marine riparian habitats that support federally listed threatened species, such as Puget Sound Chinook salmon, other salmonids, and species they depend on. The site also supports considerable wetlands associated with seeps, streams, and in some cases, such as the lower South Central Creek, stream deltas.

The University of Washington has conducted research on invertebrate assemblages at Seahurst Park comparing modified with unmodified stretches of shoreline. The study concluded that shoreline armoring decreases abundance and taxa richness in both benthic and infaunal invertebrate and insect assemblages, and that the impacts are most profound in cases where the modifications are installed below mean higher high water (MHHW), such as at Seahurst Park (Sobocinski 2003).

This section provides a summary of the physical, ecological, and socio-economic conditions (both existing and in the future) within the Project Area.

2.1 Earth

2.1.1 Topography and Bathymetry

A topographic survey was conducted prior to the execution of the 1972 King County Park development designed by Quinton Budlong (Quinton Budlong, Inc. 1972). This survey formed the base map for initial park design and construction.

The park is characterized by shorelines bordered by steep, forested coastal bluffs. The two large drainage basins within the park each support perennial streams. Elevations begin at sea level and rise to a high point of +425 feet at the park's north boundary within the northern drainage basin. The local mean higher high water line (MHHW) within the park is +11.6 (MLLW datum). Slopes within the shoreline portion of the park are below 5 percent. Generally, the upland bluffs have lower slopes of between 50 and 75 percent and middle and upper slopes of 70 to 100 percent (Anchor 2002). These steep slopes create a number of large landslide-prone areas within the park, which are discussed in more detail in Section 2.1.2.2.

Topographic and bathymetric survey data covering the Project Area come from a variety of sources. Roth Hill Engineering Partners (Roth Hill) conducted a full ground survey of most of the Project at a 1-foot contour interval (Roth Hill 2008a) (see Figures 3a-3d). At the south end of the Project Area, existing topography and bathymetry data were available from previous survey work by Duncanson Company for the South Shoreline Project (Duncanson 2006). For bathymetry between elevations 0 and -10 feet MLLW, Light Detection and Ranging (LiDAR) data were used (University of Washington 2005). For the wetland, streams, and forest trail, field flagging was conducted by Anchor and included in the Roth Hill survey. In most areas, the east edge of the Roth Hill survey extends slightly up the hillside above the path and buildings. For areas east of the Roth Hill survey, the 2002 aerial topographic survey by Walker Associates is available (Walker Associates 2002). These data use 2-foot contours and are significantly less accurate than the Roth Hill survey data.

Within the Project Area, topography and bathymetry in the high intertidal zone and up to the lower edge of the forest bluffs is significantly modified by park development, including the vertical concrete seawall and riprap revetment below it. The top elevation of the seawall is approximately +20 feet (MLLW vertical datum), and the bottom where it interfaces with

the riprap falls between +11 and +13.5 feet (MLLW). The riprap consists of wall toe protection, three semi-circular former gabion (perched beach) areas, and two rock groins (cross-shore rock structures that trap sediment on the up-drift side and often cause erosion on the down-drift side) with top and toe elevations ranging from +13.3 to +8.5 feet (MLLW), respectively. At the north portion of the park, the two rock groins were installed to protect sewer cleanouts (Roth Hill 2008). Slopes of rock structures are generally 2H: 1V (2 horizontal: 1 vertical). The bathymetry in the lower intertidal zone consists of a gently sloping sand beach terrace with slopes of between 1.5 and 3 percent from 0 feet to -10 feet MLLW.

PORTION OF THE NE & SE 1/4, SEC 13, T 23 N., R 3 E., W.M.

LEGEND

- EELGRASS DATA POINT PER REFERENCE #2
- CB — CATCH BASIN
- SM — STORM MANHOLE
- SI — STORM INVERT
- MH — SANITARY MANHOLE
- CO — CLEAN OUT
- WV — WATER VALVE
- WE — WATER WELL
- FH — FIRE HYDRANT
- WM — WATER METER
- GM — GAS METER
- GM — GAS VALVE
- UP — UTILITY POLE
- GA — GUY ANCHOR
- PO — POST
- SSP — SPRINKLER STAND PIPE
- EDGE OF GRAVEL
- EDGE OF PAVEMENT
- CONCRETE EXTRUDED CURB
- X — FENCE
- TOPOGRAPHY BREAKLINE
- SS — SANITARY SEWER
- SAN — SANITARY SEWER, SCALED FROM RECORD DRAWINGS
- SSU — SANITARY SEWER LOCATES
- SD — STORMDRAIN
- OHU — OVERHEAD UTILITY
- G — GAS LOCATES
- P — POWER LOCATES
- W — WATER LOCATES
- WTR — WATER LINE, SCALED FROM RECORD DRAWINGS
- COM — TELE-COMMUNICATION LOCATES
- EDGE OF CLEARING
- ROCKERY
- HEDGE
- P — POWER UTILITY BOX
- CV — CONCRETE VAULT
- CM — COMMUNICATION UTILITY BOX
- U — UTILITY BOX
- C — IRRIGATION CONTROL BOX
- TM — TELE-COMMUNICATION MANHOLE
- PM — POWER METER
- TV — TV UTILITY BOX
- PT — POWER TRANSFORMER
- WETLAND AND/OR CENTERLINE TRAIL FLAG
- DS — DECIDUOUS
- CF — CONIFEROUS

AR	ALDER
AP	APPLE
AH	ASH
AS	ASPEN
BI	BIRCH
CY	CHERRY
CT	CHESTNUT
CW	COTTONWOOD
DW	DOGWOOD
EM	ELM
HN	HAWTHORN
HZ	HAZELNUT
LT	LOCUST
MP	MAPLE
OK	OAK
PE	PEAR
PM	PLUM
PR	POPLAR
WT	WALNUT
WW	WILLOW
CE	CEDAR
CP	CYPRESS
FR	DOUGLAS FIR
HK	HEMLOCK
HY	HOLLY
MD	MADRONA
PI	PINE
RW	REDWOOD
SP	SPRUCE
SQ	SEQUOIA
SY	SYCAMORE

NOTES:

1) THIS SURVEY WAS PERFORMED BY CONVENTIONAL FIELD TRAVERSE WITH THE FINAL RESULTS MEETING OR EXCEEDING THE STANDARDS CONTAINED IN W.A.C. 332-130.

2) FIELD SURVEY WAS CONDUCTED ON SEPTEMBER 10-12, 17-18, AND 23-25, 2008.

3) THE PRECISION RATIO FOR THIS SURVEY MEETS OR EXCEEDS 1: 5,000 MINIMUM FOR RESIDENTIAL CLASSIFICATION PER WAC 332-130-090-1 (B).

4) THE UNDERGROUND UTILITIES SHOWN HAVE BEEN COMPILED FROM LOCATED FIELD SURVEY MEASUREMENTS, UTILITY LOCATE PAINT MARKS AS PROVIDED BY PARKER FIBER SERVICES LOCATING COMPANY, AND RECORD DRAWINGS PROVIDED BY ANCHOR ENVIRONMENTAL, LLC AND UTILITY PURVEYORS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES ARE IN THE EXACT LOCATION INDICATED. THE SURVEYOR HAS NOT PHYSICALLY LOCATED ALL OF THE UNDERGROUND UTILITIES.

EQUIPMENT USED

THIS SURVEY WAS PERFORMED WITH A LEICA 1200 SERIES ROBOTIC TOTAL STATION AND CARLSON SURVCE ALLEGRO DATA COLLECTOR AND MAINTAINED IN ADJUSTMENT TO MANUFACTURERS SPECIFICATIONS AS REQUIRED BY WAC 332-130-100.

REFERENCES

1) TOPOGRAPHIC SURVEY PREPARED BY DUNCANSON COMPANY DATED JANUARY 29, 2007
2) EELGRASS DATA PROVIDED BY ANCHOR ENVIRONMENTAL, LLC
3) CORPS NEARSHORE LIDAR DATA (FROM -10 MLLW TO 0 MLLW) PROVIDED BY ANCHOR ENVIRONMENTAL, LLC
4) WETLANDS, ORDINARY HIGH WATER LINE, AND APPROX. CENTERLINE PROPOSED ADA TRAIL SHOWN HEREON AS DELINEATED BY ANCHOR ENVIRONMENTAL, LLC SEPTEMBER 2008

CONTOUR DATA NOTE

TOPOGRAPHIC AND CONTOUR DATA FROM 0 FEET MLLW TO 55 FEET MLLW ONLY WAS COLLECTED BY ROTH HILL DURING THIS SURVEY. CONTOUR AND OTHER DATA FROM -10 MLLW TO 0 MLLW WAS PROVIDED BY ANCHOR ENVIRONMENTAL, LLC

CONTROL

THIS SURVEY UTILIZES CONTROL AS SHOWN BY DUNCANSON COMPANY IN REFERENCED SURVEY (SHOWN ON SHEET 4) .

DCI CONTROL POINT (#20000)	NORTHING 178331.99	
REBAR AND RED PLASTIC CAP FOUND	EASTING 1262245.40	
	ELEV=20.98	
DCI CONTROL POINT (#20001)	NORTHING 178099.38	
REBAR AND RED PLASTIC CAP FOUND	EASTING 1262164.09	
	ELEV=18.56	

BASIS OF BEARING: N 19°16'02" E BETWEEN FOUND DUNCANSON COMPANY CONTROL POINTS (SEE SHEET 4)

DATUM

HORIZONTAL: "REFERENCED TO NAD 83 CITY OF BURIEN CONTROL POINTS" AS DEVELOPED BY DUNCANSON COMPANY PER REFERENCED SURVEY

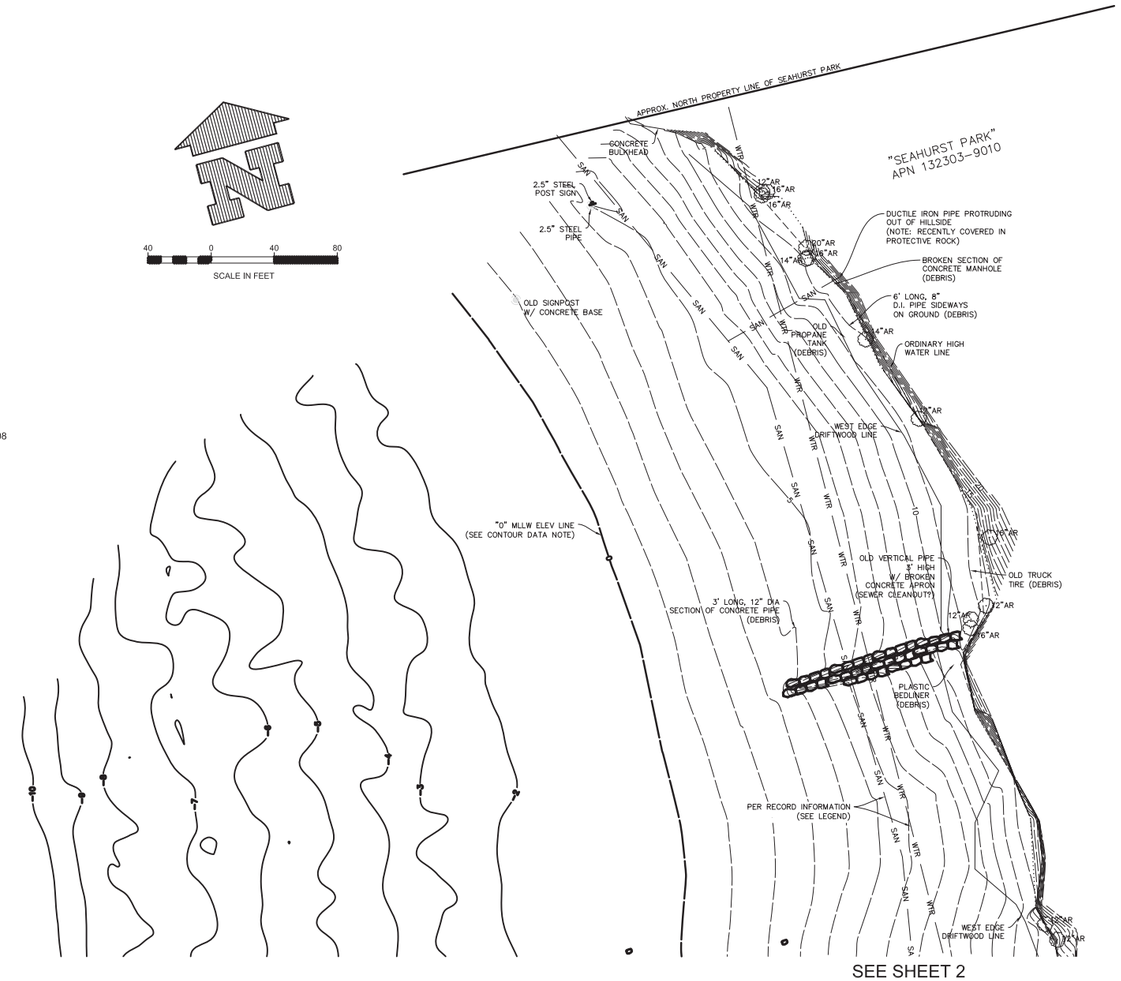
VERTICAL: "MLLW" AS DEVELOPED BY DUNCANSON COMPANY PER REFERENCED SURVEY

SURVEY PREPARED FOR:

ANCHOR ENVIRONMENTAL, LLC
1423 3RD AVENUE, SUITE 300
SEATTLE, WA 98101
(206)287-9130

UTILITY PURVEYORS OF RECORD

WATER	SEATTLE PUBLIC UTILITIES	700 5TH AVENUE, SUITE 4900, SEATTLE, WA 98124-1018	(206)386-1800
POWER	SEATTLE CITY LIGHT	700 5TH AVENUE, SUITE 3200, PO BOX 34023, SEATTLE, WA 98124	(206)684-3000
SEWER	SW SUBURBAN SEWER DISTRICT	431 SW AMBAUM BLVD, BURIEN, WA 98166-2462	(206)244-9575
TELEPHONE	QWEST	400 PINE ST, SEATTLE, WA 98101	(800)833-0825



NO.	BY	DATE	DESCRIPTION
			REVISIONS

Roth Hill Engineering Partners, LLC
2600 116th Avenue NE #100
Bellevue, Washington 98004
Tel 425.889.9448
Fax 425.889.1190

DATE 10/28/08
JOB NO. 0000.00544
APPROVED MJL
DRAWN DRK
CHECKED MJL
FIELD BOOK 405
PG. 1-59
SCALE HORIZ. 1"=40'

TOPOGRAPHIC SURVEY

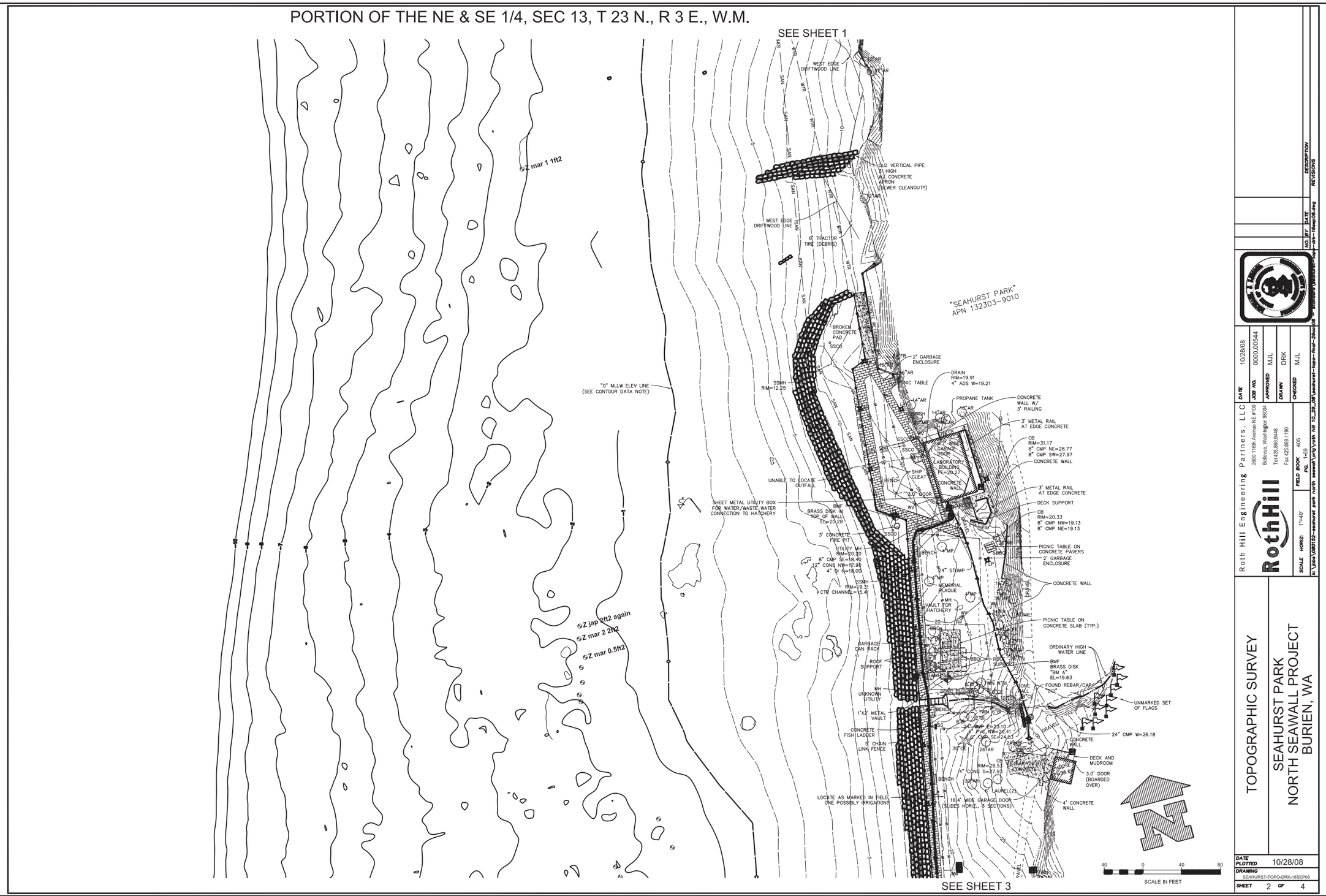
SEAHURST PARK
NORTH SEAWALL PROJECT
BURIEN, WA

DATE PLOTTED 10/28/08
DRAWING SEAHURST-TOPO-DRK-16SEP08
SHEET 1 OF 4

March 19, 2010 - hbermingham\-Projects\USACE Seattle District\PUGET SOUND NEARSHORE\Delivery Order 6 SEAHURSTES Report\Graphics\Feasibility Report Figures\Survey Folder

ANCHOR QEA

Figure 3a
Topographic Survey of Project Area - Sheet 1
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment



NO.	BY	DATE	DESCRIPTION

REVISIONS

Roth Hill Engineering Partners, LLC
2600 116th Avenue NE #100
Bellevue, Washington 98004
Tel 425.889.9448
Fax 425.889.1190

DATE 10/28/08
JOB NO. 0000.00544
APPROVED MJL
DRAWN DRK
CHECKED MJL
FIELD BOOK 405
PG. 1-59
SCALE HORIZ. 1"=40'

TOPOGRAPHIC SURVEY

SEAHURST PARK NORTH SEAWALL PROJECT BURIEN, WA

DATE PLOTTED 10/28/08
DRAWING SEAHURST-TOPO-DRK-16SEP08
SHEET 2 OF 4

March 19, 2010 hbirmingham\\Projects\USACE Seattle District\PUGET SOUND NEARSHORE\Delivery Order 6 SEAHURST\FS Report\Graphics\Feasibility Report Figures\Survey Folder

ANCHOR QEA

Figure 3b
Topographic Survey of Project Area - Sheet 2
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

Roth Hill Engineering Partners, LLC
2600 116th Avenue NE #100
Bellevue, Washington 98004
Tel 425.889.9446
Fax 425.889.1190

RothHill

DATE	10/28/08
JOB NO.	0000.005544
APPROVED	MJL
DRAWN	DRK
CHECKED	MJL
FIELD BOOK	405
PG.	1-59
SCALE HORIZ:	1"=40'

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NO.	BY	DATE	DESCRIPTION
			REVISIONS

TOPOGRAPHIC SURVEY

SEAHURST PARK NORTH SEAWALL PROJECT BURIEN, WA

DATE PLOTTED 10/28/08
DRAWING SEAHURST-TOPO-DRK-16SEP08
SHEET 3 OF 4

March 19, 2010 - bhermingham\Projects\USACE Seattle District\PUGET SOUND NEARSHORE\Delivery Order 6 SEAHURSTES Report\Graphics\Feasibility Report Figures\Survey Folder

ANCHOR QEA

Figure 3c
Topographic Survey of Project Area - Sheet 3
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

March 19, 2010 - hbermingham\\Projects\USACE Seattle District\PUGET SOUND NEARSHORE\Delivery Order 6 SEAHURSTES Report\Graphics\Feasibility Report Figures\Survey Folder

ANCHOR QEA

Figure 3d

Topographic Survey of Project Area - Sheet 4

Seahurst Phase II Shoreline Ecosystem Restoration

Detailed Project Report / Environmental Assessment

2.1.2 Geology and Subsurface Conditions

2.1.2.1 Coastal Geology

Prior to building the shoreline protection structures in the 1970s, a field reconnaissance of the beach geology was performed by Dr. Eugene Richey in order to determine future sediment nourishment requirements needed to sustain the existing beaches. Sediment samples revealed that the upland bluffs were providing a steady but moderate supply of gravel, sand, and fine material to the intertidal zones. The erosion was occurring with the help of creek surface water drainage as well as rainfall. Eroded material was drifting from the south toward the north within the park's shoreline. Groins near the northern edge of the park trapped a small volume of this material, though the creek near the Oceanography Lab (now the Marine Technology Occupational Skill Center [Marine Technology Lab, or MTLB]) washed some of the finer materials away in this area. Based on these observations made in the field, and the proposal to build seawalls that cut off the supply of beach materials, Dr. Richey recommended that a regular nourishment plan be followed, citing the need for an expected 15 cy of beach sand and gravel per month (180 cy per year), with winter months requiring more (Richey 1970).

In anticipation of beach nourishment proposals included within alternatives of the upcoming feasibility study, CGS sampled and analyzed sediment within the intertidal beach sections of the north Project Area in October 2008 (CGS 2008b). An additional description and analysis of coastal geologic conditions was prepared by CGS in the original Master Plan work (Anchor 2002).

Sediment samples were collected between the +8.5- and +11.0-foot (MLLW) contours because this high intertidal area is:

- A common habitat zone for surf smelt and sand lance within the Project Area
- Often the focus of beach nourishment applications
- Most often used for beach monitoring studies in the Puget Sound

Study profiles were located every 200 feet. Riprap revetments covering portions of this elevation zone precluded sampling at some profiles. Sediment samples were therefore only collected at profiles that still contained upper and lower intertidal beaches.

Results indicated high variability in sediment size/type within the Project Area. Samples from profiles located between the southern and middle perched beaches indicated a relatively sandy beach. The sandy substrate is suitable for sand lance spawning although no sand lance spawning has been documented (WDFW 2010). North of the middle perched beach, sand lance spawning habitat is not available as there is no high intertidal zone. In this area, riprap and quarry spalls are found throughout the beach, and the lower intertidal area has a variety of sediment types ranging from pebbles to boulders. Samples taken just north of the MTLB showed 1- to 8-millimeter (mm) sediment sizes, which are suitable for surf smelt but marginal for sand lance habitat. The northern portion of the park, within the two existing groins, exhibited high variability in sediment type, with up to 80mm sediment and 32- to 64-centimeter (cm) in diameter pebbles and cobbles (CGS 2008b). Beach sediment tended to be coarser on the north (down-drift) side of the groins, which is typical of these structures (Komar 1976).

Shoreline protection structures within the northern portion of the park include a seawall, riprap revetments, and two rock groins. The seawall is made up of precast concrete panels that are held by concrete king piles or retaining columns that tie back to an anchor block (Quinton Budlong 1972). Three stairways associated with the seawall provide beach access from the upper (eastern) portion of the park. A gabion revetment and sand perched beach was constructed waterward of the seawall but has since been removed. Some of the remaining gabions were buried under the three semi-circular riprap revetments, which partially protect perched beaches. These higher beaches have eroded over time as evident from the 6,500 cy of coarse sand that was added in 1989 to restore their design levels (Anchor 2002).

At the northernmost 865-linear-foot segment of the park's shoreline, no walls or revetments run parallel to the shoreline, though two rock groins remain (Anchor 2002). These two groins protect cleanouts for the sewer main beneath the beach (Roth Hill 2008).

2.1.2.2 Upland Geology

The park's upland soils were formed through a cycle of glacial incursions and recessions. Based on the original geologic map of the area (Waldron 1962) and site explorations during the Master Planning process, a number of geologic units were defined. These units from oldest to youngest include:

- Pre-Vashon Stade – Pleistocene (80,000 to 16,000 years ago)
  - Olympia Formation
  - Pre-Olympia deposits
- Vashon Stade – Pleistocene (16,000 to 13,000 years ago)
  - Till
  - Advance outwash
  - Glaciolacustrine deposit
- Holocene (13,000 years ago to present)
  - Fill
  - Alluvium
  - Beach Deposits
  - Colluvium

The Pre-Vashon Stade layer is mostly made up of deformed clay beds overlaid by sand. The Vashon Stade unit is characterized by fine-grained glacial silt and clay, overlaid by a dense layer of advance outwash with coarser sediment, and above this a layer of Vashon Till or hardpan characterized by a dense and relatively impervious mix of silt, sand, gravel, and cobbles.

The Holocene unit includes a layer of gravity-deposited colluvium. This layer is thickest in areas of active slope instability. Beach deposits along the shoreline include reworked landslide materials mixed with alluvium delivered by the creek systems within the park. The remaining fill material was placed along the roadways and seawall protected shoreline (Anchor 2002).

Throughout the majority of the Project Area, landslides are provoked by water seeping through and being trapped in between pervious and impervious layers of soil. The seawall within the Project Area does not affect this process in most areas because it occurs well above the shoreline. There is a different bluff instability process occurring north of the existing seawall that is triggered by toe erosion. Therefore, the two groins found north of the seawall do provide an enhanced level of protection against landslides originating near the toe of slope for areas just south of each of the groins. The effectiveness of the groins has declined as they have deteriorated over time (Anchor 2002). The groins were originally installed to protect clean-outs for the buried sewer main line that runs parallel to shore. It does not appear that these groins were installed to trap sediment, although this is an unintended consequence of these rock structures.

Hillsides and Slide Prone Areas

Shannon & Wilson performed an upland geology study in October 2008 to update their evaluation of geology and slope stability that was presented in the Park Master Plan in 2002 (see Figure 4). They noted that the site has not changed to any noticeable degree over this time period (Shannon & Wilson 2008).

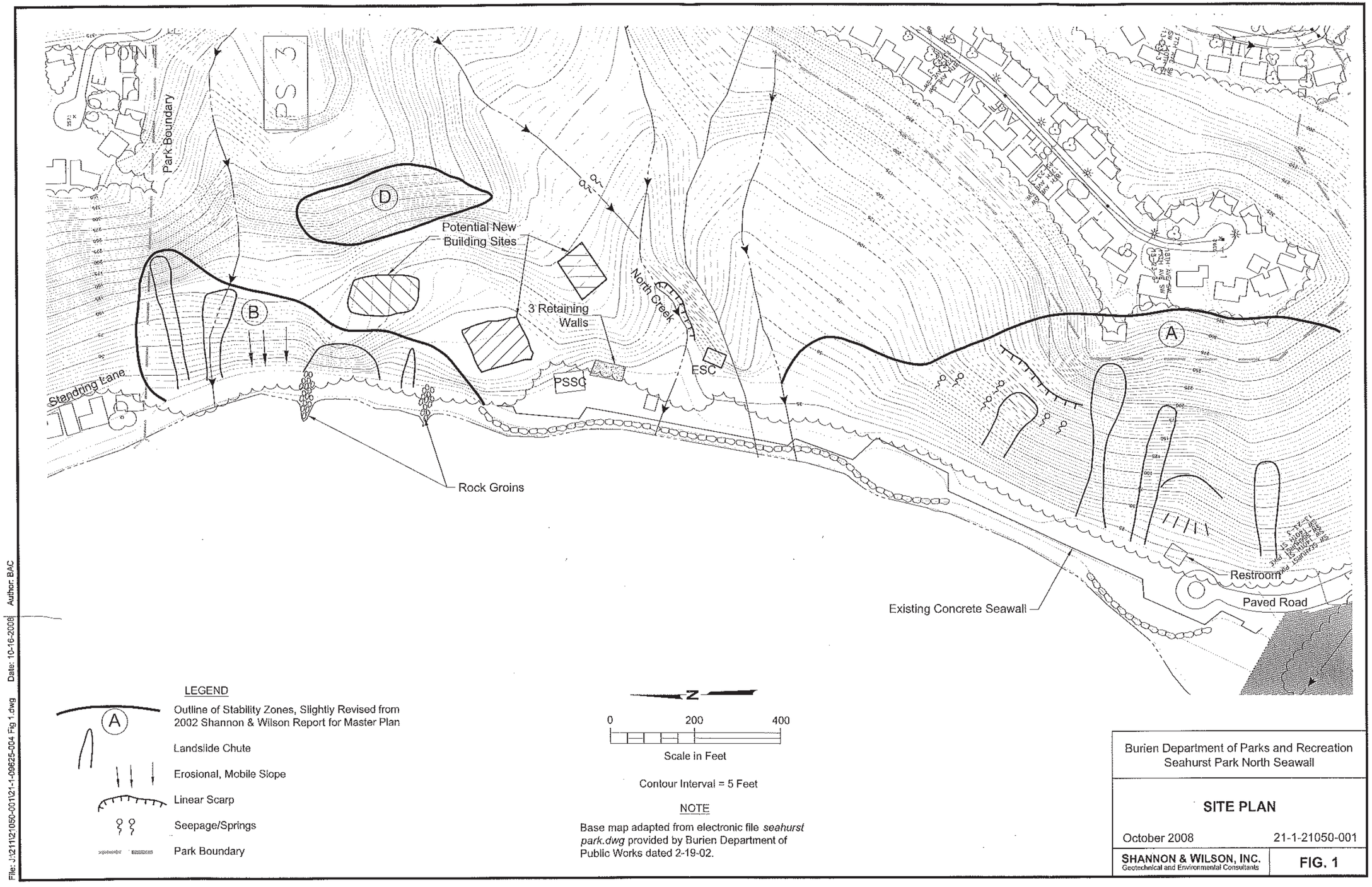
The foundation of the upland slopes is composed of Lawton Clay overlain by Advance Outwash layers, characterized by very dense or hard glacial deposits. The springs and soil instability within the upland slope are partially due to the permeability of the Advance Outwash layer and the relative imperviousness of the Lawton Clay. Plateau areas, east of the steep slopes, are made up of Vashon Till, another relatively impervious deposit. The west-facing slopes contain a variety of depositions as they receive landslide mixed soils. This gravity-placed colluvium is approximately 3 to 10 feet thick and is a source of many of the park's landslides.

Three areas within the Project Area have especially unstable slopes susceptible to landslides: one large area (Area A) is located east of the lower parking area extending approximately 900 feet north; another area (Area B) begins where the seawall ends extending to the northern park boundary; and the last area (Area D) is found within a steeper upland patch east of the shoreline, halfway up the forested slope near the northern park boundary (See Figure 4). Areas A is characterized by actively unstable, toe protected slopes. Area D is characterized

by local colluvial-filled swales that exhibit signs of ground movement and seepage. Area A formerly supplied the beach with sediment but is now cut off due to the shoreline protection structures, specifically the seawall. One exception to this is the alluvial fan that is located near the southern edge of the Project Area; these deposits are provided by South Central Creek.

Behind the seawall, landslides are most commonly triggered where groundwater perched above the Lawton clay saturates the steep slopes resulting in failure at the Advance Outwash layer and causing material (soils and vegetation) to slide down the slope. North of the seawall, in Area B, the geology is different than in areas to the south. In this northernmost section of the Project Area, the toe is being undercut by wave action, and slumping and block-calving are occurring regularly, providing mostly sand and silt to the beach.

By studying past landslides, one occurring after the seawall's construction and two occurring before, a natural sediment supply rate was estimated. These rates were provided in low and high estimates. The total landslide sediment rate was between 25 and 50 tons per year; the landslide delivered rate was between 12.5 and 25 tons per year; the amount of eroded colluvium was between 9 and 47 tons per year; and the total delivered sediment was between 21.5 and 75 tons per year. These estimates were based entirely on natural non-seawall conditions; the amount of landslide material actually reaching the beaches is estimated at around 10 percent of these totals (Shannon & Wilson 2008).



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ANCHOR QEA

Figure 4
Upland Geology Site Plan
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

Test Pit Exploration – ESC Location

Subsurface explorations were performed by Shannon & Wilson in 2003 for the ESC building that involved the renovation of the former caretaker residence building (Caretaker Residence). Two test pits and four hand-boring samples were extracted and laboratory tested. The location of this proposed building and associated earthwork is excluded from the area that will be re-graded for the Project. The new building was constructed in 2009.

Results of Test Pit Exploration – Lawn Area behind Seawall

A geotechnical subsurface investigation was conducted to determine if soils behind the north seawall at the park are suitable for reuse on site (Anchor 2008a). Ten geotechnical test pits were dug on September 25, 2008. These data are important in describing the materials that could be excavated from behind the seawall to restore the beach. Sahli Construction Services were used to excavate the test pits and refill and compact them when completed. All test pits were logged by a geotechnical engineer who took soil samples and recorded the location of the test pits using a handheld global positioning system (GPS) unit. Test pits were spaced from the current parking area to the marine educational building and positioned to try to avoid any utilities and concrete wall anchors.

Test pits were conducted to varying depths ranging from 3.5 to 9 feet and generally were stopped whenever several feet of hard gray clay were encountered. Two soils were typically encountered in the test pits: a loose to dense, brown, gravelly silty sand overlaying a hard, dense to very dense, gray, silty clay. Topsoil and organic material comprised the upper 6 inches of every pit. In general, a transition from brown sand to gray clay was observed from 1 to 4 feet below the ground surface. In a few test pits (TP-3, TP-9, and TP-10), the hard gray clay was not encountered. Test Pit 7 was trenched to observe how the clay depth changes in profile. An approximately 7-foot-long trench was excavated from west to east, perpendicular to the seawall and beach. The depth of clay ranged from 1.8 feet on the west to 11 feet on the east. On the north end of the site, Test Pit 1 encountered a plastic sheet warning of utilities below, and Test Pit 2 found large rocks with sand overlying unmarked concrete and metal pipes at approximately 6 to 7 feet.

Representative samples were taken from each distinct layer in each test pit and sent to a geotechnical lab for analysis of index properties including grain size, Atterberg limits, and moisture content. Based on these lab results and a beneficial reuse evaluation, it was determined that the soil would be difficult to use as structural fill material because of its moisture sensitivity due to a high fines content. The high fines content of the seawall fill would also make reuse for beach nourishment difficult because placement of the sediment would result in high turbidity as the finer fractions were lost to the water column (Anchor 2008a).

2.2 Water

2.2.1 Hydrology and Hydraulics

Seahurst Park's water resources include marine tidal areas, and freshwater streams and small watersheds. This section covers both tidal and freshwater hydrology and marine hydraulics. Tidal hydrology includes tidal effects, and freshwater hydrology includes watershed characteristics. Hydraulics focuses on wind/wave conditions affecting the park's shoreline.

2.2.1.1 Tidal Hydrology

The tides within Puget Sound are semi-diurnal, with two high tides and two low tides commonly occurring during an approximate 25 hour time period. The tide levels vary considerably throughout the sound. There are two official sources of information for tidal heights in the vicinity of the Project Area: (1) published tidal benchmarks from National Oceanic and Atmospheric Administration (NOAA)/National Ocean Service (NOS), which are created using observations at discrete locations; and (2) the VDatum program developed by NOAA, which uses numerical modeling results to predict tidal information between observation stations.

Seahurst is located approximately 8 miles south of the NOAA/NOS tidal benchmark at Seattle (No. 9447130) and approximately 14 miles north of the NOAA/NOS tidal benchmark at Tacoma (No. 9446484). Tables 2-1 and 2-2 provide the tidal elevations (relative to MLLW) for the Seattle and Tacoma benchmarks, respectively.

Table 2-1
Tidal Datums for Seattle, Puget Sound (NOAA/NOS #9447130)

Tidal Stage	Elevation (feet relative to MLLW)
Highest Observed Water Level (during observation period)	+14.5
MHHW	+11.4
MHW	+10.5
MTLB	+6.7
MLW	+2.8
NAVD88	+2.3
MLLW	0
Lowest Observed Water Level (during observation period)	-5.0

Table 2-2
Tidal Datums for Tacoma, Commencement Bay (NOAA/NOS #9446484)

Tidal Stage	Elevation (feet relative to MLLW)
Highest Observed Water Level (during observation period)	+14.3
MHHW	+11.8
MHW	+10.9
MTLB	+6.9
MLW	+2.9
NAVD88	+2.5
MLLW	0
Lowest Observed Water Level (during observation period)	-4.3

Table 2-3 provides output from the VDatum program, which provides site specific tidal elevations throughout Puget Sound from numerical model results. Since the information provided by the VDatum program is site specific to the Project Area's location, these tidal elevations were used for the alternatives evaluation.

Table 2-3
Tidal Datums for Seahurst (N 47.480439 W 122.361766) by VDatum

Tidal Stage	Elevation (feet relative to MLLW)
MHHW	+11.6
MHW	+10.7
MTLB	+6.8
NGVD29	+6.3
MLW	+2.9
NAVD88	+2.5
MLLW	0

These tidal ranges are the key factor in establishing certain breaks between habitat types described in this report. For instance, the backshore/supratidal zone approximates MHHW (elevation +12.0 feet MLLW) on the low end and extreme high water on the high end (elevation +16 feet MLLW). Similarly, the low and high intertidal habitat bands occur between elevations 0 to +6 feet (MLLW), and +6 to +12 feet (MLLW) respectively.

2.2.1.2 Stream Hydrology

During the stream reconnaissance, Anchor biologists identified and flagged the ordinary high water mark (OHWM) of four streams (see Figure 5):

- South Central Creek, located just south of the lower parking lot
- A small unnamed creek flowing through Wetland T
- A small unnamed creek flowing to the north of Wetland P
- North Creek, located directly north of the northern picnic shelter

All four streams are Type 2 under the City of Burien Critical Areas Ordinance (Burien Municipal Code 19.40.340), based on the assumption that they are perennial. The South Central Creek Basin contains South Central Creek and a large spring complex between elevations +250 and +300 feet. North Creek occurs within the North Basin, and springs near elevations +275' and +150' maintain flows in these smaller streams year-round (Anchor 2002). The two unnamed creeks are also spring fed.

South Central Creek is a Type F stream based on the Washington Department of Natural Resources (WDNR) Forest Practices Water Typing System. The stream was sampled as part of the Renton Sewage Treatment Plant project in the early 1980s. Fish caught and identified included steelhead (*O. mykiss*), cutthroat trout (*O. clarki*), and coho salmon (*O. kisutch)* (Donnelly et al. 1984). Although a few coho were seen in this stream, Washington Department of Fish and Wildlife (WDFW) does not consider it a salmon spawning stream (WDFW 2005). Adult coho and chum (O. *keta*) have been seen attempting to migrate upstream at the bridge (Personal observation of John Small with Anchor).

South Central Creek has a large watershed, though the precise delineation of the watershed boundaries is difficult due to Southwest Seahurst Park Drive and other development that runs adjacent to it. South Central Creek's watershed extends beyond the Seahurst Park boundary into adjacent residential development; because of this it is likely affected by stormwater runoff from nearby development.

Both of the unnamed streams are Type Np based on the WDNR system. They are disconnected from Puget Sound by culverts and are too steep to maintain adequate habitat to support fish. The sources of both streams are springs located part way up the bluff within the park (Figure 4). One section of the 2.9 acre watershed of the southern unnamed creek extends approximately 100 feet into residential development outside of the park (Figure 5). The northern unnamed creek has a small 0.4 acre watershed that does not extend past the Park boundaries. Due to these watershed boundaries, the unnamed creeks are little affected by stormwater runoff from developed lands.

North Creek has a short fish ladder at the mouth that allows fish passage for about 20 feet during higher tides. This ladder is used to capture brood stock for a hatchery located on site in the MTLB. No fish use upstream of that point is known, and physical conditions of the stream (e.g., steep gradient and culvert with two to three foot vertical drop at outlet) make fish use in the rest of the system extremely unlikely. With the exception of 20 lineal feet at the mouth, the stream is Type Np based on the WDNR system (Anchor 2008b). North Creek originates in a large wetland complex within the park, the 77-acre watershed it resides in (Figure 5) receives limited runoff from developed areas above.

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0 200
Scale in Feet

Stream Ordinary High Water Mark
Wetland Boundary
Watershed Boundaries

Figure 5
Wetlands and Streams
Seahurst Phase II Shoreline Ecosystem Restoration
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2.2.1.3 Hydraulics

The Project Area is characterized as an open coast environment within the sheltered waters of Puget Sound. The hydraulics of the area is dominated by tidal currents and fetch-limited locally generated waves from the Sound. The waves within Puget Sound are created from the surface wind field and are dependent on the geometry of the Sound, sustained wind speed, and the distance and direction over water that the wind blows.

The primary hydrodynamic forcing mechanisms for sediment transport processes at the Project Area are wave-induced currents in the nearshore region. These currents move sediment both parallel to the shoreline (longshore drift) and perpendicular to the shoreline. The alongshore movement of sediment is considered a continual long-term process with its magnitude and direction related to the predominant wind climate at the Project Area. The cross-shore transport of sediment is also considered a continual process which alters the shape of the beach profile (cross-section) based on tide levels and wave climate. However, short duration storm events can induce significant changes to the beach profile, and large transport volumes in the cross-shore direction. Therefore while the magnitude of alongshore and cross-shore transport can often be the same over an extended period of time, transport due to storm events in the cross-shore direction can occur in a much shorter amount of time.

The presence of the vertical concrete seawall and the rock riprap has likely negatively affected beach stability and increased erosion of the beach. The effects of seawalls and bulkheads on physical processes have been the subject of much concern in the Puget Sound region (Johannessen and MacLennan 2007). Bulkheads, especially those located in the intertidal zone, have been shown to cause increased reflectivity, sediment suspension, and longshore transport (Miles et al. 2001; Tait and Griggs 1991). Miles et al. (2001) report that in front of a bulkhead, the suspended sediment volume and littoral drift rate increase substantially compared to along adjacent unarmored shores, which results in beach scouring and lowering along armored shores. In Seahurst Park, the combination of seawall-induced erosion from reflected wave energy and loss of sediment supply resulted in a 0.5- to 2.5-foot lowering of the beach between 1970 and 2008 in the central portion of the Project Area (Johannessen 2010). The majority of the beach lowering in this area was 1.0 to 1.5 feet. It should be noted that this analysis was complicated by the paucity of reliable older data and

the numerous episodes of shore protection and fill that have occurred in the northern part of the park over past decades, such that erosion may have been greater without the addition of fill and beach nourishment.

A wind-wave hindcast study was completed for the Project Area to evaluate the wave climate at the Project Area. The study utilized existing wind information from Alki Point Lighthouse, Richardson Point Lighthouse, and Seattle-Tacoma Airport to develop an estimate of the wave climate offshore of the Seahurst Project Area. The winds were evaluated in direction bands (from true north) in 20 degree increments. Table 2.4 below provides the wind velocity estimates for a variety of return periods for each direction band and the fetch distance overwater for that direction band to the Project Area. The longest fetch (11.2 miles) is from the north-west, but the wind velocities are relatively small from that direction. The largest wind velocities are from the south (180-220 degrees), however the Project Area is sheltered almost completely from waves from that direction due to the protruding headland south of the Project Area. The largest wind velocities (and therefore largest waves) that will impact the site are generally from the southwest and westerly directions, approximately 225 to 270 degrees. The largest significant wave height and peak wave period for a 5-year and 50-year storm from those direction bands is approximately 2.8 ft. and 3.2 seconds and 4.5 ft. and 3.7 seconds, respectively.

Table 2.4
Wind Climate Used for Wave Hindcast Study

Direction from true North (degrees)	T (years)	Wind (mph)	Fetch length (miles)
180-200	100	75.89	3
	50	72.84	
	25	69.53	
	10	64.61	
	2	53.12	
	1	36.00	
	<1	20.00	
200-220	100	52.00	6.2
	50	49.90	
	25	47.50	
	10	44.10	
	2	35.90	
	1	20	
	<1	15	
220-240	100	37.70	4.7
	50	36.50	
	25	35.20	
	10	33.30	
	2	28.70	
	1	22.60	
	<1	10	
240-260	100	59.10	4.2
	50	56.10	
	25	52.90	
	10	48.10	
	2	36.80	
	1	21.50	
	<1	10	
260-280	100	30.60	4.5
	50	29.10	
	25	27.50	

Direction from true North (degrees)	T (years)	Wind (mph)	Fetch length (miles)
	10	25.00	
	5	22.80	
	1	10.00	
	<1	7	
280-300	100	19.98	6.7
	50	19.22	
	25	18.40	
	10	17.20	
	2	14.50	
	1	9.50	
	<1	7	
300-320	100	22.20	11.2
	50	21.10	
	25	20.00	
	10	18.40	
	2	14.60	
	1	9.50	
	<1	7	
320-340	100.0	39.30	2
	50.0	36.40	
	25.0	33.30	
	10.0	28.60	
	1.5	15.00	
	1.0	5.00	
	<1	5	
340-360	100	33.02	1.5
	50	31.10	
	25	29.01	
	10	25.90	
	2	18.00	
	1	8.60	
	<1	6	

The wind-wave hindcast study was used to inform the numerical modeling for the Alternative Evaluation. The modeling is described in Section 3.6.2.3.1 of the report and it

addresses sediment transport for each alternative relative to the long-term maintenance and sustainability of the beach.

2.2.2 Water Quality

Little quantitative water quality information exists for the Project Area, but quantitative baseline water quality parameters can be estimated based on the habitat conditions of the parklands and the tributary watershed. Freshwater water quality parameters that most directly influence fish, invertebrate, and vegetation production at the site include chemical compounds and elements from urban runoff, turbidity from upland disturbances, highly variable flows from urban development, temperature impacts from canopy removal, upland disturbances, and to some extent, dissolved oxygen. Marine water quality parameters of interest are primarily from toxic chemicals from ship traffic or upland releases. The small drainage area of the tributary basin and the urban nature of the upper drainage make it probable that some impairment of water quality could be occurring in the tributary. Elevated concentrations of turbidity, petrochemical inputs, pesticides, fecal coliform, or other common compounds found in suburban regions may be found. Dissolved oxygen impairment is possible as it relates to turbidity and temperature, but is not likely to be a limiting factor in itself. Highly variable flows from modifications to the drainage area of the tributary can cause excessive high flows from rain events and can also reduce summer low flows. Water quality in East Passage is generally good, particularly considering the urban nature of the Seattle shoreline. Seahurst Park was found to have a lower incidence of elevated fecal coliform levels than other nearby marine parks (King County 1996). There are currently no known areas of contamination above action levels on the Project Area.

2.3 Vegetation and Wetlands

2.3.1 Upland Vegetation

Historically, the majority of vegetative communities within the Project Area contributed to a riparian zone at the shoreline edge. The dense vegetation within this habitat type contributes to enhanced water quality, bank stability, nutrient, and debris inputs to the nearshore and wildlife habitat within the upland and intertidal zones (Williams et al. 2001).

Because of timber harvesting and development prior to Seahurst Park's purchase and development in the 1960s, the majority of remaining mature trees are second growth forest types characterized by deciduous rather than coniferous old growth. The communities found within the Project Area include deciduous forest dominated by red alder (*Alnus rubra*) and big leaf maple (*Acer macrophyllum*), and conifer forest dominated by western hemlock (*Tsuga heterophylla*), Douglas fir (*Psuedotsuga menziesii*) and western red cedar (*Thuja plicata*) communities. The forest types form a mosaic with different species dominating at lower elevations. Alder and cedar are more common in moist areas including wetland and stream riparian areas. At higher elevations within the park drier soil conditions dominate and Douglas fir and Pacific madrone (*Arbutus menziesii*) are more dominant. Some infestations of non-native and ornamental vegetation occur within the park.

The areas of the site colonized by red alder communities were subjected to logging or landslides in the early 20th century. The understory of these dense stands include Nootka rose (*Rosa nutkana*), salmonberry (*Rubus spectabilis*), and sword fern (*Polystichum munitum*). While the active slide areas within the park will continue to support this early-colonizing community, the red alder found in historic logging areas will be eventually be replaced by more shade-tolerant species. The community that was found onsite historically and is slowly replacing the red alder community is the hemlock/cedar community. This group is characterized by a mixture of western hemlock, western red cedar, Douglas fir, and big leaf maple. The wetland and stream riparian communities within the park have understories characterized by maidenhair and lady ferns (*Adiantum aleuticum, Athyrium filix femina*) and skunk cabbage (*Lysichiton americanum*). These zones tend to be shaded by a mix of red alder, big leaf maple, western red cedar, and western hemlock canopies.

The non-native and ornamental vegetation group is found predominately within the central shoreline and along areas of development within and adjacent to the park. Lawn areas dominate the ornamental category within the Project Area, however invasive plants like Himalayan blackberry (*Rubus discolor*), English ivy (*Hedera helix*), and English holly (*Ilex aquifolium*) have spread into portions of the park through bird dispersal.

2.3.2 Wetlands

A field investigation in September 2008 concluded that three distinct wetlands can be found within the Project Area. One of these wetlands can be found along the ravine slope, while the other two wetlands are located at the toe of the slope. (For wetland and stream locations, refer to Figure 5.)

Wetland T, found at the slope of the ravine, includes an understory of salmonberry and ground cover species including scouring rush (*Equisetum hyemale*), giant horsetail (*E. telmatica*), and swordfern (*Polystichum munitum*). No overstory canopy cover was observed. Standing water was found 6 inches below the soil surface, and soil horizons included 5 inches of sandy muck and 13 inches of sandy gravel. Upland of Wetland T, a dense (70 percent) canopy cover of red alder trees begins. Understory species of mostly salmonberry and big leaf maple were observed along with patchy groups of groundcover species including swordfern and trailing blackberry (*Rubus ursinus*). Soil horizons include a 2-inch duff layer, a 4-inch loam horizon, and 10 inches of sandy gravel loam that includes a few large concrete patches.

Wetland P, found north of Wetland T, contains little canopy or understory coverage; the area is instead dominated by a groundcover of youth on age (*Tolmeia menziesii*) with giant horsetail, trailing blackberry, and Himalayan blackberry also present. Soil horizons include an 8-inch sandy loam layer with gravel below the surface and an 8-inch gravelly loam layer. Wood fragments are present between 8 and 16 inches below the surface. No standing water was observed in this area though the soils were saturated at the surface. Upland of Wetland P, a mowed lawn is partially included and is thus regularly disturbed. A few red alder trees are present here but do not contribute to a significant canopy cover. Himalayan blackberry is observed in the understory and the groundcover is dominated by buttercup (*Rananculus repens*) and to a lesser extent stinging nettle (*Urtica dioica*), bent grass (*Agraostis species*), and giant horsetail. While no standing water was observed, the soils are saturated up to 6 inches below the surface.

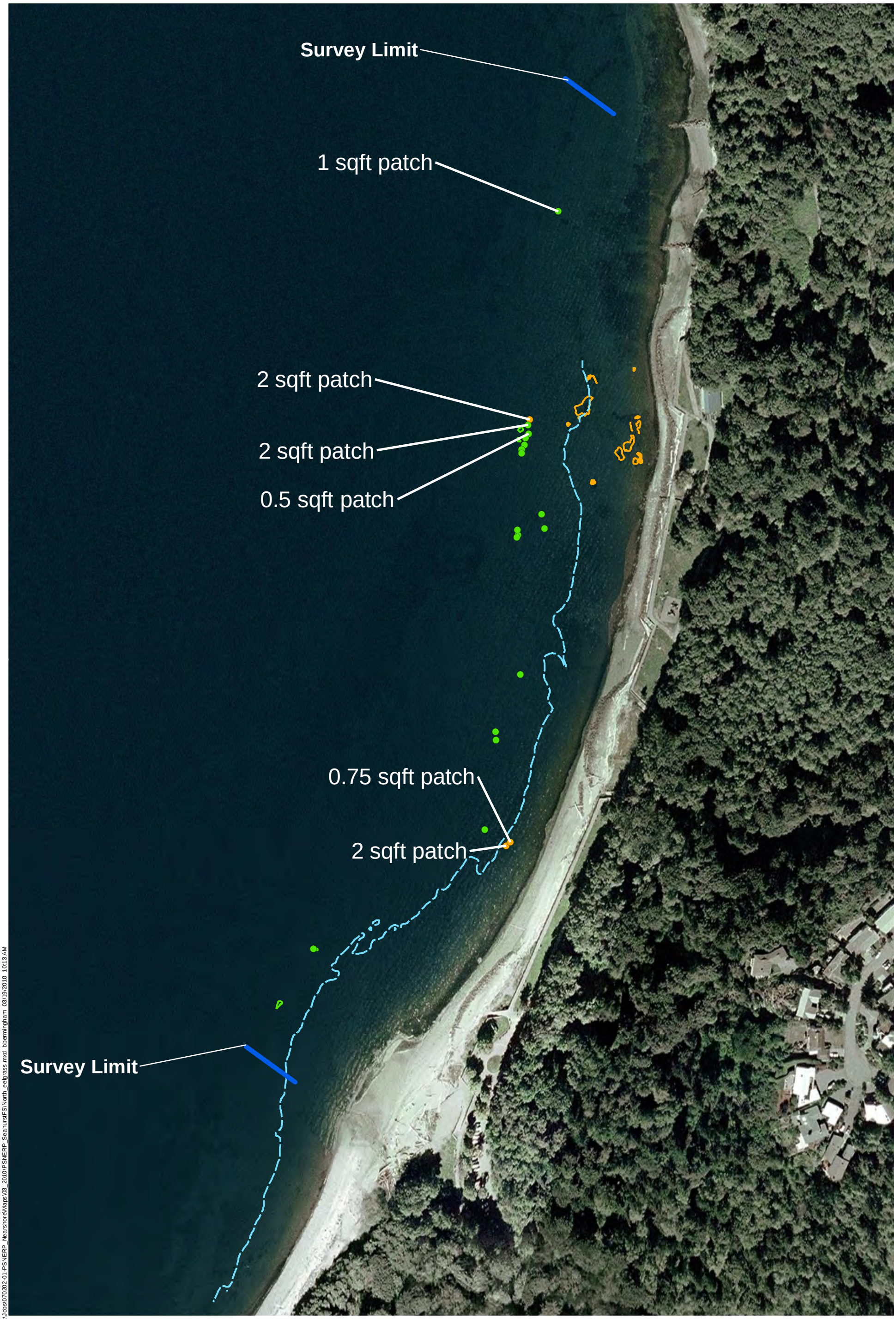
Wetland N is located near the former Caretaker Residence and just south of North Creek at the toe of the slope. This wetland is quite small and is classified as a seep wetland. The

vegetation of Wetland N is very similar to Wetland P with stinging nettle, youth on age, and salmonberry present (Anchor 2008b).

2.3.3 Eelgrass Beds

Monitoring of eelgrass beds south of the Project Area but within the park has occurred during 2004 and 2005 before and after construction of the Phase I project (Anchor 2005a and 2005b, see Appendix F). The monitoring documented eelgrass distribution in the park before and after seawall removal and beach nourishment to show whether construction activities affected the eelgrass beds. Monitoring showed that there were no negative impacts to the eelgrass bed from Phase I project construction.

Preliminary eelgrass bed monitoring for this project occurred in October 2007. The method undertaken was significantly less comprehensive than pre- and post-construction monitoring in the southern portion of the park. The upper limits of eelgrass beds were identified by walking the beach at low tide and collecting GPS points that were later differentially corrected. Attributes, including species type and patch size, were noted though the low light conditions at the time of the survey made these detailed observations difficult in some areas. A complete dive/transect survey, as was completed in the Phase I site, will occur after this feasibility study/EA and 35 percent design is complete and the Phase II permitting process begins. For the eelgrass survey results, refer to Figure 6.



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0 100
Scale in Feet

Zostera marina
Zostera japonica

Z.marina
Z. japonica
0' MLLW

Figure 6
Eelgrass Survey
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

2.4 Fish and Wildlife

2.4.1 Fish

The nearshore waters of Seahurst Park can be expected to support populations of marine fishes and serve as an important migration corridor for migratory salmon. The freshwater tributary likely supports small populations of resident fishes and perhaps coho salmon. The beach substrate is suitable in places for spawning by marine forage fish such as sand lance and surf smelt (WDFW 2010). The freshwater influence of the tributary on the nearshore serves as an important holding area and nursery area for juvenile flatfish, perch, and invertebrates important to juvenile salmon growth. Gunnels, flatfish, sculpins, shiner, and surf perches all frequent the intertidal ranges. In the subtidal elevations of the Project Area, cabezon, lingcod, and dogfish shark can be found in search of crab, octopus, bivalves, small forage fish, and other prey items.

Between February and July, juvenile anadromous salmon outmigrate from their natal streams and move along the nearshore in search of food and protection. The nearshore environment is critically important to the survival of these juvenile salmon between the time they emerge from the mouth of their natal stream and the time they leave Puget Sound. The closest large sources of salmon outmigrants to the Project Area are the Puyallup River to the south and the Duwamish River to the north. Both of these systems, along with small creeks along the shoreline, provide a consistent source of juvenile salmon to the Project Area. Salmon migrants would be made up predominantly of Chinook, coho, and sea-run cutthroat trout. Chum, sockeye (*O. nerka*), steelhead, and bull trout (*Salvelinus confluentus*) may also pass along the project shoreline. Adult salmon migrating back to freshwater to spawn would also pass along the Project Area.

Many marine fishes use the nearshore for feeding, spawning, and migration. Of particular importance to the Project Area are sand lance and surf smelt, which commonly spawn in the mid- to upper intertidal ranges on beach substrates of coarse sands and small gravel. Spawning can occur year round but is most common between the months of October and April. Forage fish spawning has been documented in some mid-1990s sampling in the park (WDFW 2010), and suitable beach gravels for forage fish spawning can be found, but no egg

sampling has been done recently to confirm spawning. Other marine fishes such as shiner perch, flatfishes, herring, and sculpins use the nearshore and intertidal elevations for feeding and protection from predators. All of these fishes benefit from uninhibited access to upper intertidal habitats.

The park has several small freshwater springs and seeps along the Project Area. There is one tributary of note within the project boundary. The tributary appears to be fed primarily by small seeps and runoff from the uplands above the bluff. The small basin, which gives rise to the tributary, is influenced greatly by upland development and frequent perturbations by hillside instability and highly variable flows. It is even possible that resident fish have been extirpated at some point by a number of physical and geomorphic disruptions. For migratory fishes, the tributary does hold some promise for smaller salmonids that can take advantage of smaller coastal tributaries such as coho salmon. However, coho spawning in the tributary has not been documented recently. Out-planting of juvenile coho or rainbow trout may occur yearly in the creek as part of local school efforts or associated with the MTLB.

If coho were to use the tributary, they would return within the months of October and November and complete spawning by January. Cutthroat trout would typically spawn in early spring between February and March, but possibly through the month of June.

2.4.2 Wildlife

Wildlife in the Project Area includes various large and small mammals and many bird species. Red-tailed hawks and other raptors have been seen perching within the Project Area. Small songbirds inhabit the upland hillsides and floodplain. Dabbling ducks, geese, seaducks, and gulls often fly past and occasionally land in the park. Pisciverous birds such as cormorants, grebes, loons, mergansers, and great blue herons, and bivalve eating birds such as scoters and goldeneye may use the beach as feeding areas. Shorebirds also frequent the Project Area as they probe into the substrate, or sweep the shallow water with their bills for invertebrate prey. Coyotes and foxes may occasionally visit the park as they hunt voles, rabbits, and other small mammals or scavenge for carrion on the beach. Furbearers such as raccoon, otter, mink, opossum, and others also forage along the beach and hillside. The creek also acts as a corridor for foxes and many wildlife species, which travel up and down

the drainage. Deer are known to visit the Project Area. Although not documented as a critical haul-out or feeding area, resident pinnipeds and cetaceans can occasionally be seen passing offshore of the Project Area.

2.4.3 Invertebrates

The Seahurst Park intertidal area provides habitat for a variety of mollusks including butter clams (*Saxidomus sp.*), littleneck clams (*Protothaca staminea*), macoma clams (*Macoma* spp.), and common cockle (*Clinocardium nuttalli*); and crabs including Dungeness crabs (*Cancer magister*) and red rock crab (*Cancer productus*). The Washington State Department of Health advises against shellfish harvest on any beach on the eastern shore of Puget Sound between Everett and Tacoma due to public health concerns related to biotoxins and pollution. Seahurst Park is closed for shellfish harvesting based on these concerns about pollution.

A King County beach assessment report indicated a clam band covered about 3.5 acres with most clams found along the southern beach. King County found macoma clams comprised about half of the clams found in 1996/1997and that littlenecks comprised about 19 percent. By weight, the littlenecks comprised about half of the biomass, and macomas comprised about 25 percent. Heavy human disturbance of the beach was noted. The clams found at Seahurst Park were scarce and very small; 188 clams weighed about 1.2 grams each. The density estimate of 8 clams per square foot was the second lowest of the surveyed beaches, yielding about 9.2 grams per square foot, which was the lowest yield of all of the beaches surveyed. Of the 8 manila clams, 36 littleneck clams, and 37 butter clams collected at Seahurst Park in 1996/1997, none were of legal size. The manila, littleneck, butter, macoma, and softshell clams, as well as the cockles, were all smaller than the averages from other beaches studied (King County 1998).

2.4.4 Threatened and Endangered Species

Several species may be present in the Project Area that have some degree of federal protection under the Endangered Species Act of 1973 (ESA), including Chinook salmon (*Oncorhynchus tshawytscha*); steelhead (*O. mykiss*); humpback whale (*Megaptera novaeangliae*); Southern Resident killer whale (*Orcinus orca*); leatherback sea turtle

(*Demochelys coriacea*); Steller sea lion (*Eumetopias jubatus*); bull trout (*Salvelinus confluentus*); and marbled murrelet (*Brachyramphus mamoratus*). Of these species, Chinook are the most likely to use the marine nearshore habitats of the park. Steelhead and bull trout occur in the nearshore, but their dependence on these habitats is much less than Chinook. The remaining listed species either remain far offshore or very infrequently occur in the Project Area. A separate biological evaluation (BE) designed to describe and assess effects to these species has been developed and is being evaluated under the Section 7 consultation process by both the U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries Service (NMFS) (see Appendix D for concurrence letters). A summary of ESA impacts and determinations is provided in Section 5.6 of this report.

2.5 Cultural Resources

Cultural resources are locations of past human activities on the landscape. The term generally includes any material remains that are at least 50 years old and are of archaeological interest. Examples include archaeological sites such as lithic scatters, villages, procurement areas, resource extractions sites, rock shelters, rock art, and shell middens; and historic era sites such as trash scatters, homesteads, railroads, ranches, and any structures that are more than 50 years old. Under the National Historic Preservation Act (NHPA; as amended 2006), federal agencies must consider the effects of federally regulated undertakings on cultural resources that are eligible for listing on the National Register of Historic Places (NRHP).

The National Park Service has established three main standards that a resource must meet to qualify for listing on the NRHP (36 CRR 60): age, integrity, and significance. To meet the age criteria, a resource generally must be at least 50 years old. To meet the integrity criteria, a resource must possess integrity of location, design, setting, materials, workmanship, feeling, and association. Finally, a resource must be significant according to one or more of the following criteria:

- Be associated with events that have made a significant contribution to the broad patterns of our history
- Be associated with the lives of persons significant in our past
- Embody the distinctive characteristics of a type, period, or method of construction, or

that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction

- Have yielded, or may be likely to yield, information important in prehistory or history

2.5.1 Prehistoric Overview

The Project Area falls within areas traditionally occupied by the Duwamish, a Lushootseed speaking people who lived within a network of interdependent villages along Elliot Bay and the Duwamish, Black, and Cedar Rivers (Ruby and Brown 1992:72). The Duwamish are one of 50 named groups or tribes identified in the mid-18th century by ethnographers as the Southern Coast Salish. These tribes all share similar cultural features including a dietary reliance on salmon, shellfish, waterfowl, and land mammals (Tollefson 1989; Suttles and Lane 1990:488-489). Research suggests that the Duwamish and other Southern Coast Salish may have relied more heavily on vegetable foods and hunting than tribes living to the north or on the outer coast (Suttles and Lane 1990:488-489).

The Duwamish practiced a seasonal round "which consisted of spring, summer, and fall migrations to fishing grounds, berry and root patches, and shell fishing areas with retirement to a sedentary lifestyle in the winter longhouses" (Larson and Lewarch 1995:1-15). Duwamish longhouses were distinct from other Southern Coast Salish longhouses. They are referred to as gambrel longhouses and consisted of a standard shed longhouse with a lean-to built around it. These longhouses were wider than the standard longhouse, and consequently, housed a larger number of people (Tollefson 1989:137). The closest known Duwamish villages to the current Project Area were reported by Swanton (1952) and included "Tola'ltu, below Duwamish Head" and "Skwa'lko." The former is located 7 miles north of the current Project Area near Alki Beach, and the latter is located near the present day town of Tukwila (423).

2.5.2 Historic Overview

Seahurst Park falls within the Highline District, a 32-square-mile area south of Seattle that contains Burien, Normandy Park, and Des Moines. Mike Kelly acquired one of the first land

patents in the area after moving there with his wife and child in 1873 (Eyler and Yeager 1972:2). Kelly called the area Sunnydale, a name that the community still retains. Eyler and Yeager (1972) place the Kelly homestead near the intersection of 16th Avenue South and 146th Avenue South, just south of Seahurst Park; however, the homestead patent places the Kelly homestead near 8th Avenue South and 152nd Avenue South, near the Des Moines Road. This latter location would make more sense given the fact that Kelly helped to construct the Highline/ Des Moines road in order to connect his property with the City of Seattle. Mike Kelly and his wife Jane started the first school in Sunnydale at their home in 1878, and Kelly would eventually become the first postmaster of Sunnydale in 1887 (Lange 1998).

Other homesteaders followed Kelly including Gottlieb Van Boorian, who homesteaded 160 acres along the east side of Lake Burien and is the namesake of the town of Burien. Many of the early settlers turned to agriculture and forestry as their primary industry. By the turn of the century, there were approximately 320 people living in Highline (Eyler and Yeager 1972:10). The area became a popular recreation area for the people of Seattle. The uninhabited shoreline between Seahurst Park and Three Tree Points was a popular picnic spot and Charlie Shoening built a hunting lodge on the east side of Lake Burien (Eyler and Yeager 1972:47). The area surrounding Seahurst Park remained relatively rural throughout most of the 20th century. In fact the City of Burien was not incorporated until 1993.

The lands incorporated as Seahurst Park first left federal ownership under three separate cash sale entries. William J Blackwell purchased 100 acres in 1889; John G. Parker purchased 9.7 acres in 1870; and A.F. Pope, W.C. Talbot, and Cyrus Walker purchased 137 acres in 1869. This final parcel of land was probably purchased as part of Pope, Talbot, and Walker's larger logging and milling business ventures. Captain William C. Talbot and Andrew J. Pope had been business partners in San Francisco where they imported and sold lumber. In November of 1851 they partnered with Josiah Keller with the intent to build and operate a steam saw mill in the vicinity of Puget Sound. They established the Puget Mill Company in 1853 with a steam mill at Port Gamble along the Hood Canal. Cyrus Walker was one of their first employees (Wilma 2003).

Access to the Seahurst Park area was limited in the first decade of the 20th century with the only access being by steamship and overland travel on private roads. To combat this problem, several Highline residents pooled their resources and funded the construction and purchase of 9 miles of track and an electric street car. The Lake Burien street car line, which was also known as the Toonerville Trolley and the Galloping Goose, connected to the Seattle Trolleys at Riverside and then headed south through White Center past Lake Burien and terminated at Seahurst. The trolley line was completed in 1911. Concurrently, Jacob Ambaum was busy constructing a road that paralleled the street car route. Ambaum Road, as it would later be called, was slated to terminate at White Center, but residents petitioned to have the line extended to Burien and then later to Des Moines. The road was completed in 1912. The parallel routes through Highline proved beneficial since the street car tracks were not laid out well and service was interrupted by landslides, power failures, mischievous children, and even once by a caterpillar infestation (Eyler and Yeager 1972:12-14; City of Burien 2010).

In October 1913, the City of Seattle offered to take over ownership and operation of the line if it was debt-free. Property owners along the route quickly raised the needed $30,000 and the City rebuilt the track lost in the most recent landslide. Service to Burien and Seahurst was terminated in May 1929, and the line officially shut down in 1933 (City of Burien 2010). A private estate for the Fox family was established within the portion of the Project Area at the North Creek mouth in the 1930s, though the nearby beaches continued to attract picnickers (McDonald and Whitney 1997).

In the 1950s, Howie Gwinn and other investors purchased Pope and Talbot's holdings in what is now Seahurst Park and were planning to construct a residential community known as Hurstwood. Much of the community was constructed; however, Ed Munro, the commissioner of King County Parks, managed to purchase some of the waterfront through a bond proposal passed in 1962. Ed Munro Seahurst Park was managed by King County Parks until 1993, when the City of Burien was finally incorporated and management of the park was transferred to the City of Burien (Wilma 2007; City of Burien 2010).

2.5.3 Area of Analysis

Based on its history, the area has a moderate to high potential for cultural resources such as logging-related features, shell middens, short term camps sites, and historic recreation sites. USACE archaeologists completed a cultural resource inventory in November 2009 of the area of potential effect (APE) for the preferred alternative. The Cultural Resource Report, entitled *A Cultural Resource Inventory of Seahurst Park Phase II*, is on file at the USACE Seattle District Office and at the Department of Archaeology and Historic Preservation in Olympia, Washington. No eligible cultural resources were located during the inventory. Additional information about the inventory results is contained in Section 5.7 of this document.

2.6 Land Use

Park visitors intensively use the Project Area for a variety of recreational activities. Surrounding land uses are primarily single family residential and open space. Within the general boundaries of Seahurst Park, amenities include picnic shelters, the pedestrian walkway/promenade, restrooms, and trails leading up the bluff that overlooks Puget Sound. Heaviest use occurs from late spring to fall, but small numbers of people use the park year round.

2.6.1 City Context

The City of Burien is located in southwest King County on Puget Sound. It has a population of over 31,000 residents and is highly urbanized. The park was first established in 1975, and owned and operated by King County. When the City of Burien was incorporated in 1993, the ownership of the park transitioned to the City, which took full ownership and management of the park in 1997.

2.6.2 Land Uses

In the Project vicinity, the land uses are park for the park property itself, and single family residential for adjacent areas. One single family development, Hurstwood, is located on the bluff top above the central section of the Park. The shoreline area in the park is designated as a Marine Reserve by the City.

Recreational activities within the park focus on passive recreation, including walking, picnicking, and viewing. Recreational facilities include one restroom two picnic shelters, a play area, and an upper and lower parking area. In addition, there are existing and proposed educational facilities located in the Project Area which are described below.

2.6.3 ESC Building

The Environmental Science Center Foundation (ESC) is a non-profit environmental education organization that organizes and runs outdoor education programs at the park and field trips within other marine and forest habitats of South King County. The overarching goal of the ESC is to "enable students of all ages, backgrounds, and abilities to learn about the complex interactions between people and nature in rich marine and forest environments" (ESC 2008). To further this goal, Burien Parks, Recreation & Cultural Services Department commissioned Bassetti Architects to develop schematic designs to renovate the Caretaker Residence, near the North Creek and MTLB, into an environmental learning center. Bassetti completed the final design documents working directly for the ESC, and construction was completed in 2009. Construction included the completion of the building shell, and interior finish improvements will be completed in the future as additional funding is available.
The ESC building renovated and expanded the former Caretaker Residence, which is located near the toe of the forested slope on the south side of the North Creek, uphill from the seawall and Children's Play area. The former Caretaker Residence was originally constructed prior to 1970's era park and may date back to the Fox family era. The ESC building, when fully completed, will include an office, multi-purpose classroom, kitchen/prep room, mudroom, two restrooms in the upper level, and a storage and mechanical room within the lower (ground) level. Excluding the storage/mechanical space, there will be approximately 1,180 square feet of space that will be open to the public. The building will look out over the park and Puget Sound and will also have Americans with Disabilities (ADA) access that will lead to nature trails within the forested slope. The exterior surfaces include cedar siding and trim for the western, larger portion of the building and corrugated metal siding for the smaller upper level of the building, set back against the upland slope (Bassetti Architects 2003). A capital campaign is currently underway to raise funds for completion of the ESC building. In addition, the Seattle Aquarium hosts a summer

camp of beach naturalists at Seahurst Park. The supplies for this program are stored at this building (Jeff Dillon, pers. communication).

2.6.4 Existing MTLB and Facilities

The MTLB at the northern end of the park is operated by the Puget Sound Skills Center (PSSC) for marine vocational-technical classes. PSSC provides classes for junior and senior high school students within the Highline, Federal Way, Tukwila, and Tahoma school districts. The ESC's office is also currently located within this building (PSSC 2008).

The MTLB is a two-story concrete building built in 1971. The lower level contains the "wet lab" and salmon hatchery. Students use this laboratory in conjunction with rearing salmon. Saltwater tanks within the lab are also used by students to study vertebrates that are collected along the shoreline. An adjacent garage houses boats and oars used in outdoor coursework. The upstairs portion of the building contains a classroom or "dry lab" equipped with computers for student use, staff offices, and restrooms (Weiss 2008, pers. comm.).

In conjunction with the building and hatchery, the MTLB also manages a fish ladder and holding pond located at the downstream end of North Creek. These facilities are used in the fall for 2 to 3 weeks when adult coho salmon return to spawn, and ascend to the holding pond. The purpose of the holding pond is to capture the returning adult coho and extract and fertilize the eggs for the hatchery. A covered underground swimming pool, originally part of a private residence in the 1930s, provides a freshwater holding tank underneath the north picnic shelter. Water stored in this tank is used in the MTLB's hatchery operations (Anchor 2002).

The ESC and the MTLB collaborate through their educational programs and are currently, temporarily sharing facilities. The ESC focuses most of its programs on grade school children, and instructors have observed that many of the students served by the ESC eventually become involved with the MTLB (Burr 2008, pers. comm.).

2.7 Utilities and Emergency Access

2.7.1 Utility Locations and Owners

There are several existing utilities located within the proposed Project Area. These utilities include existing underground power provided by Seattle City Light; underground telecommunications provided by Qwest; existing water lines provided by Seattle Public Utilities (SPU); and existing sewer mains provided by Southwest Suburban Sewer District (SWSSD).

The utilities within the proposed Project Area were identified using both existing construction records and physical utility locates that were marked in the field. Where there was insufficient signal to locate the existing utility in the field, the location of the utilities was identified on the base maps based on approximate locations from the construction records. The locations shown on the base maps are based on the best available information without actually "pot holing" (excavating) the existing utility (Roth Hill 2008).

2.7.1.1 Seattle City Light and Qwest

Both Seattle City Light (power) and Qwest (telephone) have existing underground utilities that run through the park to provide service to the MTLB. Beginning at the south end of the proposed Project Area, the power and telephone lines share a common trench on the east side of the existing roadway and turnaround. The lines continue to the north around the east side of the small hill and proceed to follow the existing concrete paver pathway directly behind the existing seawall. The lines continue to follow the pathway behind the existing seawall until the lines turn east to tie in with the MTLB. There is also an existing power line that runs between the MTLB and the former Caretaker Residence (ESC building) to the southeast. It is also assumed that there are smaller "secondary" power lines running from the concrete paver pathway to existing light poles along the toe of the slope to the east (Roth Hill 2008).

2.7.1.2 Seattle Public Utilities

SPU provides the water service for the park, the MTLB, and predominantly residential areas to the north of the park. The utility locater picked up several existing waterlines throughout the Project Area. The current existing waterline is a combination of newer 8-inch diameter

ductile iron (DI) pipe and the original 6-inch diameter cast iron (CI) pipe. The park was originally served entirely by an existing 6-inch CI pipe. Part of this pipe was replaced in the late 1990s as evidenced by the "Record Drawings" dated October 11, 2000. The replacement project included the installation of a new 8-inch DI water main from the south end of the existing turnaround to the existing play structure. At that point, the new 8-inch DI waterline was reconnected with the existing 6-inch CI waterline, which continues to the north beyond the proposed Project Area.

In addition to the existing waterlines discussed above, the locater identified several other existing waterlines. One of the most important is a waterline identified on the west side of the existing seawall. It is believed that this waterline is the original 6-inch CI waterline that was replaced by the new 8-inch DI waterline. The original 6-inch CI waterline was abandoned in place. There are additional waterline loops identified near the play structure and again near the MTLB. It is unclear what the additional water loops are. It is possible that the waterlines are water service lines, lines serving the existing fire hydrants, or possibly irrigation lines for the park (Roth Hill 2008). Loops between the MTLB, the north picnic shelter, and the North Creek Avenue are anticipated to be for the MTLB's fish hatchery.

2.7.1.3 Southwest Suburban Sewer District

SWSSD provides the sanitary sewer service for the park, the MTLB, the former Caretaker Residence, and existing residential development to the east and north of the park. The existing gravity sewer line consists of an 8-inch diameter asbestos cement (AC) pipe that comes down the entrance road to the park and then continues north through the entire park. Based on construction records, it appears that the line was constructed between the fall of 1964 and the spring of 1965.

The existing sewer line follows various alignments as it travels south to north through the park. At the south end of the park, near the turnaround, the existing sewer line is near the toe of the existing slope. In fact, the existing sewer line runs directly under the "front porch" of the new restroom facility. The sewer line continues to follow the toe of the existing slope to the north until it reaches an existing manhole (MH No. 2500) near a picnic table to the southeast of the play structure. At that point, the existing sewer line turns west, penetrates

the seawall, and ends up in the armor rock waterward of the seawall where it reaches a manhole (MH unnamed). The sewer then turns north again and continues along the alignment through the armor rock until it reaches another manhole waterward of the seawall (MH No. 2499A) found to the northwest of the MTLB. From that point, the sewer line proceeds north past the armor rock and is located beneath the sand beach. Further to the north, the sewer line crosses two rock groins that extend out from the base of the slope (see Sheets G-4.0 through G-4.3 in Appendix E).

Both groins were constructed to protect existing cleanouts for the sewer line. These groins were constructed with the sewer line and cleanouts between 1964 and 1965. To the north of the northernmost rock groin is an additional 6-inch DI line that exits the slope and enters the sand beach. This line once ran through an existing manhole (MH No. 1778A), which has been destroyed. The line currently is tight-lined into the existing sewer line running along the beach. The line serves approximately nine homes at the end of Cove Point Road to the east (Roth Hill 2008).

2.7.2 Emergency Access and Public Safety

Two roads leading into the Project Area are used as fire apparatus access roads. The north site access consists of a two-lane, paved route, 16th Avenue Southwest, dead ending at the park boundary. From this point, a gated, one-lane, soil-surface road continues into the park, ending at the 10-foot wide crushed rock pathways that extend to the MTLB. The main park access follows the South Central Creek and is a two-lane, paved road called Southwest Seahurst Park Road. This road is a continuation of Southwest 140th Street. Both the north and south park access roads connect via other local, two-lane, paved streets to Ambaum Boulevard Southwest, the main arterial road on the west side of Burien.

Title 17 of the King County Code covers fire code requirements. Sections of the International Fire Code, which are amended within the King County Code, relate to the surface, turning radius, dead ends, grading, and marking specifications of access roads. To comply with King County requirements, the roads must be able to support the imposed load of 25 tons and have a surface material that allows for all-weather driving. Turning radii must maintain a 40-foot outside and 20-foot inside radius. Dead end roads greater than 150 feet in length must provide a hammerhead turn-around design at their terminus or an approved

turn-around with a turning radius of at least 40 feet. All turn-around legs must have an unobstructed width of at least 20 feet. The specifications for road grades state that an access road shall not exceed a 15 percent slope at any point. Exceptions to the surface, turning radius, and dead end requirements can be granted with the approval of the Fire Marshal (King County 2008).

The Fire Marshal stated the one-lane, dirt road coming from the north upland and the 10-foot-wide, crushed rock pathway coming from the south do not meet the City of Burien Fire Department 20-foot width criteria. Design proposals that would rely on the crushed rock path at the toe of slope for emergency access would need to widen the path from 10 to at least 12 feet. The Fire Marshal would allow an exception for the 20-foot width requirement for this site if the shoulders of the path were made of reinforced turf products such as "grasscrete" or "turfstone," and were at least 4 feet wide each. These products are designed to support the weight of a fire truck. Any design proposals that relocate buildings, such as the MTLB, along the dirt road coming from the north would require an enhancement of the portion of this road leading to the relocated building. These enhancements would include widening the road to at least 20 feet and meeting other King County requirements for slope, loading, and radii. The site would also need a standard turn-around within 100 feet and a hydrant within 150 feet of the building. In addition to the hydrant, any new building would require a sprinkler system and thus a fire department connection water utility line (Burien Fire Department 2008).

2.8 Park Facilities

Seahurst is the most heavily used park in Burien and is also a popular attraction to visitors from throughout the region. The park is located near the Salmon Creek Ravine; combining the two sites contributes to 85 percent of the City's parkland (City of Burien 2000). Natural elements, including the forests, shoreline, and streams, are the main attractions of the park; these are in turn supported by facilities that support public recreation within the site. Current recreation facilities within the park include:

- Primary paved entrance road and two parking lots
- Secondary unpaved access road/path
- Trail system running parallel to shoreline

- Hiking trails
- Two picnic shelters
- Play area
- One public restroom
- Informal lawn areas along the shoreline

Most of these facilities can be found within the Project Area. These elements include the lower parking lot, unpaved access road/path, shoreline and hiking trails, the north picnic shelter, play area, public restroom, and informal lawn areas along the shoreline. The main entrance to the park terminates at the lower parking lot found near the South Creek outlet. This lot provides approximately 20 regular and five handicapped parking stalls facing Puget Sound and an additional eight parallel parking spots adjacent to the toe of the forested slope. A turn-around accommodates pick-ups and drop-offs, and also allows traffic to circulate back up the hill to a larger lot if this parking area reaches capacity. Conversations with park users indicate that this lower lot has excellent views of Puget Sound and the parking stalls, especially those facing the water, are used year-round because of these views.

The park's views and beaches are the main attraction for visitors. Because of beach lowering, the seawall, and rock riprap at the base of the seawall, walking on the beach itself during high tides within the Project Area is not possible north of the South Creek Delta. Two trails between the seawall and the forested slope allow users to walk along the shoreline from the parking lot to the northern seawall terminus. Because of the age, the installation methods and types of pavers used in the western pathway adjacent to the seawall do not meet ADA guidelines and are not suitable for use by elderly and disabled park users. The crushed gravel pathway to the east provides emergency access to the MTLB and ESC building on the north portion of the site. This path has a better surface, but the slopes in some areas may exceed ADA guidelines where the path follows mounded grass topography. In addition to these shoreline trails, a few unpaved trails traverse through the upland forested area, but these pathways are not well defined and do not meet ADA guidelines for width, slopes or surfacing.

The north picnic shelter is located south of the MTLB. Park users can reserve the shelter for a moderate fee, and when not reserved, it is often used informally. The picnic shelter floor

covers the Fox estate's original swimming pool. This nearly 40,000-gallon-capacity pool is used as a freshwater holding tank for the MTLB's wet lab and coho salmon fish hatchery. The large capacity of the tank allows for flexibility in the hatchery operations; if any portion of the input system developed problems the lab has about 6 hours of water available to the salmon tanks before the reservoir runs dry.

A children's play area is located southwest of the existing ESC building. While this play area is used by school groups at break times during ESC classes (Burr 2008, pers. comm.), its distance from the activity hub near the parking lot and public restroom, often leaves it deserted.

Subsequent to the USACE/City Phase I shoreline restoration, a new restroom was installed by the City in 2008. This new facility is fully ADA accessible and replaced the concrete restroom built in the 1970's by King County. The restroom is located at the base of the bluff adjacent to the turn-around associated with the parking lot. This portion of the park serves the majority of users and thus the restroom is ideally located to serve the majority of park users.

2.9 Future without Project Conditions

This section presents the most likely future conditions in Puget Sound without an authorized project. To have a uniform period for future assessments, USACE defines the planning period as spanning 50 years beyond when the first benefits could be expected to occur once an authorized project is implemented. For this study, we expect that period to start in 2011 and extend to 2061.

2.9.1 Water and Bathymetry Changes Associated with Sea-Level Change

The sea-level change forecasts developed for the PSNERP study were used in this report. These forecasts were prepared using USACE Engineering Circular No. 1165-2-211 (July 2009; hereinafter referred to as the SLC Circular).

The SLC Circular requires coastal study teams to examine three diverse sea-level change scenarios in acknowledgement of the uncertainty of the magnitude of change to expect. The

three scenarios required are: historic sea-level change trend from local, long-term, tidal gage stations; and two National Research Council (NRC) computer-model produced graphs (or curves), which were first published in 1986 and later modified by new data from the Interagency Panel for Climate Change (IPCC). The SLC Circular prescribes that coastal investigation is to use modified NRC curves "Scenario I" and "Scenario III." The analysis requires combining local, vertical land movement with values from the three sea-level change scenarios to determine total sea-level change for each scenario forecast for the period-of-analysis, which is a period extending 50 years beyond the year when the first project benefits can be expected. For the PSNERP study, the period-of-analysis was 2015 to 2065, which provides applicable forecasts for consideration in this report.

In the South Central Puget Sound sub-basin where Seahurst Park is located, the sea-level change forecasts by the three scenarios were 0.4 feet, 0.8 feet, and 2.1 feet. Consistent with the PSNERP study, this study applied the high scenario estimate of 2.1 feet in developing alternatives and evaluating potential effects.

In the future without project condition, keeping the shoreline armoring will result in the continued disconnection between the aquatic habitats and the coastal sediment supplies. The interruption of the connection between coastal bluffs and the intertidal zone is significant because of the sediment contribution the bluffs make to the nearshore. Coastal bluffs are the primary source of sediment for most Puget Sound beaches, delivering nearly 90 percent of the region's beach material (Johannessen and MacLennan 2007). MacDonald et al. (1994) stated that of all the negative impacts of shore armoring in Puget Sound, sediment impoundment has been noted as probably one of the most significant, especially when armoring occurs along feeder bluffs such as it does in Seahurst Park. Because sediment moves along the shoreline, a bulkhead's interruption of sediment supplies in one area can impact beach conditions up to several miles beyond the site of the structure.

The encroachment of shoreline armoring into the intertidal zone results in waves breaking against the armoring during a portion of the tidal cycle. When this occurs, wave energy tends to increase and be reflected from the face of the structure. The increased energy entrains increased amounts of sediment and transports it offshore or alongshore at unnaturally high rates that are faster than the system's natural erosion of bluffs would

replace. As a result, there is increased erosion and scour of beach sediment near the armor face, leading to decreased elevations and changes in habitat structure (Williams and Thom 2001; Downing 1983; Plant and Griggs 1992). Finer sediment, such as sand, tends to be more quickly redistributed because it is more easily moved by waves and currents. As a result, the intertidal areas in front of and down-drift of armored shorelines often have larger substrate than would occur naturally. The erosional effects of the seawall coupled with the disconnection of natural sediment supplies to the Seahurst Park beach has led to intertidal scour since 1970. An analysis of beach surface changes in the central portion of the Project Area between 1970 and 2008 indicate that elevations have lowered between 0.5 and 2.5 feet with the majority of the beach lowering between 1.0 and 1.5 feet (Johannessen 2010). Based on this analysis, it is estimated that the beach will further lower by approximately 1.0 to 1.5 feet over the next 50 years (Johannessen 2010).

The effects of shoreline armoring on shoreline stability and beach erosion in the park and down-drift of the park will likely be exacerbated by the predicted sea-level rise. As the mean sea level rises over time, the MHHW line, surf zone, and swash zone will move landward encroaching on shoreline armoring. This encroachment will result in more frequent inundation of shoreline armoring due to the tide and larger water depths at shoreline armoring locations compared to the present day. These deeper water depths (during some phase of the tide at a minimum) will allow larger waves to directly impact shoreline armoring as the sea level rises. This increase in wave energy will likely increase the depth and spatial extent of local scour in the near vicinity of shoreline armoring and may have additional erosive impacts to fronting and downdrift beaches.

It is difficult to predict with precision the increase in localized and far-field erosion to the Project Area due to sea level rise. In the absence of backshore constraints (and any hardbottom that may be exposed as the shoreline moved landward), it is likely that local longshore drift would remain relatively constant over time. However, the presence of shoreline armoring and other infrastructure limits the landward progression of the shoreline and complicates predictions of morphology change due to rising sea levels. For the purposes of this study, a conservative estimate of increase in scour due to sea-level rise was calculated using existing topography of the site and geometry of shoreline armoring (both riprap and vertical structures).

As sea level rises, shoreline armoring will be impacted by direct wave attack more often than in the past. Wave reflection, refraction, and diffraction due to the interaction of shoreline armoring with the wave climate will increase erosion of the beach in front of the armoring beyond historical values. The increase in erosion will be a combination of two processes: localized scour at the toe of the armoring and lowering of the beach profile landward of the armored sections due to increases in wave reflection (Griggs et al. 1997; Plant and Griggs 1992). Over a 50-year design life, which may be subjected to increasing sea levels and changing wave conditions, the interaction between these two processes in the Project Area is difficult to quantify. For the purposes of this evaluation, the total increase in erosion of the beach was assumed less than or equal to the localized scour depth at the toe of shoreline armoring. The value of localized scour was estimated using information presented in Wallingford (2006), which provided a graphical comparison of scour estimates in sandy substrate from numerous researchers including Kraus, Fowler, Sumer, Fredsoe, and others. This is a conservative estimate, but provides a reasonable assumption of impact given available data. The estimate of localized scour was evaluated using the 50-year significant wave heights and peak periods calculated as part of the wind-wave hindcast study completed for this Project (see Section 2.2.1.3). The maximum estimated wave conditions for a 50-year return interval (associated with winds from the west) had a significant wave height of approximately 3 feet and a peak period of approximately 4 seconds. Based on this analysis, it is predicted that sea-level rise will lead to a maximum lowering of the beach of 1.5 feet due to increased impacts from coastal armoring as sea level rises.

The estimates of sea-level rise (2.1 feet), intertidal scour at current water levels (1.0 to 1.5 feet), and increased scour due to sea-level rise (1.5 feet) were combined to predict how the Seahurst Park shoreline would function in future without project conditions over the next 50 years. These three factors contribute to approximately 4 feet in elevation change. This was interpreted such that intertidal elevations lose 4 feet relative to MLLW (e.g., currently +6 feet MLLW equates to +2 feet MLLW in 50 years). Because the shoreline armoring prevents the landward migration of the intertidal zone, the intertidal zone is expected to be smaller in the future. In the Project Area, it is expected that the intertidal zone between 0 feet and +12 feet MLLW will decrease in size from 12.5 acres currently to 7.7 acres in 50 years. This loss of 4.8 acres equates to a loss of approximately 40 percent of the intertidal area.

As sea level rises and waves can encroach farther upslope, coastal structures on site may be subjected to an increase in hydrostatic and hydrodynamic loads (wave loads), and toe and overwash scour. The shoreline armoring structures in the park are currently structurally intact and in good repair. There are no concerns about the condition of the shoreline armoring that form a motivation for the restoration work. Nevertheless, due to sea-level rise and the increased inundation and wave energy at the toe of the armoring, it is anticipated that maintenance costs to coastal structures may increase over time. The magnitude of impacts to the structure and its maintenance will depend heavily upon the criteria on which the structure was originally designed and built. An evaluation of structural stability under a range of sea-level rise scenarios will be included in the design phase of the Project.

2.9.2 Vegetation (Eelgrass)

The eelgrass meadows present offshore of the Project Area face two notable threats in the future without project condition. First, the predicted sea-level rise may result in the offshore portions of the eelgrass bed not receiving sufficient light to support continued eelgrass growth. Native eelgrass (*Zostera marina*) typically grows between 0 feet MLLW and -20 feet MLLW, although site-specific light penetration conditions through the water column contributes to variability in the maximum depth of eelgrass in an area. The predicted 1.5 feet of sea-level rise may result in loss of eelgrass along the waterward margin and, if conditions are suitable, an expansion of eelgrass along the landward margin. The second threat relates to the shoreline armoring present in the park and the impacts it has on site conditions. As described above, sea-level rise is expected to exacerbate the sediment erosion resulting from waves hitting the shoreline armoring. Such increased erosion could potentially have a positive or negative impact on the availability of sand substrate for native eelgrass to grow in. A positive impact would result if the increased erosion in the high intertidal resulted in cross-shore transport of sand into areas of elevation 0 feet MLLW and deeper. A negative impact would result if the high intertidal sand material is transported away and does not provide habitat for eelgrass to grow in.

There is also a non-native eelgrass (*Z. japonica*) that grows along the Seahurst Park shoreline. It is a smaller plant that grows higher into the intertidal zone (up to approximately +4 feet

MLLW) than native eelgrass, but overlaps in distribution with native eelgrass at around 0 feet MLLW. The ecological function of the non-native eelgrass is not well understood, but it is protected as eelgrass in Washington State. In the Project Area, there are small patches of non-native eelgrass present in the low intertidal zone. These small patches and the rhizome network holding them together tend to be slightly elevated above surrounding areas with no eelgrass. This appears to be due to the erosion of sediment in the unvegetated surrounding areas, while the eelgrass rhizome network holds the substrate in place. It appears that wave energy and sediment transport conditions in the Project Area will not support the continued growth of all of the non-native eelgrass patches over time, due to erosion of sediment around the patches.

2.9.3 Fish and Wildlife

There is evidence that the Puget Sound ecosystem is imperiled as nearly 40 species are threatened, endangered, or candidate species for listing under ESA (Puget Sound Nearshore Partnership 2006). Among these species is Chinook salmon, which is listed as threatened under the ESA and occupies the nearshore after outmigrating from rivers of origin. The Puget Sound ecosystem has been degraded by numerous stressors associated with shoreline and watershed development. The nearshore environments that contribute vitally to the ecosystem and support a complex food web have been particularly impacted.

In the future without project conditions, the changes to the beach due to the sediment supply and transport changes associated with shoreline armoring degrade habitat function for aquatic fauna and flora present in the nearshore. For example, surf smelt and Pacific sand lance are two species of forage fish that are important prey resources for many other species, most notably Chinook salmon. Surf smelt and Pacific sand lance spawn in high intertidal areas and require fine substrate (less than 0.25 inch in diameter). The availability of suitable spawning areas for these forage fish would be greatly impacted by the continued encroachment of shoreline armoring into the intertidal zone as sea-level rises and the loss of suitably sized substrate for spawning. With the predicted sea-level rise, the intertidal zone would naturally shift landward; however, the shoreline armoring will prevent the landward migration of the upper extents of the intertidal zone. The location of 0 feet MLLW is expected to move closer to the seawall, thus narrowing and steepening the intertidal zone

along the park. Based on changes related to sea-level rise described in Section 2.9.1, the amount of high intertidal habitat is expected to decrease the current 3.4 acres to 3.0 acres in 50 years. The suitability of the remaining 3.0 acres for spawning, in terms of substrate size, is expected to be further degraded from current conditions due to the increased scour along the shoreline.

2.9.4 Future Planned Changes to Utilities

SWSSD is currently working toward addressing several chronic problems with the existing sewer line. In April 2008, SWSSD installed a new manhole at the end of Standring Lane, north of the park property, and replaced the existing manhole (MH No. 2499A) near the MTLB. This project was intended to allow for easier access to the existing sewer line for cleaning. The existing sewer line was installed at a very flat slope and has issues with plugging and, in fact, has overflowed in the existing park. Preliminary design discussions have called for the installation of a new sewer lift station near the existing restroom facility at the south end of the Project Area (see Appendix E, Sheets C-4.0, 4.1, and 4.2 for utilities improvements). The proposed sewer lift station is located on the landward side of the proposed lower parking lot improvements and is therefore landward and does not affect the shoreline restoration. The corresponding force main would likely be a smaller diameter pipe that would be installed inside of the existing 8-inch AC sewer main. This approach (called "slip lining") would allow the construction of the new force main without digging up the park. SWSSD's intent is that the line would need to follow the existing pipe location as a way of minimizing costs for new construction. Once installed, the force main would not require the two manholes or two cleanouts within the northern portion of the Project Area. These abandoned utilities would be removed by a combination of the sewer improvement project and the restoration project.

3 PLAN FORMULATION AND EVALUTION

Plan formulation and evaluation is composed of multiple steps. These include the identification of specific problems, opportunities, and constraints; the identification of planning goals and objectives; the identification of management measures to address the specified problems; the combining of management measures into feasible alternatives; and the evaluation of alternatives for the identification of the preferred alternative based on study objectives and consistent with the four planning criteria (completeness, effectiveness, efficiency, and acceptability). Evaluation of alternatives requires the inventory and forecasting of existing and future without project conditions.

3.1 Problems and Opportunities

Water resources projects are planned and implemented to solve problems, address challenges, and realize opportunities. In the planning setting, a problem is identified as an undesirable condition, while an opportunity is a chance for progress or improvement. The identification of problems and opportunities gives focus to the planning effort and aids in the development of goals and objectives.

Modifications to nearshore habitats are widespread in Puget Sound. The modifications not only impact the habitats located at the site of the alterations, but also degrade ecosystem processes that create and sustain habitats far beyond the site of the modifications. In an assessment of nearshore conditions in Puget Sound, Schlenger et al. (In Review) reported that almost the entire 90-mile shoreline of Puget Sound from Everett to the Nisqually River near Olympia was among the most degraded for 11 nearshore ecosystem processes[2]. Shoreline armoring is the most widespread nearshore modification present in this portion of Puget Sound. In fact, shoreline armoring is present in more than 60 percent of the shoreline of the eastern shoreline of Central Puget Sound (Anchor 2004). In the drift cell that Seahurst Park is located in more than 87 percent of the shoreline is armored and more than 70 percent of the armoring extends into the intertidal zone (Anchor 2004).

[2] The nearshore ecosystem processes evaluated are the 11 landscape-forming processes identified and used by PSNERP in marine nearshore ecosystem restoration planning (Simenstad et al. In Revision). The 11 processes are: sediment input, sediment transport, erosion and accretion of sediments, tidal flow, distributary channel migration, tidal channel formation and maintenance, freshwater input, detritus import and export, exchange of aquatic organisms, physical disturbance, and solar incidence.

Like the rest of this portion of Puget Sound, Seahurst Park contains shoreline modifications that degrade ecosystem processes and functions. The following problems are caused by the modifications that have occurred in Seahurst Park.

1. The shoreline armoring present along 2,075 feet of the 2,865 linear feet of shoreline in the Project Area disconnects coastal bluff sediment sources from the beach. Sediment supply is a key habitat-forming process along Puget Sound, and the primary sediment source for Puget Sound is unstable coastal bluffs (Johannessen and MacLennan 2007). Eroding bluffs in Puget Sound are known to provide 90 percent of the region's beach material (Johannessen and MacLennan 2007). Under natural conditions, periodic slumping of the bluffs and the resulting redistribution of the material maintains sediment at the beaches. Eroding bluffs are critical to the maintenance of shallow water habitats in Puget Sound. The wave and current transport of sediment under natural conditions results in an eroding bluff contributing material to marine nearshore habitat conditions over long stretches of shoreline, often several miles. By disconnecting natural sediment sources, the foreshore and backshore portions within the park and downdrift of the park do not receive sediment necessary to maintain natural beach habitats or habitat quality. The intertidal areas erode in elevation and the substrate sizes increase as smaller material is transported away and not resupplied.
2. The shoreline armoring degrades the sediment transport processes in the park. Bulkheads, especially those located in the intertidal zone, have been shown to cause increased reflectivity, sediment suspension, and longshore transport (Miles et al. 2001; Tait and Griggs 1991). Miles et al. (2001) report that in front of a bulkhead, the suspended sediment volume and littoral drift rate increase substantially compared to along adjacent unarmored shores, which results in beach scouring and lowering along armored shores. Seahurst Park's location at the updrift end of the longest drift cell in Central Puget Sound (more than 10 miles; Schwartz et al. 1991) means that the park's impacts to sediment transport because of the shoreline armoring affects conditions over a large area.
3. The park's shoreline armoring has decreased the availability of suitable high intertidal spawning areas for forage fish and for juvenile salmon refuge and prey production. Two species of forage fish, surf smelt and Pacific sand lance, spawn in high intertidal

areas and require fine substrate (less than 0.25 inch in diameter). The availability of suitable spawning areas for these forage fish, as well as refuge and foraging areas for juvenile salmon, is greatly reduced because the shoreline armoring encroaches the intertidal zone and because the degradation of sediment supply and transport processes results in too coarse of sediment remaining on the upper beach. The encroachment of the shoreline armoring into the intertidal zone truncates the upper intertidal habitats. As a result, there's less shallow water habitat for forage fish and juvenile salmon.

4. The park's configuration separates the nearshore riparian areas from the aquatic areas and provides little room for backshore habitats. These conditions result in a discontinuous transition from upland to aquatic habitats. Under natural beach conditions, the nearshore habitats provide a gradual transition from upland habitats, to supratidal/backshore habitats that are only occasionally wetted, to intertidal and subtidal habitats. This connectivity is important for the nearshore ecosystem processes and food web through the direct input of terrestrial-origin insects to the aquatic areas and the exchange of organic matter that supports the base of the food web. The connectivity allows for the natural input of sediment supply described in number 1, shading of the intertidal zone, large woody debris habitat, natural migration of stream mouths across the foreshore beach.
5. The long stretches of armored shoreline and associated placement of nearshore fill or other construction tend to provide a much more homogenous and simplified nearshore setting than would naturally occur. Historically, the Central Puget Sound shoreline included a diverse mosaic of beaches, marshes, and embayments (Simenstad et al. In Revision). The nearshore modifications have reduced the number of marshes and embayments, often replacing them with filled lands protected by shoreline armoring.

Seahurst Park provides a significant and unique restoration opportunity in Central Puget Sound. The approximately 4,500 linear feet of shoreline in the park is the largest public shoreline park between Seattle and Tacoma. Much of the Central Puget Sound shoreline is privately owned and the parcels tend to include only short portions of the shoreline. As a result, restoration opportunities on the scale possible for the Project are very limited and

very few have been completed elsewhere in Central Puget Sound, due to the costs and logistics of working with a large number of landowners or finding appropriate large sites.

Seahurst Park also provides the opportunity to restore sediment supply and transport processes near the updrift end of the largest drift cell in Central Puget Sound (Schwartz et al. 1991). In this way, restoration of the park is an opportunity to contribute to improved habitats as far away to the Duwamish Head nearly 10 miles north in Seattle.

3.2 Planning Goal, Objectives and Constraints

The goal of the Project is to restore natural nearshore processes that will sustain a naturally functioning shoreline and contribute to nearshore function within and beyond the park boundaries. Consistent with the authorizing language, the Project will produce "consistent with Federal programs, projects, and activities, immediate and substantial ecosystem restoration, preservation, and protection benefits."

The water and related land resource problems and opportunities identified in this study are translated to specific planning objectives, in order to provide focus for the formulation of alternatives. These planning objectives reflect the problems and opportunities and represent desired positive changes to the future without project conditions.

3.2.1 Planning Objectives

The team established the specific project objectives and constraints stated below to guide alternative plan development:

- Restore natural sediment supply processes in the Project Area
- Restore a more natural setting for longshore and cross-shore sediment transport
- Increase availability of suitable high intertidal spawning areas for forage fish and for juvenile salmon refuge and prey production
- Restore connectivity between upland and shallow water intertidal habitats
- Diversify habitat at the saltwater/freshwater interface

These project objectives are closely aligned with each of the following regional marine restoration objectives described in the WRIA 9 Salmon Habitat Plan (Green/Duwamish and Central Puget Sound Watershed WRIA 9 Steering Committee 2005):

- Restore nearshore sediment transport processes by reconnecting sediment sources and removing shoreline armoring that affects sediment transport
- Restore pocket estuaries (i.e., mouths of smaller salmon-bearing and non-salmon-bearing streams)
- Protect and expand forage fish spawning areas by maintaining/increasing high intertidal zone access and availability of suitable substrate sizes

This Project is specifically recommended in the regional Salmon Habitat Plan list of priority projects and is fully consistent with the Shared Strategy Puget Sound Salmon Recovery Plan (Shared Strategy 2007).

3.2.2 Constraints

Unlike planning objectives that represent desired positive changes, planning constraints represent restrictions that should be avoided or not be violated. A planning constraint is any technical, legal, departmental, or operational restriction that limits the extent of the planning process or scope. Overall, project constraints include:

- Avoid adverse impacts to the existing recreational opportunities to Seahurst Park
- No adverse impacts to existing levels of flood risk management

There were several constraints inherent in development of the criteria, management measures, and alternatives. First, the Project Area is a heavily used public park and includes important educational facilities. The main attractions of the park are the shoreline, beach, and views. The ability to walk along the shoreline for most of the length of the Project Area has been clearly documented by the community in public meetings as a high priority (Anchor 2002, Appendix A). In addition, the ability to have gathering spaces as well as relatively flat, multi-use, open space with lawn adjacent to the shoreline with water views is also a documented public need (Anchor 2002, Appendix A). Therefore, while the configuration of these recreation spaces can be changed, there is a constraint that they need to remain within the Project Area in an appropriate location.

Access for recreation, maintenance, utilities, emergency vehicles, and educational programs is also needed for park uses and existing education functions to occur. These access facilities must adhere to federal American with Disabilities Act (ADA) requirements, as well as local fire department requirements. Park and educational facilities such as the MTLB and the north picnic shelter depend on a specific location within the Project Area. Therefore, if removal of these facilities was included in an alternative for shoreline restoration, replacement within the Project Area was included as well. In addition, the MTLB has two constraints associated with it. One is that it contains facilities supporting a fish hatchery, and the other is that it must have access to the beach via a ramp. The fish hatchery requires an access (fish ladder) and holding pond near North Creek and MTLB. The fish ladder and holding pond are actively used up to 3 weeks per year in the fall when coho salmon are returning to spawn. These fish-access facilities currently have problems with maintenance in the form of sedimentation from North Creek that is difficult to remove under current conditions. The fish ladder and holding pond, while currently in line with North Creek, do not have to stay directly in the redesigned North Creek channel (Joe Weiss, personal communication). However, it is critical that flows from North Creek be diverted to the fish ladder and holding pond if these facilities are moved. Otherwise, returning coho salmon will return to the redesigned stream mouth and not be able to locate the fish ladder.

Topography/bathymetry is a major constraint with many educational, park, and access facilities, as well as utilities, all located in a narrow corridor between the base of the bluffs and the seawall and rock riprap. This narrow corridor is also the location where nearshore habitat restoration yields the greatest ecological benefit. Balancing and optimizing these seemingly competing interests is the central design challenge for the Project. In alternatives where the MTLB and the picnic shelter remain in place, the adjacent seawall and toe protection rock are needed to protect these facilities due to their horizontal and vertical relationship to the wall, and due to the tidal regime. Two facilities within the Project Area have undergone recent implementation. These facilities include the public restroom near the existing parking area, which was constructed in 2008, and the ESC building, which was constructed in 2009. Both buildings are in locations that do not interfere with shoreline restoration. Because of these recent or imminent investments and the position of the

structures relative to the shoreline, it was assumed that these facilities would remain in their existing locations.

3.3 Plan Formulation Methodology

The plan formulation methodology is composed of the identification of appropriate management measures, scaling of management measures, combining of management measures into alternative plans, and the evaluation of alternatives.

Alternative plans were crafted using five of the 21 management measures recommended in the widely accepted Clancy et al. (2009), which is comprehensive in an attempt to identify key management measures that would successfully accomplish process-based, sustainable restoration within Puget Sound.

Outputs are then measured in terms of anticipated ecological benefit using the ecological function assessment method described in Section 3.6.1. A scoring system was established to measure restored habitat and numerically convert it into Average Annual Habitat Units. Criteria used to establish Average Annual Habitat Units included length of barrier removal, acres of reconnected landforms, and acres of restored or created marshes.

3.4 Description of Selected Management Measures

Management measures are the building blocks for alternative plans. These are features and/or actions that, when combined, address established project objectives and constraints. The management measures are directly related to the planning objectives. Of the 21 measures covering all of Puget Sound described in Clancy et al. 2009, five were determined to be the most directly relevant to the Seahurst Project and site conditions. These five measures include:

- Armor removal and modification
- Beach nourishment
- Topographic restoration
- Groin removal
- Revegetation

Additional management measures that have relevance to the Project but are considered secondary due to their limited scale and application are: channel rehabilitation or creation; hydraulic modification; invasive species control; large wood placement; physical exclusion; substrate modification.

Dependencies between these management measures are identified as well as constraints. Some of the key dependencies include the need to remove armor, restore suitable intertidal topography, and provide beach nourishment to allow for a relatively rapid ecological benefits trajectory. In addition, given the constraint of the Project's public park setting, these dependencies address the safety issues associated with long time periods where steep and unstable shoreline bank conditions (following armor removal) are left to erode until a suitable beach forms.

Another key constraint is more spatial and relates to the need to allow sufficient land area along the shoreline for the public to use, and providing an access corridor along the shoreline. The access corridor is needed for park use and maintenance, and user access and emergency access to facilities such as the MTLB and ESC building. These constraints primarily affect the extent of topographic restoration (Management Measure [MM] 3) and revegetation (MM 5). Other constraints include a cultural resource site, and access to the water from the MTLB to the beach via an existing ramp. These latter constraints affected MM 4, groin removal.

Dependencies between measures factored into scaling. For instance, beach nourishment (MM 2) is included as "full, or partial" in all alternatives because other management measures are dependent on beach nourishment due to the project objectives, and park use constraints described above. On the other hand, armor removal (MM 1) is explored in a range of scales from all, to partial (varying degrees), to almost none.

3.4.1 MM 1: Armor Removal

This management measure is defined as removal, modification, or relocation of coastal erosion protection structures such as rock revetments (riprap), bulkheads, and concrete walls (seawalls) on bluff-backed beaches, barrier beaches, and other shorelines (Clancy et al. 2009).

- Justification/planning objectives targeted include:
  - Reconnect feeder bluffs to the intertidal zone to restore natural sediment supply processes in the Project Area
  - Improve intertidal habitat within and beyond the park boundaries by restoring a more natural setting for longshore and cross-shore sediment transport by addressing shoreline armoring impacts occurring within the Project Area
  - Enhance intertidal habitat by restoring natural slopes and substrate sizes to increase availability of suitable high intertidal spawning areas for forage fish and for juvenile salmon refuge and prey production
  - Restore connectivity between upland and shallow water intertidal habitats, including revegetation and creek daylighting
- Dependencies: dependent on topographic restoration and beach nourishment in order to provide an accelerated trajectory of ecological benefits, and to address park constraints
- Constraints: Park constraint of maintaining useable and safe shoreline and beach and avoiding a dangerous, eroding drop-off along the entire shoreline
- Scales: Full removal, partial removal (varying amounts), none (seawall), and very limited rock removal
- Secondary management measures included: channel rehabilitation or creation; hydraulic modification; substrate modification

3.4.2 MM 2: Beach Nourishment

This management measure is defined as the intentional placement of sand and/or gravel on the upper portion of a beach where historic supplies have been eliminated or reduced (Clancy et al. 2009).

- Justification/Planning objectives targeted include:
  - Improve intertidal habitat within and beyond the park boundaries by restoring a more natural setting for longshore and cross-shore sediment transport by addressing shoreline armoring impacts occurring within the Project Area

  - Enhance intertidal habitat by restoring natural slopes and substrate sizes to increase availability of suitable high intertidal spawning areas for forage fish and for juvenile salmon refuge and prey production

- Dependencies: Not dependant on other management measures; however, leaving armoring in place significantly affects the period of performance and the degree of maintenance
- Constraints: Waterward limits of beach nourishment constrained by presence of eelgrass (*Zostera marina*) beds from approximately elevation 0.0 feet (MLLW) and below; frequency of nourishment is a constraint in terms of cost and impacts to invertebrates from burial
- Scales: Full nourishment, partial nourishment (varying amounts)
- Secondary management measures included: substrate modification

3.4.3 MM 3: Topographic Restoration

This management measure is defined as dredging, excavation, and/or filling to remove or add layers of surface material so that beaches, banks, tidal wetlands, or mudflats can be created (Clancy et al. 2009).

- Justification/Planning objectives targeted include:
  - Reconnect feeder bluffs to the intertidal zone to restore natural sediment supply processes in the Project Area (see Figure 7).
  - Improve intertidal habitat within and beyond the park boundaries by restoring a more natural setting for longshore and cross-shore sediment transport by addressing shoreline armoring impacts occurring within the Project Area
  - Enhance intertidal habitat by restoring natural slopes and substrate sizes to increase availability of suitable high intertidal spawning areas for forage fish and for juvenile salmon refuge and prey production
  - Restore connectivity between upland and shallow water intertidal habitats, including revegetation and creek daylighting

- Dependencies: Dependent on armor removal and beach nourishment; armor removal needed to allow for proper tidal inundation and beach nourishment needed to accelerate trajectory and sustain ecological benefits

- Constraints: There is a park use constraint and an emergency access constraint on how much topographic restoration can be done
- Scales: Full topographic restoration, partial topographic restoration (varying amounts with and without marsh), and none
- Secondary management measures included: channel rehabilitation or creation; hydraulic modification; large wood placement; substrate modification

3.4.4 MM 4: Groin Removal or Modification

This management measure is defined as the removal or modification of groins and similar nearshore structures built on bluff-backed beaches or barrier beaches in Puget Sound (Clancy et al. 2009).

- Justification/Planning objectives targeted include:
  - Improve intertidal habitat within and beyond the park boundaries by restoring a more natural setting for longshore and cross-shore sediment transport by addressing shoreline armoring impacts occurring within the Project Area
- Dependencies: Not dependent on other management measures; however, beach nourishment improves ecological benefits
- Constraints: MTLB water access ramp currently is eroded at the base and is more vulnerable to erosion without a drift sill to replace the groin
- Scales: Remove all groins; remove groin and replace with drift sill; and none (no groin removal)
- Secondary management measures included: None

3.4.5 MM 5: Revegetation (Riparian, Backshore, and Marsh)

This management measure is defined as site preparation, planting, and maintenance to manipulate soils and vascular plant populations to supplement the natural development of native vegetation (Clancy et al. 2009).

- Justification/Planning objectives targeted include:
  - Restore connectivity between upland and shallow water intertidal habitats, including revegetation and creek daylighting

- Dependencies: Full riparian/backshore and marsh revegetation is dependent on armor removal and topographic restoration. Partial riparian restoration is not dependent. Full riparian/backshore revegetation requires the proper grades to connect these two habitats with the beach, without the wall/armor interfering. Wall/armor precludes any marsh restoration due to lack of tidal access. For partial riparian/backshore, the wall/armor separates these two habitats.
- Constraints: There are park and emergency access constraints on how much area can be revegetated. Partial backshore revegetation more vulnerable to frequent disruption and partial riparian ecological benefits are constrained by being above and behind the wall.
- Scales: Full riparian and backshore in all areas within constraints; full riparian and backshore within most areas, partial riparian and backshore in areas with armor (walls) remaining; partial riparian and backshore in all areas; small marsh, medium marsh, maximum marsh within park constraints.
- Secondary management measures included: invasive species control (maintenance period); large wood placement; physical exclusion (temporary); substrate modification (for planting).

3.5 Formulation of Alternative Plans

Once the team established the desired management measures and identified their dependencies, the measures were scaled and combined to form feasible alternative plans. Constraints that limited the application of management measures to the entire length of shoreline dictated what measures were applicable and to what extent they could be applied (scaled). For instance, the most extensive ecological restoration would have been achieved by removal of all barriers that interrupted the topographic relief from upland to the tidal zone, which would conflict with the public use of the park. Additionally, armor removal that would result in temporary steep and unstable shoreline bank conditions that over time would erode naturally until a suitable beach was formed cannot be implemented in areas that are heavily used by the public. Also, along stretches of shoreline where there existed an access corridor, the extent of topographic restoration and revegetation is very limited and full restoration via reconnected upland and tidal zone was not possible. Consequently, management measures were scaled to provide a range of feasible solutions to site-specific

conditions along various reaches of shoreline. Sufficient land area along the shoreline was required along this corridor length for park use and maintenance as well as for user and emergency access to features such as the MTLB and ESC building. Section 3.4 provides more detail by management measure as to how these were selected and scaled depending on the specific shoreline.

The alternative that best addressed sponsor intent as per their Master Plan appeared to be an excellent middle ground between maximum restoration and minimal restoration. Varying scales of the measures were determined to achieve the desired "bookends" of highest and least anticipated ecological benefits. Initially, five alternative plans were crafted with two being high-end and two being low-end efforts. After a preliminary run of the CE/ICA analysis, the middle alternative, Alternative 3, proved to be both cost-effective and a best buy. However, the Project team decided that the risks and uncertainties associated with the attempt to recreate a tidal marsh were too high to pursue when costs were compared to the benefits, as desirable as these were to the team. As a result, another alternative plan similar to Alternative 3 but revised to create a smaller marsh constructed such that it would be freshwater as opposed to tidal was crafted. Due to its similarities with Alternative 3, it was labeled Alternative 3A. The CE/ICA analysis was rerun with six action alternatives and one no-action. Table 3-1 summarizes how varying scales of management measures were combined to form the six alternatives.

3.5.1 Presentation of Management Measures by Scale and Alternative

A range of scales for the management measures was developed specific to this site. In addition, dependencies between management measures were considered as described in the previous sections. In some cases, these dependencies determined which management measures could logically be combined at what scales. Table 3-1 illustrates how the previously described management measures are assembled into the six action alternatives; this is further described in Section 3.5.2.

Table 3-1
Management Measures by Scale (Largest to Smallest) and Alternative

Management Measures	Alternative 1 Full (100%) Armor Removal/Small Marsh	Alternative 2 92% Armor Removal/Max. Marsh	Alternative 3 84% Armor Removal/Med. Marsh	Alternative 3A 84% Armor Removal/Freshwater Wetland	Alternative 4 77% Armor Removal/ No Marsh	Alternative 5 Limited (19%) Armor Removal/Nourishment Only
1. Armor Removal						
Remove All Armoring	x					
Protect MTLB: Relocate Armoring		x	x	x		
Protect MTLB: No Action at North End					x	
No Wall and Very limited Rock Removal						x
2. Beach Nourishment						
All	x					x
End Full Nourishment at MTLB with Limited Nourishment at Groin Removal		x	x	x		
End at MTLB					x	
3. Topographic Restoration						
Maximum Within Park Constraints	x					
Partial with Expanded Salt Marsh and Outlet		x				
Partial with Salt Marsh			x			
Partial with Freshwater Wetland				x		
Partial without Marsh					x	
None						x
4. Groin Removal						
Full	x					
Partial		x	x	x		

Management Measures	Alternative 1 Full (100%) Armor Removal/Small Marsh	Alternative 2 92% Armor Removal/Max. Marsh	Alternative 3 84% Armor Removal/Med. Marsh	Alternative 3A 84% Armor Removal/Freshwater Wetland	Alternative 4 77% Armor Removal/ No Marsh	Alternative 5 Limited (19%) Armor Removal/Nourishment Only
None					x	x
5. Revegetation (Riparian, Backshore, Marsh)						
Full Riparian/Backshore with Salt Marsh/ Freshwater Wetland	x	x	x	x		
Full Riparian/Backshore without Salt Marsh or Freshwater Wetland					x	
Partial Riparian/Backshore		x	x	x	x	x

3.5.2 Description of Alternative Plans

Seven alternatives, including six "action" alternatives and one "no action" alternative, are described in this section. The no action alternative consists of the existing conditions shown on Figures 2, 3a, 3b, 3c, and 3d. The written description in Section 2.9 provides a baseline "future without project" condition reference point. The action alternatives meet the Project's ecological restoration objectives to varying degrees by implementing some or all of the management measures described above at different scales. Figures 7, 8, and 9 illustrate the implementation of most of the management measures at various locations within the Project Area, and different scales of management measure implementation. Groin removal, Management Measure 4, is not shown in these figures.

Figure 10 shows the difference in how landslide material will reach the beach once the armor is removed. It compares the run-out with the seawall in place (No Action Alternative) and the necessity to remove the material from the site with the restored condition. In the restored condition (Alternatives 1 through 4), in most locations an emergency access route necessitates the mechanical removal of some landslide material. However, the restored beach design provides a platform between MHHW and extreme high water where this landslide material can be placed and where it can be redistributed through the site, shoreline, and drift cell by high tides and storms.

The alternatives also address constraints of the site's use as a park and the existing educational facilities located within the park. For the six action alternatives, two buildings, the recently replaced restroom (2008) and newly completed ESC building (2009), remain in their existing locations. Relocating these buildings was not evaluated because the objectives of the Project can be achieved without doing so due to their more landward locations. With the exception of Alternative 5, which leaves the entire wall and facilities landward of it in place, all action alternatives provide a replacement pedestrian walkway/emergency vehicle and maintenance access route. This route will be relocated along the toe of the forested slope to satisfy life safety and federal ADA requirements. Other replacement items common to Alternatives 1 through 4 include a relocated parking lot, children's play area, fish ladder, and holding pond. In Alternatives 1 and 2, some of the buildings, including the MTLB (Alternative 1 only), and North Picnic Shelter are relocated. Recreation features that are planned by the local sponsor, but are not replacement items, are not included in the alternatives.

The existing gravity sewer line will be replaced in all action alternatives with a new force main sewer line by SWSSD. Sewer improvements, including a sanitary sewer pump station, are anticipated to precede the shoreline restoration project. Other utility relocations such as domestic water, electrical, drainage, and MTLB hatchery water lines are included in the scope of the Project as part of the restoration.

The percentage of armor removal used to describe each alternative is based on a linear foot measurement using the following approach. Armor as defined in MM 1 includes both concrete seawalls and rock riprap. Where riprap and the seawall are adjacent, such as where rock is placed at the toe of the wall, the linear foot measure counts these two items together. Where the rock riprap is separated from the seawall, such as at the three former "perched beaches," it is, counted separately from the wall. Using this approach, a total length of armored shoreline consisting of 2,830 linear feet is calculated. This total includes 2,040 linear feet of seawall and toe rock, 35 linear feet of gabion (cross-section width), and 755 linear feet of "perched beach" rock riprap.

The six action alternatives are described in the following subsections.

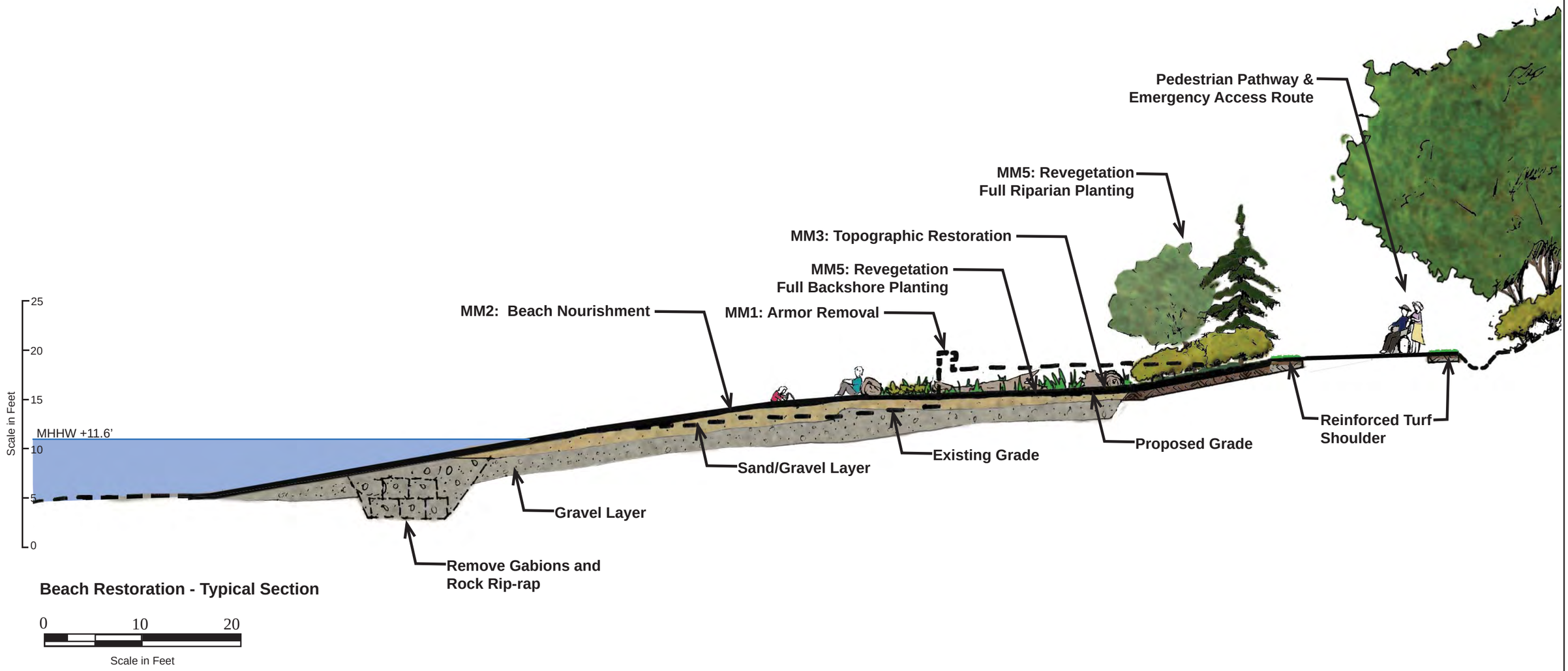

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Figure 7

Management Measures 1, 2, 3, & 5 - Typical Beach Restoration
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

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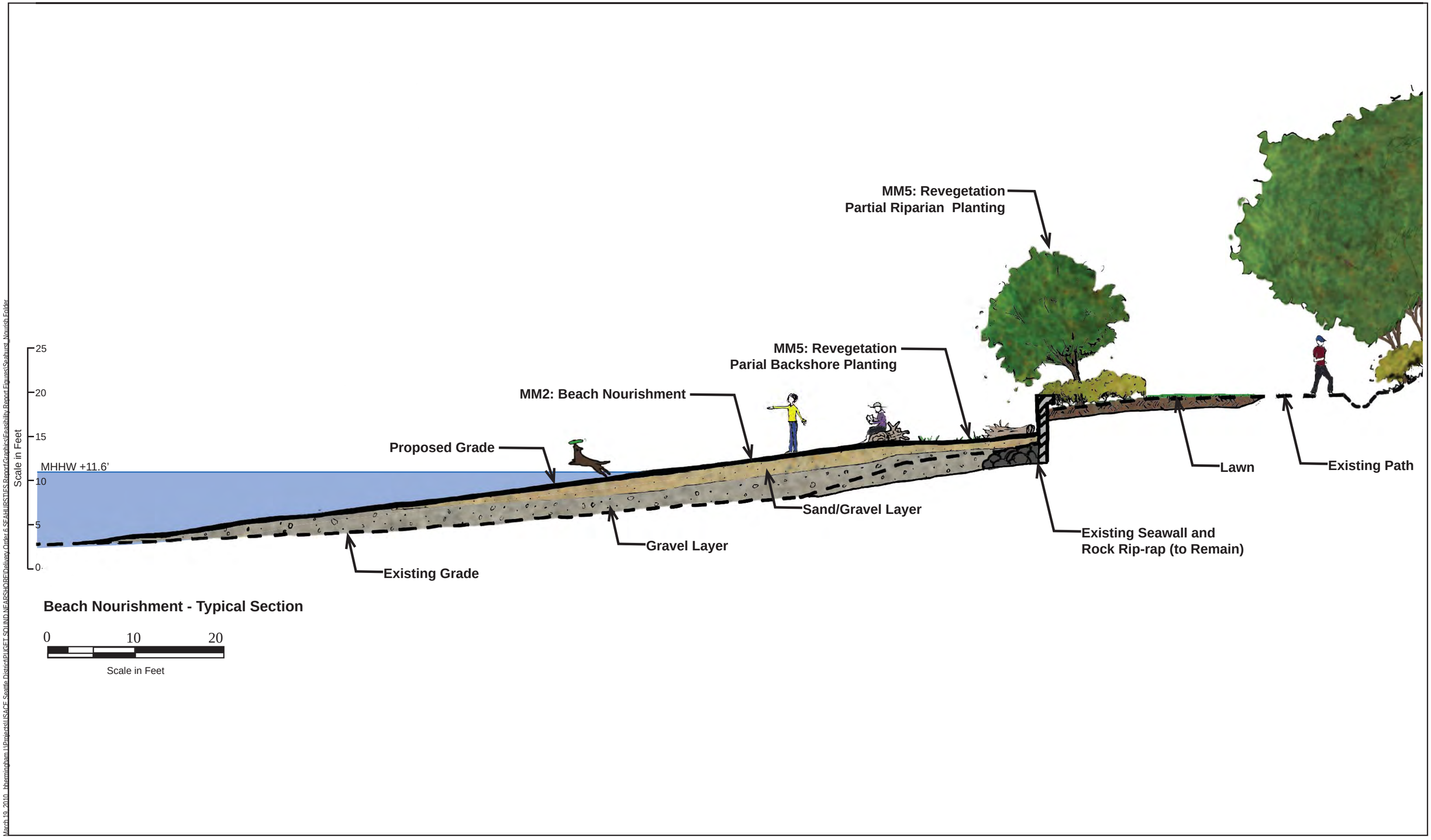

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Figure 8
Management Measures 2 & 5 - Typical Beach Nourishment, Seawall Remains
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

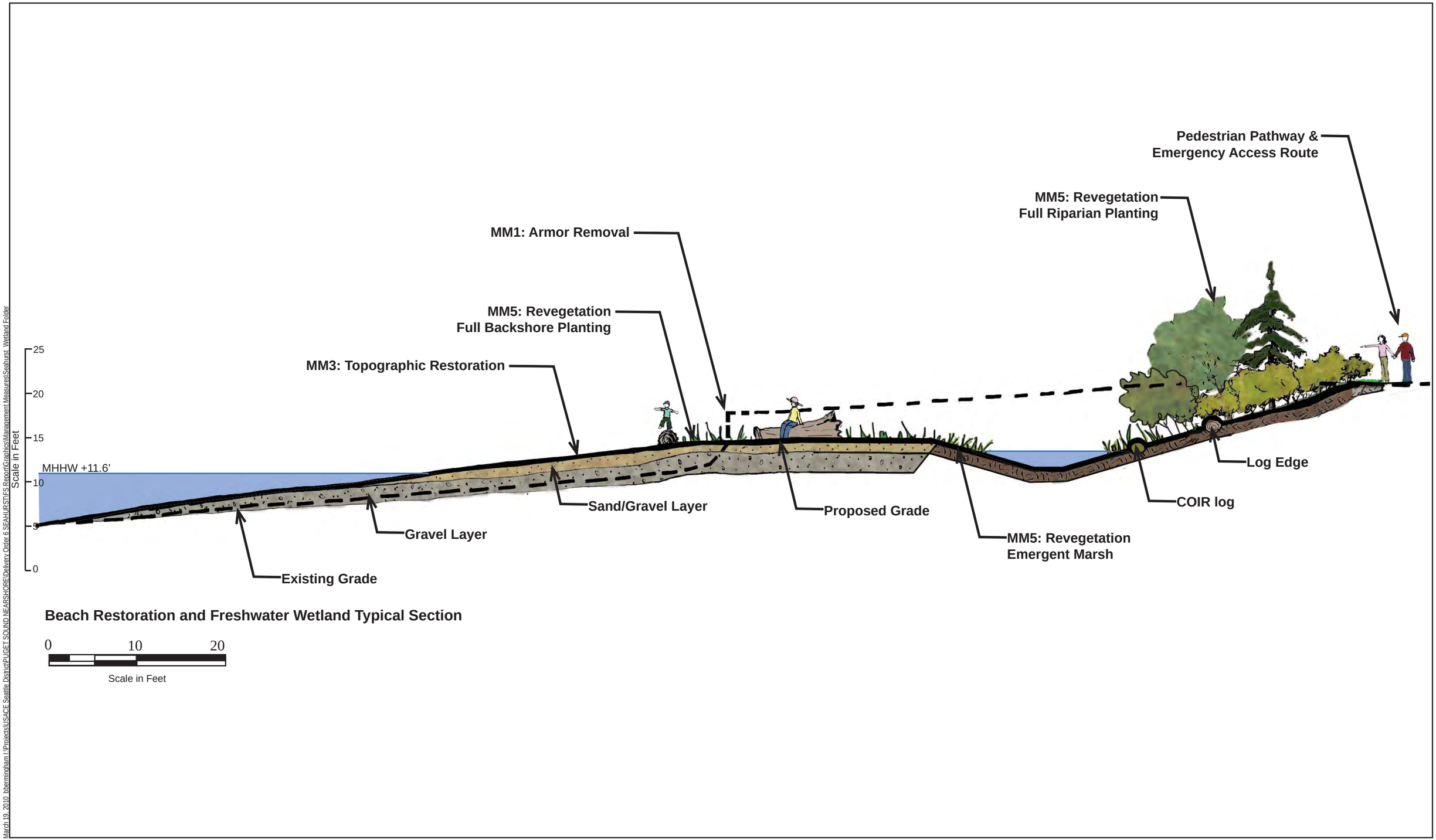

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Figure 9
Management Measures 1, 2, 3, & 5 at Freshwater Wetland
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

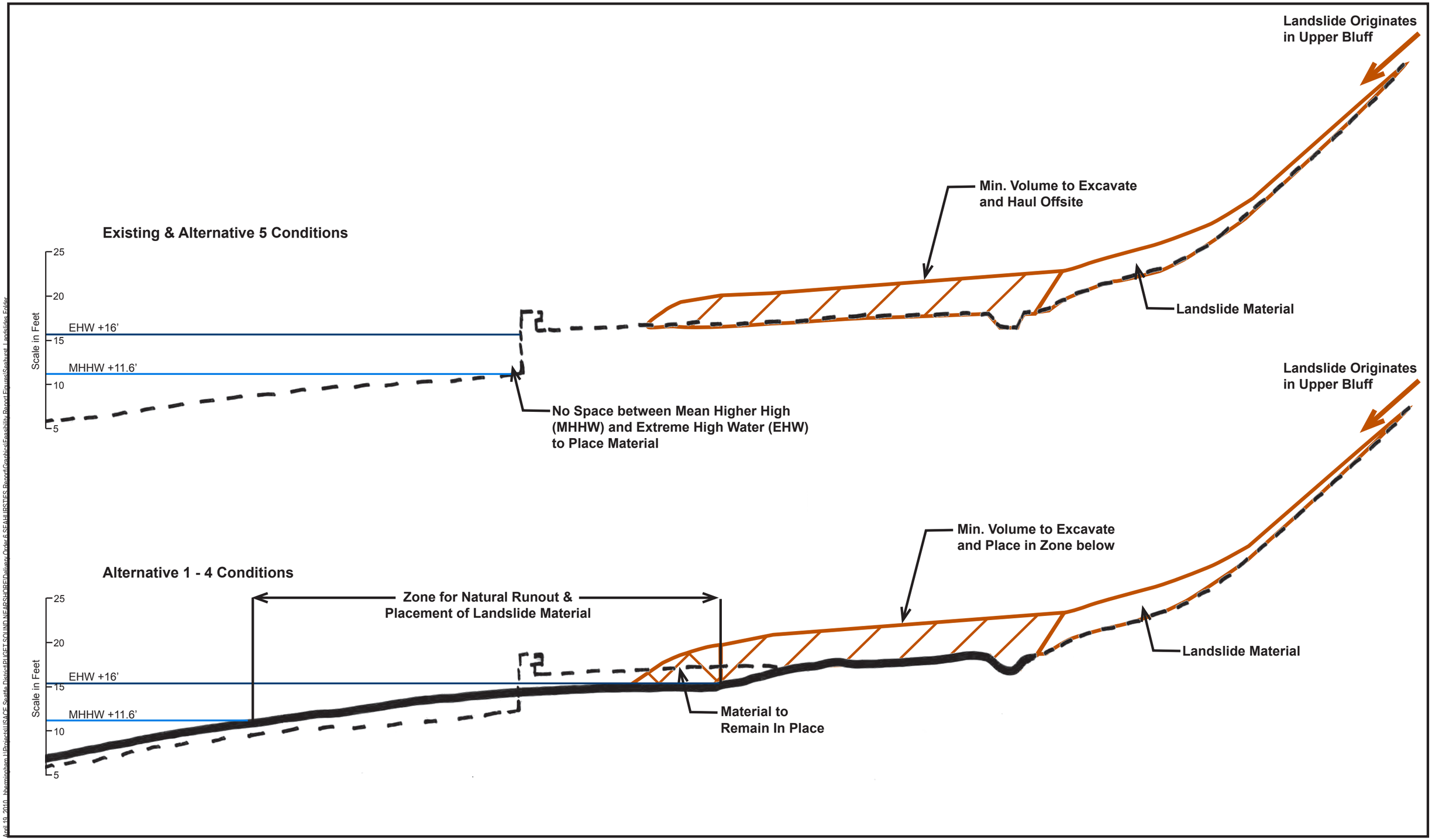

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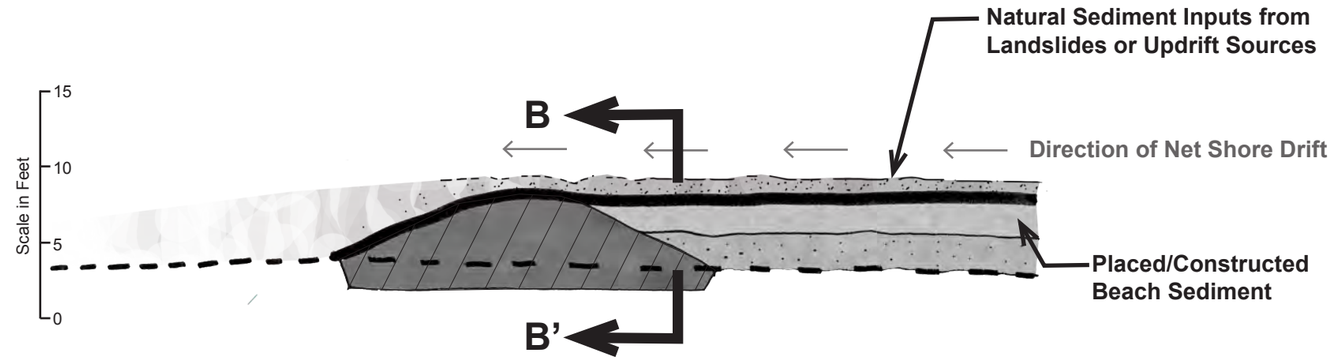
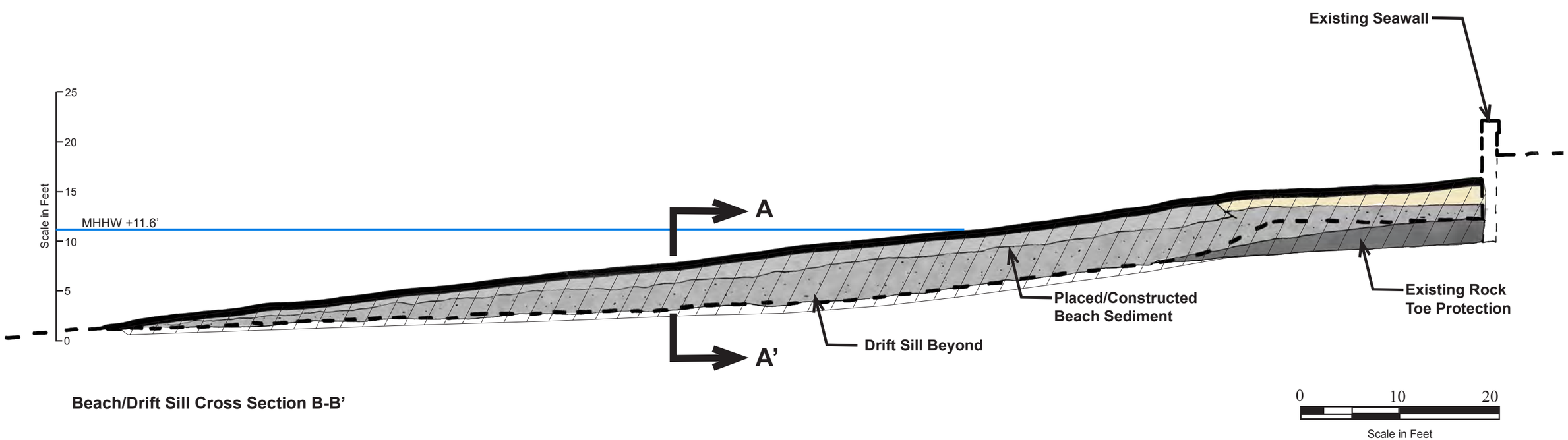
Figure 10
Landslide Material Management
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment



Drift Sill Cross Section A-A'



Beach/Drift Sill Cross Section B-B'

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Figure 11
Drift Sill Sections
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

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3.5.2.1 Alternative 1 Full (100 Percent) Armor Removal/Small Marsh

Alternative 1 (see Figure 12) represents the maximum habitat restoration option. It consists of Management Measures 1, 2, 3, 4, and 5 to the largest scale while addressing park and other constraints. .

In this alternative, all armoring is removed, and the entire north shoreline beach is restored while allowing for continued use of the park for recreation and educational uses. Because of the full armor removal, two buildings will require replacement in this alternative: the MTLB and the North Picnic Shelter. In addition to the armor removal, full beach nourishment, maximum topographic restoration, full groin removal, and full riparian/backshore restoration, with a small marsh, are proposed. North Creek is restored to a natural channel and one smaller stream to the south supports the revegetated brackish marsh. A replacement, off-channel fish ladder and holding pond for the MTLB are also provided.

The MTLB is replaced with a new facility located uphill and northeast of its current location more than 150 feet from the MHHW line. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated picnic shelter, lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens to for water quality treatment.

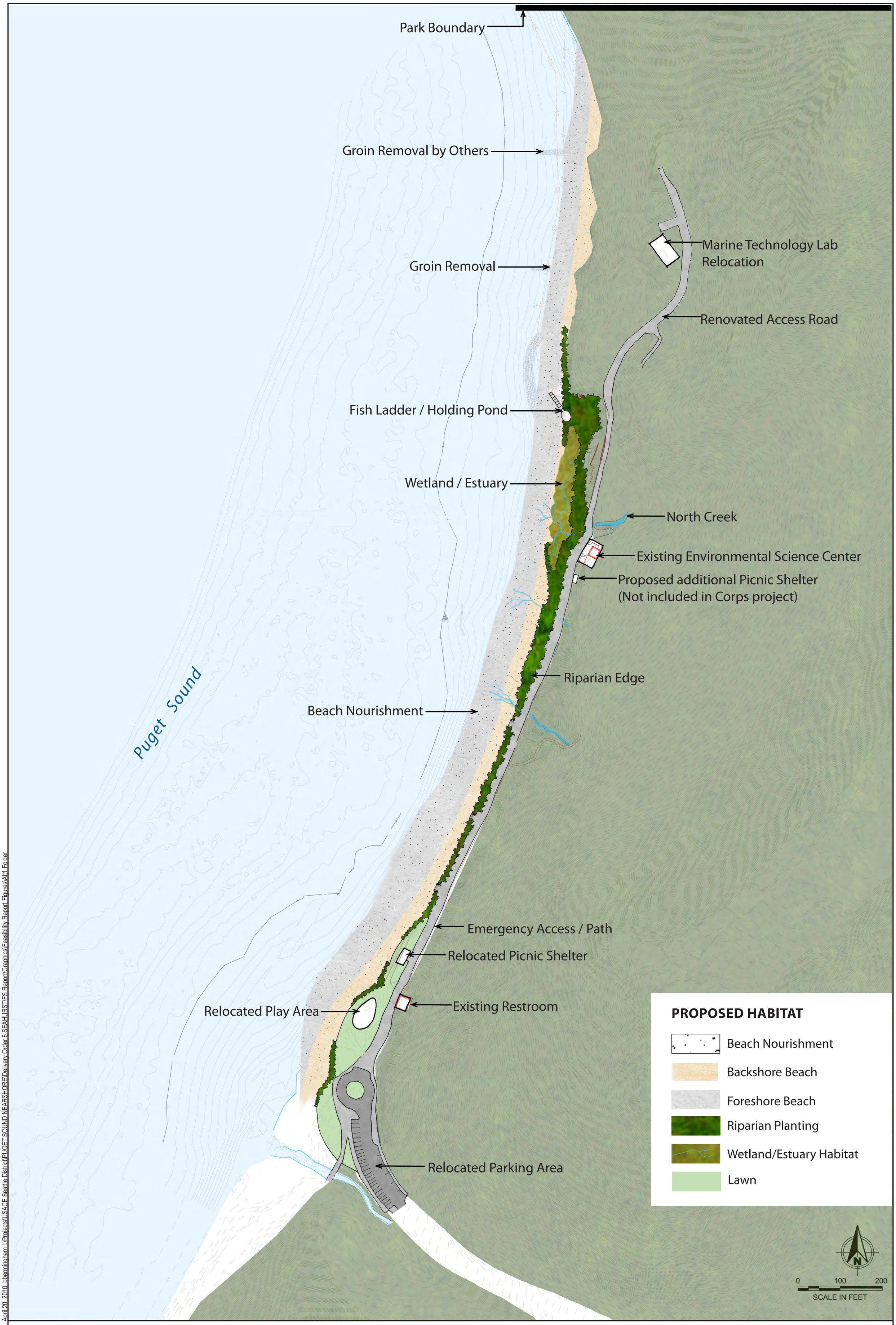

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Figure 12
Alternative 1: Full (100%) Armor Removal / Small Marsh
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.5.2.2 Alternative 2: 92 Percent Armor Removal/Maximum Marsh

Alternative 2 (see Figure 13) represents the next highest degree of habitat restoration, without relocating the MTLB. It consists of Management Measures 1, 2, 3, 4, and 5 at the largest scale possible with the MTLB left in place and addressing park and other constraints.

Alternative 2 includes removal of all armoring except at the MTLB so that this facility can remain in its current location. Armor rock is relocated landward to the toe of the remaining section of wall to maximize the extent of beach restoration in this portion of the Project Area. Tidepools are proposed in this toe armor rock for educational purposes and habitat diversity. One of the goals of this alternative is to create a restored North Creek mouth with the largest marsh possible under the site constraints. Because of the extent of armor removal in this alternative, the North Picnic Shelter and a MTLB hatchery water storage tank and piping will require replacement.

In addition to the approximately 92 percent armor removal, beach nourishment and topographic restoration are included in restored shoreline areas. A drift sill is proposed at the south end of the remaining wall to reduce long-term maintenance of the restored beach to the south. Partial beach nourishment is proposed at three locations north of the MTLB. Groin removal is proposed to include removal and reconstruction of a second drift sill north of the MTLB ramp. The drift sills are intended to provide increased beach stability to address constraints associated with park and education facilities as described in Section 3.2.2. The drift sills are designed to hold the profile of the beach as constructed. This is accomplished by building the drift sill to the same length and slope as the finished beach, and not higher than the finished beach. Natural sediment from updrift and from landslides will therefore be able to move over the restored beach and driftsill through longshore transport processes. In this way, beach sediment can continue north of the drift sills and beyond the Project Area. This is different than a groin, which is built higher than the beach profile with the intent of trapping natural beach sediment on the updrift side. See Figure 11 for the schematic drift sill cross sections.

Full riparian/backshore revegetation is proposed in all areas except where the MTLB remains. The largest marsh of the five alternatives is proposed in Alternative 2. North Creek

is restored to a natural channel along with two other smaller streams to the south that all support a revegetated brackish marsh.

This alternative allows for continued use of the park for both recreational and educational purposes. A replacement, off-channel fish ladder and holding pond for the MTLB hatchery operations is provided. It is located on the water side of the MTLB, separate from North Creek. The relocated fish ladder and holding pond are associated with a hatchery in the MTLB. This hatchery operation is for educational purposes only. The relocation of the fish ladder and holding pond is not the driving factor for retaining the armoring in this location. The armor is retained in order to allow the existing MTLB to remain in its current location. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated picnic shelter, lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens for water quality treatment.

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Figure 13
Alternative 2: 92% Armor Removal / Max. Marsh
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.5.2.3 Alternative 3: 84 Percent Armor Removal/Medium Marsh

Alternative 3 (see Figure 14) represents a more modest degree of habitat restoration than Alternative 2. It consists of Management Measures 1, 2, 3, 4, and 5, leaving approximately 8 percent more armor in place than Alternative 2, while also leaving the MTLB and North Picnic Shelter in place to simplify the overall Project and still address park and other constraints.

Alternative 3 includes removal of 84 percent of the Project Area armoring. In addition to the armoring (wall) protecting the MTLB, the armoring for the North Picnic Shelter (wall and rock) immediately south of the MTLB is left in place as well, with the beach waterward of this armoring renourished. By leaving these structures in their current locations, the cost and complexity of the Project is significantly reduced. At the same time, most of the armoring is removed, and other shoreline restoration goals are achieved at a slightly reduced scale from Alternative 2. Armor rock is relocated landward to the toe of the northern section of wall to maximize the extent of beach restoration in this portion of the Project Area. Tidepools are proposed in this toe armor rock for educational purposes and habitat diversity.

In addition to the approximately 84 percent armor removal, beach nourishment, topographic restoration, and revegetation are included. A drift sill is proposed in the same location as in Alternative 2, to reduce long-term maintenance of the restored beach to the south. Partial beach nourishment is proposed at three locations north of the MTLB in conjunction with groin removal. Groin removal is proposed to include removal and reconstruction of a second drift sill north of the MTLB ramp.

This alternative creates a restored North Creek mouth with a marsh of a medium scale, in between the marsh size in Alternatives 1 (minimum) and 2 (maximum) while responding to site constraints. The outlet of North Creek is constrained on the north side by the toe protection and return wall protecting the existing picnic shelter. Large woody debris, cobbles, and limited riparian planting are added to this toe protection armor to improve its habitat function at the creek mouth. Full riparian/backshore restoration is proposed in all areas except where armoring remains. Where armoring remains, partial riparian/backshore

revegetation is proposed. North Creek is restored to a more natural channel along with two other smaller streams to the south that all support a revegetated brackish marsh.

This alternative allows for continued use of the park for both recreational and educational purposes. A replacement, off-channel fish ladder and holding pond for the MTLB hatchery operations is provided. It is located on the water side of the MTLB, separate from North Creek. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens for water quality treatment.

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Figure 14
Alternative 3: 84% Armor Removal / Medium Marsh
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.5.2.4 Alternative 3A: 84 Percent Armor Removal/Freshwater Wetland

Alternative 3A (see Figure 15) is similar to Alternative 3 in most respects, but replaces the tidal salt marsh with a freshwater wetland of smaller size. This alternative represents a more modest degree of habitat restoration than Alternative 2, and addresses risk and uncertainty issues with the tidal marsh in Alternative 3. It consists of Management Measures 1, 2, 3, 4, and 5, leaving approximately 8 percent more armor in place than Alternative 2, while also leaving the MTLB and North Picnic Shelter in place to simplify the overall Project and still address park and other constraints.

Alternative 3A consists of removal of approximately 84 percent of the Project Area armoring. In addition to the armor (concrete wall and rock) protecting the MTLB, the armor for the North Picnic Shelter (wall and rock) immediately south of the MTLB is left in place as well. This latter section of shoreline includes beach nourishment over the armor. By leaving these structures in their current locations, the cost and complexity of the Project is significantly reduced as compared to Alternatives 1 and 2. At the same time, most of the armor is removed, and other shoreline restoration goals are largely achieved. Armor rock waterward of the MTLB is relocated landward to the toe of the wall to maximize the extent of beach restoration. Tidepools are proposed in this toe armor rock for educational purposes and habitat diversity.

In addition to the approximately 84 percent armor removal, beach nourishment, topographic restoration, and revegetation are included. A drift sill is included in order to reduce long-term maintenance of the restored beach to the south. Partial beach nourishment is proposed at three locations north of the MTLB in conjunction with groin removal. The northern groin will be removed by the sewer district as mitigation for their shoreline sewer upgrade. For the southern groin, partial removal is proposed with shortening and reconstruction into a shorter drift sill in association with the nourishment described above.

This alternative creates a restored North Creek mouth with a freshwater wetland of a small scale, while responding to site constraints. This freshwater wetland approach is intended to address uncertainties and risks associated with creating a regularly tidally-inundated wetland in this location, particularly with the armoring in place and new return wall for the North

Picnic Shelter. The outlet of North Creek is proposed to be oriented in a southwesterly direction downstream of the proposed culvert under the main path. The wetland will consist of a shallow, widened swale that collects the freshwater from North Creek and two small perennial streams to the south. The wetland swale would be 15 to 35 feet wide and approximately 300 feet long. The outlet of the proposed freshwater wetland would be designed to flow through the backshore berm to the foreshore beach face in a natural manner, without any hard structures, similar to the existing creek mouth at South Creek. Riparian vegetation would border the wetland on the upland side, and backshore vegetation would border the wetland on the beach side. It is anticipated that the wetland will be inundated with marine water that tops the backshore berm crest at certain times of year when very high tides occur. The natural stream mouth that forms at the wetland outlet will also provide a mixing zone for freshwater and saltwater.

Full riparian/backshore restoration is proposed in all areas except where armoring remains. Where armoring remains, partial riparian/backshore revegetation is proposed.

This alternative allows for continued use of the park for both recreational and educational purposes. A replacement, off-channel fish ladder and holding pond for the MTLB hatchery operations is provided. It is located on the water side of the MTLB, separate from the North Creek. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens for water quality treatment.

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Figure 15
Alternative 3a: 84% Armor Removal / Freshwater Wetland
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.5.2.5 Alternative 4: 77 Percent Armor Removal/No Marsh

Alternative 4 (see Figure 16) represents a more modest degree of habitat restoration, and a further simplified Project than Alternative 2, 3, and 3A. It consists of Management Measures 1, 2, 3, and 5, leaving approximately 15 percent more armor in place than Alternative 2 does, while also leaving the MTLB and North Picnic Shelter in place to simplify the overall Project and still address park and other constraints. It is differentiated from Alternatives 3 and 3A by the following: it does not include a salt marsh or freshwater wetland at the north creek mouth; it does not include groin removal and beach nourishment north of the MTLB; and it leaves rock armor in place waterward of the wall protecting the MTLB.

Alternative 4 includes removal of approximately 3/4 of the Project Area armoring. In addition to the wall and rock armor protecting the MTLB, the armoring for the North Picnic Shelter immediately south of the MTLB is left in place as well, with the beach waterward of this armoring renourished. No beach nourishment is proposed directly in front of or north of the MTLB, and no groin removal is proposed. North Creek and two other small creeks south of it are exposed at the high tide beach, with no provisions to create low energy conditions to support marsh habitat. By leaving more armoring in its current locations and not including any marsh habitat at the creek mouth, the complexity of the Project is further reduced as compared to Alternative 3.

In addition to the approximately 77 percent armor removal, beach nourishment, topographic restoration, and revegetation are included. A drift sill is proposed in the same location as in Alternatives 2, 3, and 3A in order to reduce long-term maintenance of the restored beach to the south. This alternative creates a restored North Creek mouth that outfalls to the exposed beach face. The outlet of North Creek is constrained on the north side by the toe protection and return wall protecting the existing picnic shelter. Large woody debris, cobbles, and limited riparian planting are added to this toe protection armor to improve its habitat function at the creek mouth. Full riparian/backshore restoration is proposed in all areas except where armoring remains. Where armoring remains, partial riparian/backshore revegetation is proposed.

This alternative allows for continued use of the park for both recreational and educational purposes. A replacement, off-channel fish ladder and holding pond for the MTLB hatchery operations is provided. It is located on the water side of the MTLB, separate from North Creek. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens for water quality treatment.

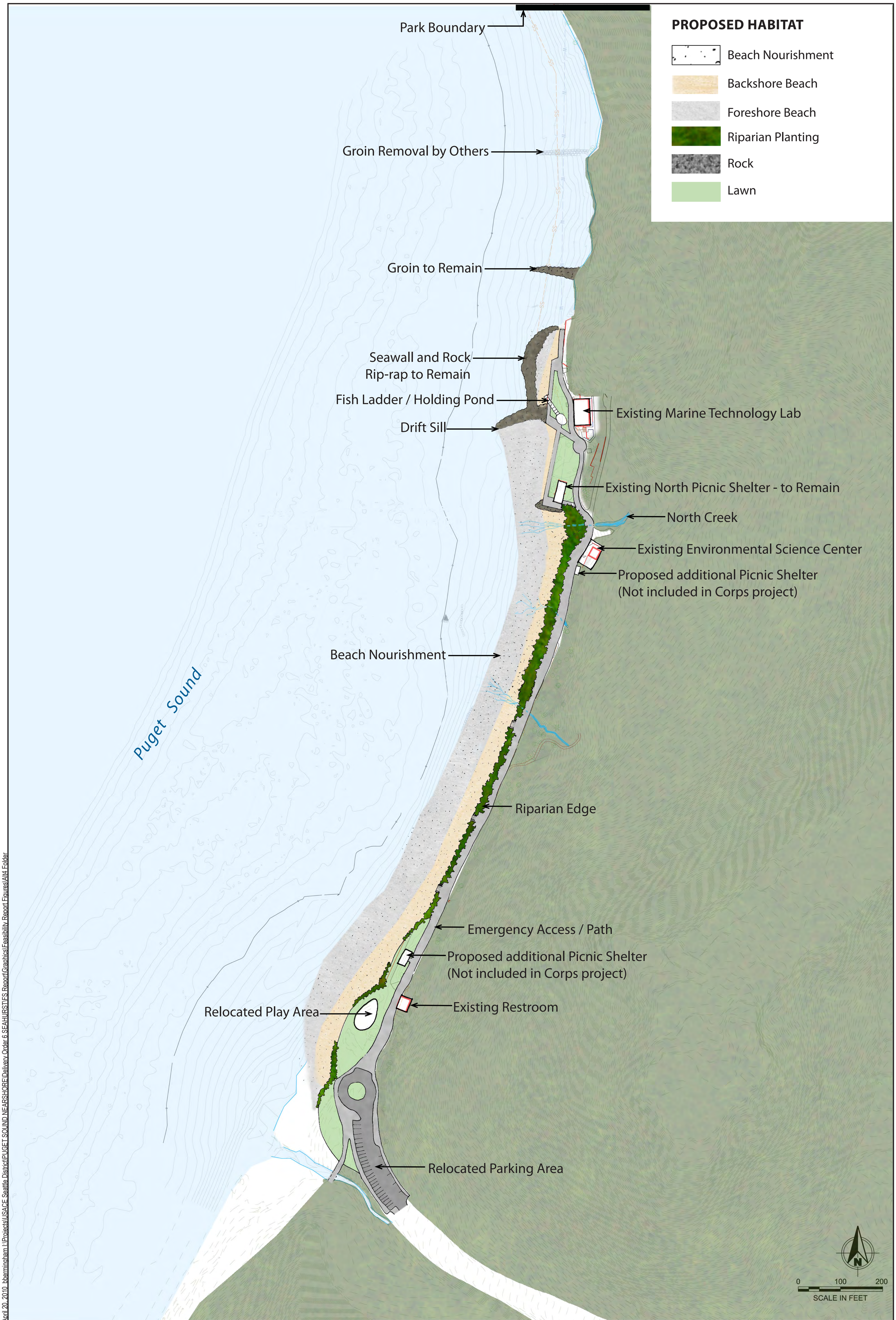

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Figure 16
Alternative 4: 77% Armor Removal / No Marsh
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.5.2.6 Alternative 5: Very Limited (19 Percent) Armor Removal/Beach Nourishment Only

Alternative 5 (see Figure 17) represents the least ecological benefit and the least change from existing conditions, with the entire seawall and adjacent pedestrian pathway remaining. It consists of Management Measures 1 (very limited), 2, and 5 (partial only).

Armor removal in this alternative is limited removal of two rock structures that cover buried gabion baskets from former middle and south perched beaches. All concrete seawall and toe protection rock remains. Extensive beach nourishment occurs from the south to the north end of the Project Area. The footprint of the beach nourishment extends further waterward than in the other four alternatives because no wall armoring is removed, which would otherwise allow the beach to be lowered and moved landward. Beach nourishment is intended to cover rock toe protection armoring. No groin removal is included in this alternative. Revegetation is limited to partial riparian/backshore plantings separated by the existing wall armoring. All riparian plantings would occur above and behind the existing wall. All backshore plantings would occur on the upper surface of the beach nourishment on the waterward side of the wall. No marsh revegetation is proposed.

This alternative represents the least change to the park and its recreation and educational uses. No replacement or relocation of park or education facilities is proposed in this alternative.

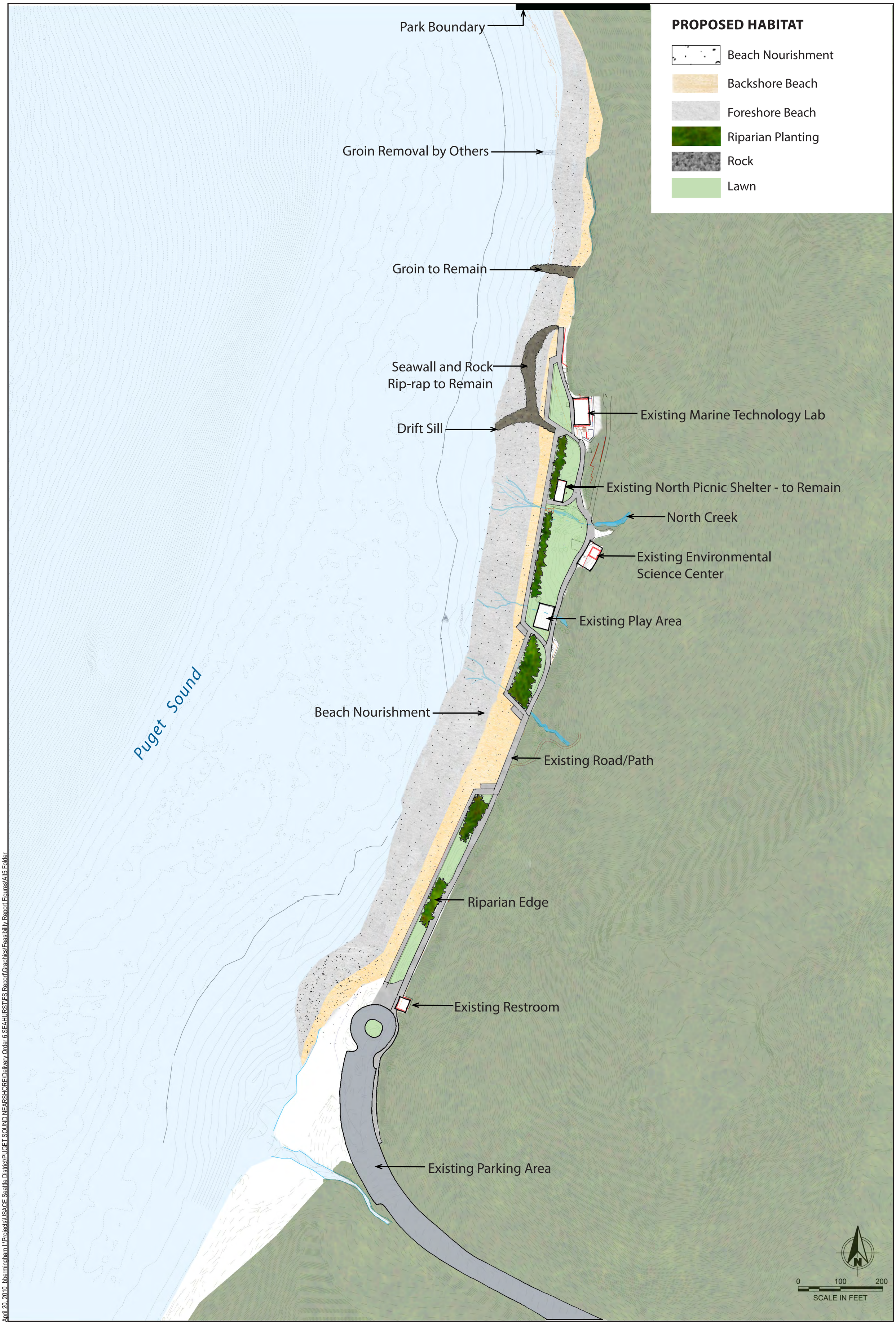

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Figure 17
Alternative 5: Limited (19%) Armor Removal / Nourishment Only
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

3.6 Alternative Plan Evaluation

The alternative plans were evaluated for their potential results in addressing the specific problems, needs, and objectives of the study. This evaluation focused on ecosystem benefits, which are measured in metrics that reflect the quantities (counts), areal extent, length, productivity, and value of habitats that are restored or maintained. Evaluation of alternative plans was accomplished consistent with USACE guidelines on the planning process and requirements as outlined in ER-1105-2-100 for ecosystem restoration projects.

3.6.1 Ecological Benefits

To evaluate the ecological benefits provided through various restoration activities considered for the Project, a quantitative scoring system was developed. The scoring system provides a scientifically-based, area-weighted method for estimating and comparing the habitat function benefits provided by the various restoration activities considered. The area-weighted approach is similar to the Habitat Equivalency Analysis (HEA) used for Natural Resource Damage Assessments (NRDA) to determine habitat function (e.g., Iadanza 2001; Wolotira 2008).

The ecological benefits analysis was conducted using the following conceptual foundation. The nearshore environment is composed of multiple habitat components (from riparian to aquatic) that function differently for different resource groups. The conditions in each habitat component affect the degree to which functions are provided. Restoration actions can include the addition or removal of habitat components, as well as the conditions in each habitat component. The functions provided also depend upon the size of each habitat component, such that the larger the component, the more functions are provided. Lastly, the functions provided will change over time depending upon the integrity of ecosystem processes (e.g., sediment supply and sediment transport) to sustain the habitat conditions. The scoring system developed for this analysis is not an exact science. It was developed using the best available science for Puget Sound nearshore species, adapted to the Project Area. While a quantitative approach was used, this is not meant to imply that the level of benefit from each specific action can be perfectly compared to other specific actions.

The scoring system incorporates each of the factors listed above: resource groups using the nearshore, habitat components, habitat elements to describe conditions, function over time, and area of each habitat component. The steps to developing the scoring system are summarized here and described in detail in subsequent sections.

1. The first step in developing the scoring system was to identify the biological resource groups for whom ecological benefits are to be estimated and the marine nearshore habitat components that would be affected by the restoration activities.
2. Next, the relative habitat function for each habitat component was assigned separately for each resource group and combined to provide one composite score. Relative habitat function indicates the level of function each habitat component contributes to each resource group on a scale from no function to maximum function.
3. The third step was to modify the relative habitat function scores based on the presence of habitat elements that increase or decrease the ecological function of one or more habitat components. The habitat element modifiers were included separately for separate portions of the restoration.
4. The fourth step was to calculate the area of each habitat component. Area was calculated in acres using AutoCAD.
5. The next step was to multiply the relative habitat function of each habitat component by the calculated acreage of the habitat component.
6. The scores calculated in that step were modified by multipliers assigned based on the presence of habitat elements that increase or decrease the ecological function of one or more habitat components.
7. The seventh step was to calculate the annual ecological function over the next 50 years by multiplying the score from the preceding step using a relative restoration function. The relative restoration function indicates the level of function each portion of the Project is expected to provide relative to the maximum function it would provide during the 50-year time period.
8. The final step was to add together all of the resulting scores to provide one score for each alternative.

3.6.1.1.1 Resource Groups Included in Evaluation

Seahurst Park is situated along the shoreline of Puget Sound in what is commonly referred to as the "marine nearshore." The Puget Sound marine nearshore is the transitional zone between terrestrial upland habitats and marine aquatic habitats. It includes riparian upland habitats, intertidal habitats, and shallow aquatic habitats. The marine nearshore supports many processes that fuel the Puget Sound food chain. It is used by a diverse community of fauna and flora, including fish, shellfish, marine mammals, invertebrates, shorebirds, terrestrial wildlife, eelgrass, macroalgae, marsh vegetation, and terrestrial plants and trees.

The scoring system was developed to account for how different species groups use the various habitat components of the marine nearshore. The relative amount of function provided by each habitat component was assigned separately for three resource groups: juvenile Chinook salmon, forage fish (surf smelt and sand lance), and all other fauna and flora combined. Chinook salmon and forage fish were considered separately in this analysis due to their reliance on nearshore habitats and apparent vulnerability to alterations, as well as their protection status. Chinook salmon have been a focus of nearshore restoration efforts throughout Puget Sound and in this Project because they are listed as threatened under ESA. Chinook salmon rear and migrate through the estuarine and marine nearshore habitats during their initial outmigration from freshwater environments (Simenstad et al. 1982; Healey 1982; Brennan et al. 2004). Among the Pacific salmon species, juvenile Chinook salmon are considered the most dependent on estuarine and nearshore habitats (Healey 1982; Fresh 2006). In addition, there is evidence indicating that juvenile salmon growth during their early marine life history influences their subsequent marine survival (Holtby et al. 1990; Hargreaves 1997; Beamish and Mahnken 1998; Murphy et al. 1998; Tovey 1999; Duffy et al. 2003).

Forage fish are small, schooling fish that are key prey items for larger predatory fish, including salmon, and wildlife in the marine food web (Penttila 2007). Two forage fish species, surf smelt and Pacific sand lance, require high intertidal habitats with fine-grained substrates (generally 0.25-inch and smaller) for spawning. Pacific herring were not considered in this analysis. Forage fish were included in this analysis because these species are an important prey item for salmon and because they are vulnerable to shoreline

alterations that limit the availability of suitable spawning habitats (Rice 2006; Johannessen and MacLennan 2007).

To account for the diverse community of additional aquatic and terrestrial animals and plants that use the nearshore environments, these species groups were included in one additional resource group category. This category includes terrestrial fauna, marine fauna, and marine flora. The terrestrial wildlife documented in the park includes raccoons, fox, shorebirds, songbirds, raptors, and piscivorous birds such as merganser, great blue herons, and cormorants (see Section 2.4.2). The marine fauna community includes clams, such as Macoma, littleneck, and butter clams, Dungeness and red rock crab, and numerous fish species (see Section 2.4.1). The marine flora composition includes native eelgrass (*Zostera marina*) offshore of the Project Area and non-native eelgrass (*Z. japonica*) in the lower intertidal portion of the Project Area (see Section 2.3.3). An expansive bed of native eelgrass occurs between approximately 0 feet and -15 feet MLLW although a detailed survey has not yet been conducted. Small patches, generally 10 square feet or smaller, of non-native eelgrass are distributed in the lower intertidal zone of the Project Area. The macroalgae community includes *Ulva* spp., *Enteromorpha* spp., and *Fucus gardneri*.

3.6.1.1.2 Habitat Components

The Project Area was divided into ecologically distinct habitat components that provide different degrees of ecological function for the resource groups evaluated. The habitat components were determined based on their ecological functions, particularly with respect to the resource groups evaluated. Eight ecologically distinct habitat components were identified in the Project Area nearshore between 0 feet MLLW and 300 feet landward of the approximately ordinary high water line (+12 feet MLLW was used). The habitat components included in the evaluation, based on existing elevations, were:

- Low intertidal areas between 0 feet and +6 feet MLLW
- High intertidal areas between +6 feet and +12 feet MLLW
- Riprap between 0 feet and +12 feet MLLW
- Backshore areas between +12 feet and +16 feet MLLW
- Salt marsh with constructed channel between +10 feet and +16 feet MLLW
- Freshwater wetland without a constructed channel between +14 feet and +16 feet

MLLW

- Mature riparian vegetation areas within 100 feet of +12 feet MLLW
- Mature riparian vegetation areas between 100 feet and 300 feet from +12 feet MLLW

The evaluation did not extend below 0 feet MLLW because none of the restoration activities extends below that elevation. The landward margin of the evaluation was established to account for the functional contributions of riparian vegetation in close proximity to the intertidal habitats and upland alterations that occur in one or more of the alternatives evaluated.

3.6.1.1.3 Relative Habitat Function Values of Each Habitat Component

Relative habitat function values were assigned to each habitat component. These scores range from 0.0 (no function) to 1.0 (full function). The relative habitat function values were assigned to habitat components for each resource group using available information on the feeding, refuge, and spawning functions. Each resource group had one habitat component that was assigned a score of 1.0. The other habitat component scores for the resource group were assigned based on the relative function compared to the full function habitat component. There was no requirement for the minimum score to be a specific number (i.e., no requirement to assign a score of 0.0 to a habitat component).

A combined relative habitat function value for each habitat component was calculated by averaging the scores of the three contributing resource groups and normalizing the scores to a maximum score of 1.0. The average scores were normalized to a maximum of 1.0 by dividing the average of each habitat component score by the highest average score assigned.

Table 3-2 presents the relative habitat function values for each resource group and the combined score used in the evaluation calculation. The rationale for these habitat components and assigned relative habitat function values follow the table.

Table 3-2
Relative Habitat Function Values Assigned to Each Habitat Component

Habitat Component	Juvenile Salmon	Forage Fish	Additional Fauna and Flora (e.g., crabs, heron, eelgrass, macroalgae, eagles, shorebirds, resident fish, invertebrates)	Combined Value Used In Calculation
Low Intertidal (0 ft to +6 ft MLLW)	0.8	0.4	0.8	0.7
High Intertidal (+6 ft to +12 ft MLLW)	0.7	1.0	0.6	0.8
Riprap (0 ft to +12 ft MLLW)	0.1	0.1	0.2	0.1
Backshore (+12 ft to +16 ft MLLW)	0.5	0.3	0.3	0.4
Salt marsh with a constructed channel (+10 ft to +16 ft MLLW)	1.0	0.9	1.0	1.0
Freshwater wetland without constructed channel (+14 ft to +16 ft MLLW)	0.6	0.4	0.6	0.6
Mature riparian vegetation within 100 ft of +12 ft MLLW	0.4	0.3	0.4	0.4
Mature riparian vegetation between 100 ft and 300 ft of +12 ft MLLW	0.2	0.1	0.3	0.2
Riparian planting area	0.4	0.3	0.4	0.4

Low Intertidal (0 feet to +6 feet MLLW)

This habitat component includes the lowest elevations at which restoration activities are proposed. The upper margin of this habitat component was established in consideration of common spawning elevations of surf smelt and Pacific sand lance, two forage fish that spawn in the high intertidal at +6 feet MLLW and higher.

The combined relative habitat function value assigned to low intertidal habitats was 0.7. This value is based on consideration of low intertidal habitats providing high function for juvenile salmon and the additional flora and fauna resource group, but having a lower relative habitat function value for forage fish. Juvenile salmon, particularly fall Chinook and chum rearing and moving along the marine nearshore, depend upon shallow water habitats

to avoid predators and grow rapidly (Fresh and Averill 2005; King County and Washington State Conservation Commission 2000; City of Seattle 2003). Small chum salmon fry (less than 60 millimeters [mm] long) appear to migrate primarily along the shoreline in shallow water less than 2 meters in depth (Healey 1979; Simenstad et al. 1982). Use of shallow water habitats relates to predator avoidance and prey availability (Fresh 2006). As juvenile Chinook and chum salmon grow and increase in size, the depth of water and habitats they use expands (Fresh 2006; Healey 1982; Simenstad et al. 1982; Levings et al. 1986; Duffy 2003; Miller and Sadro 2003). In this ecological benefit evaluation, a maximum relative habitat function value of 0.8 was assigned to low intertidal habitats because of the shallow water conditions these areas provide and the fact that these areas are inundated and accessible to fish during longer periods of the tidal cycle than the high intertidal zone.

Little is known about forage fish biology away from their high intertidal spawning grounds (Penttila 2007). Surf smelt and sand lance are small schooling fish that are commonly observed using shallow nearshore habitats during non-spawning periods (e.g., Brennan et al. 2004); however, the contribution of low intertidal habitats to their feeding and growth is not well understood. A relative habitat function value of 0.4 was assigned for forage fish use of low intertidal habitats.

The additional fauna and flora resource group considered includes aquatic and terrestrial species. Low intertidal habitats are more accessible to aquatic organisms than high intertidal areas and are wetted for long enough periods of the tidal cycle to support macroalgae, eelgrass, clams, and other organisms that cannot survive at higher intertidal elevations. Low intertidal habitats also have ecological value for shorebirds, eagles, and other wildlife that use the areas for feeding during low tide periods. For these reasons, a relative functional habitat value of 0.8 was assigned for the additional fauna and flora resource group use of low intertidal habitats.

As described earlier, a combined relative habitat function value was calculated by averaging the scores of the three resource groups and normalizing it to arrive at a maximum relative habitat function score of 1.0 for the highest scoring habitat component. In this evaluation of the low intertidal habitat component, the average of the three resource group values was 0.67. To normalize the scoring range, this value was divided by the average calculated for

the highest relative functioning habitat component. In this evaluation, the habitat component with the highest relative habitat function was salt marsh habitats with an average value of 0.97. Dividing 0.67 by 0.97 yielded a combined relative habitat function score of 0.7.

High Intertidal (+6 feet to +12 feet MLLW)

The high intertidal habitat component extends from +6 feet to the approximate ordinary high water level of +12 feet MLLW. High intertidal habitats were assigned a combined relative habitat function value of 0.8. This value is based on consideration of high intertidal habitats providing maximum function for forage fish, and moderate to high relative habitat function value for juvenile salmon (0.7) and the additional flora and fauna research group (0.6).

As described above, juvenile salmon, particularly Chinook and chum, depend upon shallow water habitats to avoid predators and grow rapidly. High intertidal areas are highly used by juvenile salmon to avoid predation and for the productive prey resources in these areas. During a rising tide, the shallow water along the waterline can provide an abundance of high intertidal and terrestrial origin prey items that are inundated by the rising water. Because these areas are accessible by juvenile salmon during a shorter portion of the tidal cycle, a slightly lower relative habitat function value was assigned compared to the value assigned to low intertidal habitats.

For forage fish, the availability of high intertidal habitats with appropriately sized and textured spawning substrate at a certain tidal elevation along the shoreline is critical for their spawning success (Penttila 2007). Surf smelt and Pacific sand lance spawn in the upper one-third of the tidal range. Surf smelt generally spawn in areas with mixed sand and gravel substrate with a bulk of the material between 1 and 7 mm. Pacific sand lance spawn on smaller sandy substrate with diameters of 3 mm or smaller. As obligate spawners in these habitats, these forage fish require high intertidal beaches for survival, and therefore, the maximum relative habitat function value was assigned to high intertidal areas.

A slightly lower relative habitat function value was assigned to high intertidal habitats in consideration of ecological functions for the additional fauna and flora resource group. The

high intertidal habitats are less accessible to aquatic organisms than low intertidal areas, but are more accessible to shorebirds and terrestrial wildlife. High intertidal habitats typically support less macroalgae growth and are above the elevation range that eelgrass grows in.

Riprap (0 feet to +12 feet MLLW)

Riprap is large angular rock that is placed along some shorelines to protect against shoreline erosion. While this material can effectively protect shoreline areas for upland uses, riprap is highly disruptive to nearshore processes and often causes long-term degradation of habitats. Due to the overall detrimental effects of riprap on nearshore processes, a relative habitat function value of 0.1 was assigned as a combined score.

Like other types of shoreline armoring, riprap placed along the shoreline acts to disconnect eroding bluffs from the intertidal zone. MacDonald et al. (1994) stated that of all the negative impacts of shore armoring in Puget Sound, sediment impoundment has been noted as probably one of the most significant, especially when armoring occurs along feeder bluffs. In addition, riprap and other shoreline armoring often increase wave energy at the face of the structure, thus increasing erosion and scour of beach sediments at the armor face and leading to decreased elevations and changes in habitat structure and their resulting biota (Williams and Thom 2001; Downing 1983). The impacts of shoreline armoring are strikingly apparent at Seahurst Park. The combination of seawall-induced erosion from reflected wave energy and loss of sediment supply resulted in a 0.5- to 2.5-foot lowering of the beach between 1970 and 2008 in the central portion of the Project Area (Johannessen 2010). The majority of the beach lowering in this area was 1.0 to 1.5 feet.

Riprap and other shoreline armoring also bury or otherwise limit the availability of shallow intertidal habitats that are used by juvenile salmon to avoid predators and forage. Riprap is unsuitable substrate for spawning for surf smelt and Pacific sand lance, and, therefore, the presence of riprap decreases the availability of suitable spawning habitat. Riprap was assigned a relative habitat function value of 0.1 for juvenile salmon and forage fish.

As detrimental as riprap is to natural nearshore processes, the altered habitat setting does provide habitat for some species. The hard surfaces of riprap provide suitable substrate for macroalgae growth. In higher intertidal areas, rockweed (*Fucus garderi*) and laver (*Porphyra*

spp.) commonly grow. At lower intertidal elevations, sea lettuce (*Ulva* spp.) and the green algae, *Enteromorpha* spp., can grow on riprap. This macroalgae growth can support an invertebrate community that is prey for other species. Riprap also creates large spaces between rocks that provide habitat for many invertebrate and fish species, including potential predators to juvenile salmon and forage fish. For the additional fauna and flora resource group, a score of 0.2 was assigned.

Backshore (+12 feet to +16 feet MLLW)

The backshore habitat component extends from the approximate ordinary high water level (+12 feet MLLW) to +16 feet MLLW, which was considered the lowest elevation supporting terrestrial vegetation. The backshore habitat component was assigned a combined relative habitat function value of 0.4. This value is based on consideration of these habitats providing some accessible habitat for juvenile salmon, forage fish, and other aquatic species, as well as highly accessible habitats for terrestrial wildlife species. In addition to the habitat these areas provide, backshore areas contribute to the stability of the beach and provide increased sediment volume that over the long term contributes to intertidal beach areas that contain fine sediment at natural slopes. Backshore habitats are also important areas for the transition between upland and aquatic habitats. Backshore habitats provide locations for large woody debris and beach-wrack (vegetative debris deposited by an ebbing tide, consisting mostly of marine algae and organic matter from terrestrial riparian sources such as wood and leaves) to accumulate. Large woody debris acts to retain and accumulate sediment, as well as promote the establishment of vegetation which stabilizes the sediment and increases benthic invertebrate production and habitat complexity (Sobocinski 2003). The benthic invertebrate community in these backshore habitats includes terrestrial amphipods (beach-hoppers), aquatic amphipods, insects, oligochaetes, and nematodes (Toft 2009).

Backshore habitat areas were assigned a score of 0.5 for juvenile salmon in consideration of the habitat component's contribution to prey production and habitat when accessible. Backshore habitat areas support fringe marshes that are often used by juvenile salmon when accessible and that contribute to the production of juvenile salmon prey items. The grasses, sedges, and other vegetation that grow in these habitats support the production of insects and other terrestrial prey organisms that end up in the water. This vegetation also contributes

organic matter and detritus that fuels the base of the nearshore food web (Simenstad 1983; Brennan and Culverwell 2004; Williams et al. 2001; Sobocinski 2003).

The backshore habitat component was assigned a relative habitat function value of 0.3 in consideration of the functions it provides for forage fish. Surf smelt and Pacific sand lance spawn in the upper one-third of the intertidal zone (Penttila 2007), which includes some habitats above +12 feet MLLW that may be inundated during only the highest tides of the tidal cycle, specifically spring and neap tides. The forage fish spawn in these areas during the period they are wetted. The deposited eggs remain stuck to the sand and gravel substrate and incubate for a period of 2 to 4 weeks, depending on temperature. During this incubation period, the eggs are often out of the water, but remain sufficiently wetted by moisture in the interstitial spaces of the sand and gravel substrate. Seeps of water percolating through the beachface that are fairly common at the site act to keep the eggs wetted. Overhanging riparian vegetation that casts shade across the intertidal zone also keeps eggs from drying out and has been shown to support higher egg survival rates (Penttila 2002; Rice 2006).

The backshore habitat component for the additional fauna and flora resource group was assigned a relative habitat function value of 0.3 in consideration of the habitat functions it provides. These habitats are more accessible to terrestrial species than lower elevations.

Salt Marsh with a Constructed Channel (+10 ft to +16 ft MLLW)

Salt marsh is a habitat component that does not currently exist in the Project Area, but could be included in the restoration design because of the site configuration. The salt marsh considered in this evaluation is one fed by one or more small perennial and intermittent streams and running parallel to the beach berm. A channel would be constructed to provide connection to the intertidal zone at approximately +10 feet MLLW. The salt marsh would be planted with native salt marsh vegetation to accelerate the establishment of the marsh.

Salt marshes with open channel connections to the intertidal zone can be highly productive and contribute to ecosystem services and processes such as production of benthic invertebrates, insects, detritus inputs from decaying plant matter, and nutrient cycling (Schlenger et al. In Review). Detritus from the aquatic zone, such as marsh-exported vegetation and wrack, provides a key source of nutrients that, along with terrestrially-

derived vegetation, drives the marine nearshore food web (Simenstad 1983; Brennan and Culverwell 2004; Williams et al. 2001; Sobocinski 2003). Salt marshes are formed in estuaries at the mouths of creeks or rivers where sediments accumulate in high intertidal or supratidal backshore elevations. Salt-tolerant marsh vegetation grows on the deposited sediments and provides habitat structure. Due to the high value of salt marshes to the resource groups, this habitat component was assigned a combined relative habitat function value of 1.0. This is the highest combined relative habitat function value.

Juvenile salmon benefit directly by the prey resources that are produced in salt marshes. Several benthic invertebrates and insects preyed upon by juvenile salmon can be produced in high abundance in salt marshes (Seliskar and Gallagher 1983). Salt marshes can also provide protected shallow water refuge areas for juvenile salmon to further acclimate to the marine environment and avoid large predatory fish that cannot access the shallower areas. Recent studies have documented the use of these sub-estuaries, also known as pocket estuaries, by juvenile salmon from other stream and river systems (Hirschi et al. 2003; Beamer et al. 2003). The availability of such habitats is hypothesized to increase juvenile salmon growth in the nearshore and subsequently increase their likelihood of survival throughout the marine life stage. Due to these functions that salt marshes provide for juvenile salmon, a relative habitat function value of 1.0 was assigned.

Salt marsh habitats also provide high function for forage fish. Forage fish are commonly found in schools with juvenile salmon and move into small sub-estuary marshes (Schafer and Ritchie 2008). Forage fish are expected to realize the same foraging and predator avoidance benefits as described for juvenile salmon. In addition, the contributions of salt marshes to the base of the Puget Sound food web also benefit forage fish. The relative habitat function value assigned to salt marshes for the forage fish resource group was 0.9.

Salt marshes support primary production and provide habitat for fish and wildlife among the additional flora and fauna resource group. Marsh vegetation produces organic matter and detritus to fuel the base of the nearshore food web. Due to these functions, salt marshes were assigned a score of 1.0 for additional flora and fauna.

Freshwater Wetland without a Constructed Channel (+14 ft to +16 ft MLLW)

Freshwater wetland is a habitat component that does not currently exist in the Project Area, but could be included in the restoration design because of the site configuration. The freshwater marsh considered in this evaluation is one fed by one or more small perennial and intermittent streams and formed in the backshore behind the foreshore beach berm. The vegetation in the wetland would colonize the area from other seed sources. The wetland would not include a constructed channel to the intertidal zone; rather, water from the creek(s) would maintain a constructed flow in the berm or forge its own channel, or just infiltrate through the beach berm to ultimately flow into the intertidal zone. Such a connection is expected to be intermittent. During high water level storm events, the wetland would be expected to be inundated by saltwater. Thus, the marsh can be expected to support salt-tolerant vegetation along part or all of its extent.

Freshwater wetlands without a constructed channel to the intertidal zone provide some similar functions as salt marsh, but generally provide a lower relative habitat function than salt marshes. This habitat component was assigned a combined relative habitat function score of 0.6. This combined score is based on individual scores of 0.6 assigned to the resource groups of juvenile salmon and additional fauna and flora. The score for the forage fish resource group was 0.4.

Mature Riparian Vegetation within 100 feet of +12 feet MLLW

Riparian vegetation along the Puget Sound shoreline provides benefits for terrestrial and aquatic portions of the nearshore. Riparian vegetation functions to maintain soil stability and improve water quality (Brennan and Culverwell 2004). Riparian vegetation also provides habitat for wildlife including birds, small mammals, reptiles, and amphibians. Riparian vegetation contributes to habitat quality and function in aquatic areas through the introduction of large woody debris, which serves as habitat structure and provides organic matter to support lower trophic levels of the food web (Maser and Sedell 1994).

Riparian vegetation further contributes to production of prey items for juvenile salmon and other aquatic organisms through the process of terrestrial-origin insects being blown from trees and into the water. Brennan et al. (2004) found that a significant portion of juvenile salmon diets was highly influenced by prey from terrestrial sources (especially in the

summer and early fall). The importance of riparian vegetation to the diet of juvenile salmon in the nearshore has also been described in other recent publications, including Levings and Jamieson (2001), Brennan (2007), and Toft and Cordell (2006). Riparian vegetation also contributes fallen leaves, branches, and other organic matter that add to the detritus-based food web.

In consideration of the ecological benefits associated with mature riparian vegetation, a combined relative habitat function value of 0.4 was assigned to riparian vegetation within 100 feet of +12 feet MLLW. The contributing values assigned to juvenile salmon, forage fish, and additional resource groups were 0.4, 0.3, and 0.4, respectively. The 100-foot distance from +12 feet MLLW was established as the landward margin of this habitat component because this riparian band is most closely connected to the aquatic portion of the nearshore. The distance is a commonly applied buffer in shoreline management to protect habitat function.

Mature Riparian Vegetation between 100 feet and 300 feet of +12 feet MLLW

Riparian vegetation that is separated from the shoreline is still believed to provide some of the benefits described above for adjacent riparian vegetation. It is believed that terrestrial-origin prey separated from the shoreline can get transported into aquatic areas. Brennan et al. (2009) documents several scientific studies that document ecological benefits to the marine nearshore from riparian vegetation that is more than 100 feet from the shoreline. A combined relative habitat function value of 0.2 was assigned to marine riparian vegetation between 100 feet and 300 feet from the shoreline. The contributing values assigned to juvenile salmon, forage fish, and additional resource groups were 0.4, 0.1, and 0.3, respectively.

Riparian Planting Area

The restoration alternatives considered include the opportunity to plant riparian vegetation within 100 feet of +12 feet MLLW. Over time, these areas are expected to grow and provide the same function as the mature vegetation in the park currently provides. For this reason, the riparian planting areas were assigned the same combined relative habitat function score as mature riparian vegetation (0.4). The fact that the immature riparian plantings will not immediately provide the same function is addressed through the use of restoration

trajectories, which account for the temporal aspects of ecological benefits over the 50 years following Project construction. These trajectories are described in Section 3.6.1.1.5.

3.6.1.1.4 Habitat Element Multipliers Used in Evaluation

The ecological benefits provided by the habitat components can be higher or lower depending upon the presence or absence of additional habitat elements contributing to the habitat component function and the function of nearshore ecosystem processes that extend beyond the Project Area. To account for the influence on habitat function that these additional habitat elements contribute, the ecological benefit framework incorporated these elements by assigning a multiplier to modify the scores assigned to affected habitat components. Table 3-3 presents the habitat elements included in the ecological benefit framework and the assigned multiplier score for each. These scores were included in the ecological benefit calculation by adding all multipliers that are relevant for a habitat component, adding 1.0 to that sum, and multiplying by the habitat component score calculated. The rationale for each habitat element multiplier score and the habitat components to which they were applied are described following the table.

Table 3-3
Habitat Elements Included As Multipliers to Habitat Component Scores

Habitat Element	Assigned Multiplier	Affected Habitat Components
Stream Mouth Restoration	0.02 when stream mouths removed from pipes	In portion of park where shoreline armoring removed, multiplier applied to: • Low intertidal • High intertidal • Backshore
Salt Marsh Creation	• 0.30 for large • 0.20 for medium • 0.00 for small	• Salt marsh
	0.10	• High intertidal • Low intertidal
Freshwater Wetland Creation	0.10	• High intertidal • Low intertidal
Scarcity of Habitat in Region	0.50	• Salt marsh
	0.25	• Freshwater wetland
Connection of Eroding Bluffs to Intertidal Zone	0.25 if bluff connected	In portion of park where shoreline armoring removed, multiplier applied to: • Low intertidal • High intertidal • Backshore
Groin Removal	• 0.05 for full removal • 0.01 for partial removal	• High intertidal • Backshore
Addition of Sand, Gravel, and Small Cobble Substrate	0.10	• High intertidal • Low intertidal
Revegetation	0.3 for full revegetation	• Riparian planting area

Stream Mouth Restoration

Three relatively small streams drain into the park shoreline south of the MTLB shoreline and north of South Creek. All stream mouths are modified and flow through the existing

seawall. North Creek is the largest of the three and drains the north drainage basin of the park (Figure 5). In line with North Creek is a concrete-lined holding pond used for acclimation of hatchery-raised juvenile salmon. The pond drains into a concrete fish ladder formed into the existing seawall and then onto a riprap-armored portion of the beach. The other two smaller streams are piped under the park trail and outfall through the face of seawall, which in this section has rock riprap at the toe. The rock covers these two stream outlet pipes where they drain onto the beach.

Restoration of the stream mouths would allow for the natural flow of water across the intertidal zone and support a more productive beach area. Restoration of the stream mouths can also allow for the establishment of small, fringing salt marsh vegetation areas. This vegetation can provide habitat when accessible to salmon, as well as contribute organic matter and detritus that fuels the base of the nearshore food web that juvenile salmon are a part of (Simenstad 1983).

At North Creek, stream mouth restoration in association with the construction of a salt marsh and channel would involve building a roughened channel of rock and gravel to address the steep gradient between the beach and the salmon-holding pond. To account for the benefits associated with stream mouth restoration in alternatives that include a salt marsh and channel, a multiplier of 0.02 was included in the calculation. This multiplier was applied to the backshore, high intertidal, and low intertidal habitat components in the portion of the stream where armoring was removed. This multiplier was assigned considering the type of benefits that the restored streams could provide and the spatial area they will influence. The small multiplier number was applied because the benefits will not be realized over the entire shoreline length where armor was removed. Assuming that the stream mouth restoration benefits 10 percent of the shoreline length where armor was removed, the 0.02 multiplier applied to the entire length is equivalent to a 0.2 multiplier in the affected portion.

Salt Marsh Creation

The Project Area provides the opportunity to create a salt marsh at the mouth of the three streams. The salt marsh could be configured so that the streams flow into a single marsh and outflow through a constructed channel as low as +10 feet MLLW. Although this location is

not documented to have historically supported a marsh, the concept of creating a marsh was evaluated for several reasons. First, the absence of historic documentation of a marsh does not necessarily indicate that no marsh was present. The historic maps used as the best and earliest record of shoreline conditions of Puget Sound are U.S. Coast and Geodetic Survey topographic sheets, or T-sheets. T-sheets were created in the late-1800s. The maps were created by several authors and the scale of detail is variable, and this particular map appeared to be of lower quality than most others of the era.

Second, regardless of whether the site supported a marsh historically or not, the stream and shoreline configuration could support one, and marsh habitats perform a number of important functions. Marshes support primary production and support fish and wildlife. These areas can also act as filters to remove contaminants from the water. A salt marsh with three freshwater inputs can function at a larger scale than described above in the stream mouth restoration section and can provide better rearing habitat for juvenile salmonids. Marsh vegetation will also support the nearshore food web by providing habitat for terrestrial and aquatic invertebrates that are preyed upon by juvenile salmon. In addition, marsh vegetation produces organic matter and detritus to fuel the base of the nearshore food web.

Third, salt marshes have been destroyed or significantly impaired at numerous locations around Puget Sound. As a result, the habitat functions provided by this ecologically important habitat type are no longer available. Many such marshes have been paved over or built upon, making their restoration unfeasible, particularly in south King County. In consideration of this, the opportunity to create a marsh was evaluated in this study, among other restoration activities. While restoring habitats where they occurred historically is desirable because it tends to offer more certainty of success, opportunities to create marshes in other locations and other habitats can be ecologically beneficial and sustainable.

To account for the benefits associated with the creation of a marsh, a multiplier was included in the ecological benefit calculation for the salt marsh habitat component. The multiplier was scaled based on the size of the marsh. The larger the marsh, the more certainty there is that the channel outlet from the marsh will have room to move around and stay open to provide fish access. For a small marsh, no multiplier was included in the calculation. For

medium and maximum salt marshes, multipliers of 0.2 and 0.3, respectively, were included in the calculation.

The salt marsh benefits beyond the marsh area were accounted for by applying a multiplier of 0.1 to the low intertidal and high intertidal areas.

Freshwater Wetland Creation

The freshwater wetland benefits beyond the marsh area were accounted for by applying a multiplier of 0.1 to the low intertidal and high intertidal areas.

Scarcity of Habitat in Region

To quantitatively account for the opportunity to create habitats that are currently much scarcer in central Puget Sound than they were historically, a multiplier was included in the calculation. Salt marsh and fringing freshwater wetlands were historically much more abundant and common along the shorelines of Puget Sound. In an analysis of the loss of embayment habitats from the late 1800s to present day, embayment shoreforms that support salt marshes are among the most widely lost geomorphic shoreform type throughout Puget Sound and specifically in the central Puget Sound region (Simenstad et al. In Revision).

Connection of Eroding Bluffs to Intertidal Zone

Eroding bluffs in Puget Sound are often referred to as "feeder bluffs," and are known to provide 90 percent of the region's beach material (Johannessen and MacLennan 2007). Typically, natural beaches forming at the toe of bluffs consist of coarse-grained, poorly sorted material up to gravel and cobble size. The substrate entering the intertidal zone from eroding bluffs is transported by waves and currents in a direction that is dictated by bottom topography and the orientation of the shoreline relative to the prevailing waves and currents. Smaller materials, such as sands, tend to be redistributed more quickly because the finer sediment is moved more easily by waves and currents. Under natural conditions, periodic slumping of the bluffs and the resulting redistribution of the material maintains sediment at the beaches. Eroding bluffs are critical to the maintenance of shallow water habitats in Puget Sound. The wave and current transport of sediment under natural conditions results in a feeder bluff contributing material to marine nearshore habitat conditions over long stretches of shoreline, often several miles.

In areas where bulkheads or other shoreline armoring structures are constructed between shoreline bluffs and the intertidal zone, the frequency and volume of sediment inputs into the intertidal zone are markedly reduced or eliminated (Johannessen and MacLennan 2007; Downing 1983; MacDonald et al. 1994).

In the Project Area, shoreline bluffs are separated from the intertidal zone by a seawall, rock riprap, and a strip of lawn covered fill and paths in most areas. In the ecological benefit evaluation framework, the removal of shoreline armoring was assigned a multiplier of 0.25 to be applied to the backshore, high intertidal, and low intertidal habitat components in the portion of the park where shoreline armoring is to be removed in a given alternative.

Groin Removal

At the north end of the Project Area, two groins extend perpendicular to shore. One of these groins will be removed as part of a separate project underway by SWSSD. Full or partial removal of the other groin is part of the restoration alternatives being evaluated. While groins do not fully disconnect the bluffs from the intertidal zone like a seawall does, the groins dissipate wave energy before hitting the upper beach and thus reduce the potential for wave-generated bluff erosion. The groins also impede longshore sediment transport. Removal of the groins would fully reconnect the bluffs to the intertidal areas, thus restoring natural sediment recruitment processes in the area.

To account for these benefits associated with full removal of the groin, a multiplier of 0.05 was applied to the backshore and high intertidal habitat components. Partial removal of the groin (i.e., shortening) was assigned a multiplier of 0.01 in consideration of the slight improvement to sediment transport conditions.

Addition of Sand, Gravel, and Small Cobble Substrate

Beach nourishment and beach restoration activities that place sand, gravel, and small cobbles in the intertidal zone will provide higher habitat function than habitats at the same elevation with larger substrate. As described previously, forage fish spawn in the high intertidal zone in areas with sand- and gravel-sized substrate, and the addition of fine sediment in the high intertidal zone will increase the availability of suitable spawning habitat in the Project Area.

To account for the increased habitat function provided by those habitats with smaller substrate sizes that would naturally occur in the Project Area, a multiplier of 0.10 was included in ecological benefit calculations for high intertidal and riprap habitat components. The high intertidal zone was included because of the habitat function benefits for forage fish spawning. Transition of riprap areas to sand, gravel, and small cobble will also support higher productivity in the intertidal zone. The low intertidal zone was not included in this scoring because these areas are currently already composed of sand and gravel substrates. The multiplier score was applied once due to the expectation that once the beach is nourished or restored, then beach renourishment would be conducted at appropriate intervals to keep the substrate in the sand, gravel, and small cobble range.

Revegetation

The planting of riparian vegetation, such as native trees and shrubs, in areas that are currently unvegetated or landscaped grass can provide habitat functions such as those described for the Mature Riparian Vegetation habitat component in Section 3.6.1.1.3. The revegetation in the park would all occur within 100 feet of +12 feet MLLW, thus establishing vegetation immediately adjacent to the shoreline. The restoration alternatives for the Project Area provide either partial revegetation or full revegetation. Partial revegetation means that riparian vegetation is planted closer to the shoreline, but remains separated from the beach by shoreline armoring. Full revegetation means that the shoreline armoring is removed and the transition from upland riparian vegetation to backshore vegetation to the intertidal beach is continuous and uninterrupted. To account for the functional differences between full and partial revegetation, a multiplier of 0.3 was applied to the full revegetation area and no multiplier was applied for the partial revegetation.

3.6.1.1.5 Restoration Trajectories

The ecological function of habitat components varies over time depending on the degree to which the ecosystem processes that create and sustain the components remain intact. Temporal variability in function is also a reality for restoration techniques and also depends on the degree to which ecosystem processes are intact to support and maintain the restored habitat conditions. Some restoration techniques may be at full function immediately after

construction, then encounter some rate of decreased function over time. More typically, however, is the case in which restoration provides an immediate improvement compared to pre-restoration conditions, but the full function is not realized until some period of years afterward. In the case of riparian revegetation with native trees, the habitat function increases over time as the trees mature, and assuming plant survival, the relative function continues to increase over the entire 50-year period. In the case of beach nourishment, full habitat function is not realized immediately because much or all of the biological community present at the site prior to restoration will be buried and sacrificed. Maximum function in this case would occur when the benthic community is re-established, but before the placed sediment is transported away from the site.

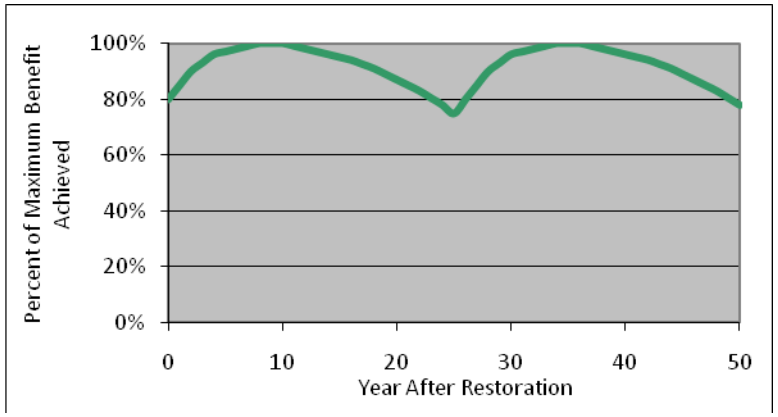
To assess the ecological benefits associated with each habitat alternative, restoration trajectories were developed to approximate the relative degree of function of each restoration technique. Experience with other Puget Sound restoration project performance and best professional judgment were used to estimate the restoration trajectories for the different management measures listed. The restoration trajectories are numeric values from 0.0 (no function) to 1.0 (full function), and each year, from year 1 through year 50, after restoration is assigned a value. The restoration trajectory developed for each restoration technique is provided in Table 3-4. These trajectories were applied as multipliers to the applicable habitat components affected by the restoration.

Table 3-4
Restoration Trajectories

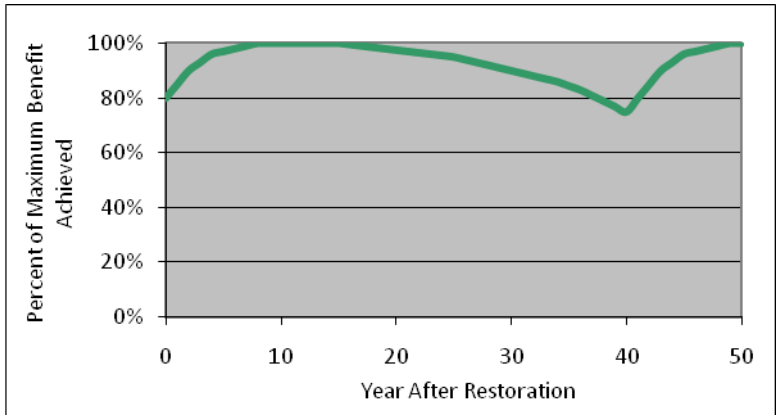
Year after Restoration	Beach and Backshore Restoration Technique			Salt Marsh – small and medium	Salt Marsh – maximum; Freshwater Wetland	Planted Riparian Vegetation	Mature Riparian Vegetation	Groin Removal
	Armor Removal, Beach Nourishment, & Backshore Restoration	Beach Nourishment Only	Unrestored Beach					
1	0.8	0.7	0.6	0.2	0.2	0.05	1	0.8
2	0.85	0.82	0.6	0.3	0.3	0.06	1	0.84
3	0.9	0.94	0.6	0.45	0.45	0.07	1	0.88
4	0.93	1	0.6	0.6	0.6	0.09	1	0.92
5	0.96	0.92	0.6	0.8	0.8	0.12	1	0.96
6	0.97	0.75	0.6	0.88	0.88	0.15	1	1
7	0.98	0.6	0.59	0.9	0.9	0.18	1	1
8	0.99	0.65	0.59	0.92	0.92	0.21	1	1
9	1	0.7	0.59	0.93	0.93	0.25	1	1
10	1	0.82	0.59	0.94	0.94	0.29	1	1
11	1	0.94	0.59	0.95	0.95	0.33	1	1
12	1	1	0.58	0.96	0.96	0.37	1	1
13	1	0.92	0.58	0.97	0.97	0.41	1	1
14	1	0.75	0.58	0.98	0.98	0.45	1	1
15	1	0.6	0.58	0.99	0.99	0.5	1	1
16	1	0.65	0.58	1	1	0.55	1	1
17	0.995	0.7	0.57	1	1	0.6	1	1
18	0.99	0.82	0.57	1	1	0.65	1	1

Year after Restoration	Beach and Backshore Restoration Technique			Salt Marsh – small and medium	Salt Marsh – maximum; Freshwater Wetland	Planted Riparian Vegetation	Mature Riparian Vegetation	Groin Removal
	Armor Removal, Beach Nourishment, & Backshore Restoration	Beach Nourishment Only	Unrestored Beach					
19	0.985	0.94	0.57	1	1	0.7	1	1
20	0.98	1	0.57	1	1	0.75	1	1
21	0.975	0.92	0.57	1	1	0.8	1	1
22	0.97	0.75	0.56	1	1	0.84	1	1
23	0.965	0.6	0.56	1	1	0.87	1	1
24	0.96	0.65	0.56	1	1	0.9	1	1
25	0.955	0.7	0.56	1	1	0.92	1	1
26	0.95	0.82	0.56	1	1	0.94	1	1
27	0.94	0.94	0.55	1	1	0.95	1	1
28	0.93	1	0.55	1	1	0.96	1	1
29	0.92	0.92	0.55	1	1	0.96	1	1
30	0.91	0.75	0.55	1	1	0.96	1	1
31	0.9	0.6	0.55	1	1	0.96	1	1
32	0.89	0.65	0.54	0.985	0.99	0.97	1	1
33	0.88	0.7	0.54	0.97	0.98	0.97	1	1
34	0.87	0.82	0.54	0.955	0.97	0.97	1	1
35	0.86	0.94	0.54	0.94	0.96	0.97	1	1
36	0.845	1	0.54	0.925	0.95	0.97	1	1
37	0.83	0.92	0.53	0.91	0.94	0.98	1	1
38	0.81	0.75	0.53	0.895	0.93	0.98	1	1
39	0.79	0.6	0.53	0.88	0.92	0.98	1	1

Year after Restoration	Beach and Backshore Restoration Technique			Salt Marsh – small and medium	Salt Marsh – maximum; Freshwater Wetland	Planted Riparian Vegetation	Mature Riparian Vegetation	Groin Removal
	Armor Removal, Beach Nourishment, & Backshore Restoration	Beach Nourishment Only	Unrestored Beach					
40	0.77	0.65	0.53	0.865	0.91	0.98	1	1
41	0.75	0.7	0.53	0.85	0.9	0.98	1	1
42	0.8	0.82	0.52	0.835	0.89	0.99	1	1
43	0.85	0.94	0.52	0.82	0.88	0.99	1	1
44	0.9	1	0.52	0.805	0.87	0.99	1	1
45	0.93	0.92	0.52	0.79	0.86	0.99	1	1
46	0.96	0.75	0.52	0.775	0.85	0.99	1	1
47	0.97	0.6	0.51	0.76	0.84	1	1	1
48	0.98	0.65	0.51	0.745	0.83	1	1	1
49	0.99	0.7	0.51	0.73	0.82	1	1	1
50	1	0.82	0.51	0.715	0.81	1	1	1



Armor Removal, Beach Nourishment, and Backshore Restoration – Faster Erosion



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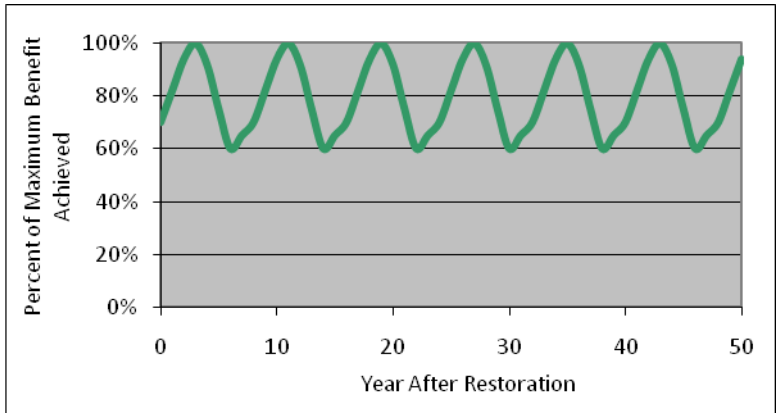
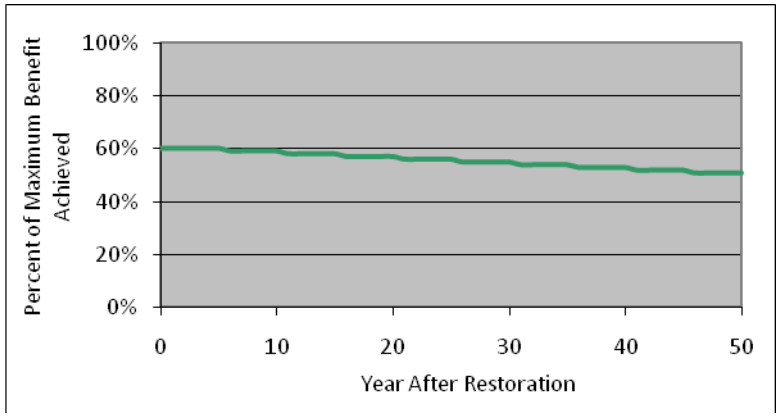
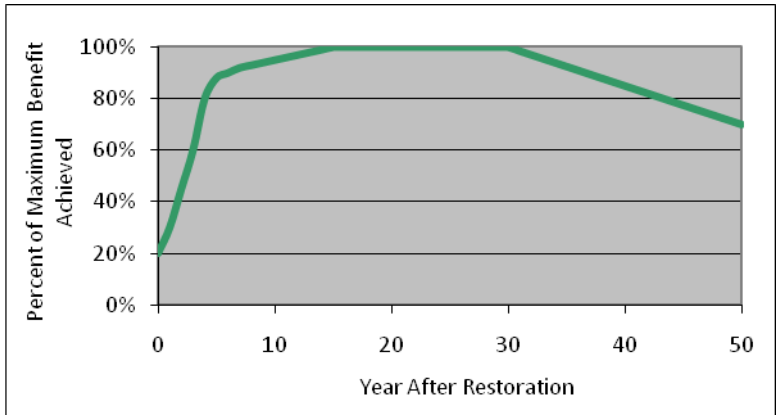


Beach Nourishment Only

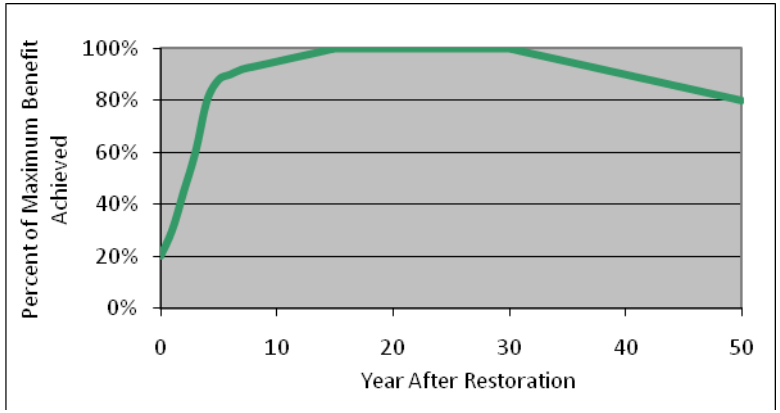


Unrestored Beach

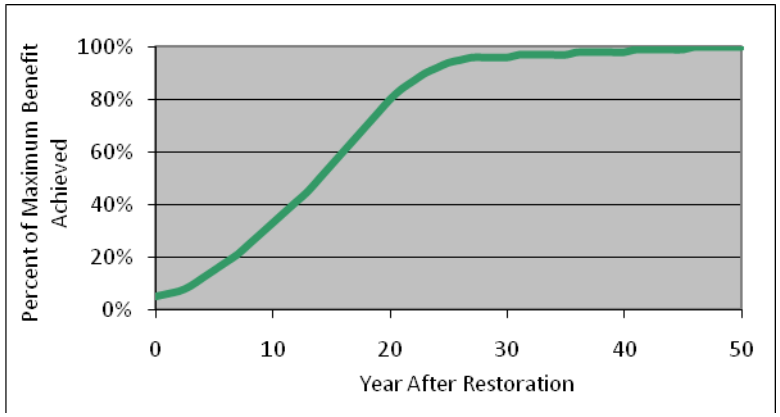
Figure 18a Functional Trajectories of Restoration Techniques included in Alternatives Evaluated



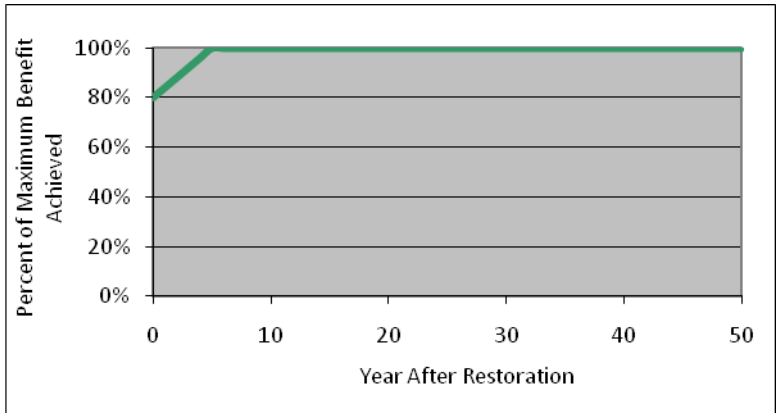
Salt Marsh – Small



Salt Marsh – Medium and Maximum; Freshwater Wetland



Planted Riparian Vegetation



Groin Removal

Figure 18b Functional Trajectories of Restoration Techniques included in Alternatives Evaluated

3.6.1.2 Results

The ecological benefit scoring system was applied successfully and provides useful outputs to evaluate the alternatives. The summary total habitat scores are provided in Table 3-5. A more detailed summary of habitat scoring is provided in Appendix C.

Table 3-5
Ecological Benefit Evaluation Table

Alternative	Total Habitat Score
Alternative 1	741
Alternative 2	645
Alternative 3	590
Alternative 3A	567
Alternative 4	521
Alternative 5	439
No Action: Future Without Project	161

3.6.2 Cost Estimates

Planning level costs were estimated for each of the alternative plans. These costs included construction costs, real estate costs, and operation and maintenance costs. For purposes of the economic analysis in Section 3.6.2.4, these costs were converted to average annual equivalents using a period of analysis of 50 years and a project discount rate of 4.375 percent.

3.6.2.1 Construction Costs

The planning level construction cost estimates were developed based on unit costs from past projects with similar scopes, including costs for the recently completed South Shoreline Project at Seahurst Park. The costs were assessed in October 2010 dollars and covered complete Project costs with the exception of any administrative costs for City staff.

The categories of construction costs that were estimated include temporary facilities, demolition, earthwork, seawall construction, building construction, utility construction, fish ladder improvements, and general Project improvements. The temporary facilities category

includes the costs of construction fencing and stormwater pollution prevention practices. Demolition includes removal of buildings and other facilities, removal of shoreline rock and debris, removal of utility lines and fisheries infrastructure, and finally, clearing the site of selected vegetation, paving, site furnishings, and miscellaneous debris.

The earthwork category includes all excavation and sediment placement for the beach restoration and miscellaneous cobble and gravel substrate placement near a proposed wetland feature. Seawall construction costs were included for alternatives that retained the northern portion of the seawall; in order for this seawall to function, a "return" wall, perpendicular to the remaining segment, is necessary.

Building construction includes a new facility for the MTLB in Alternative 1 and the replacement of shelters. Utility construction includes the replacement of utility lines and also building infrastructure such as storage tanks and pumps needed for the MTLB's fisheries program. Fish ladder construction includes costs for "naturalizing" the North Creek channel and relocating a seasonally used fish ladder and holding pond nearer the MTLB. The Project improvements category includes costs for creating or improving crushed rock pathways, parking, planting, and the play area. A mobilization percentage has been added to the overall cost by alternative, and contingencies for design, construction, and permitting have also been applied. A sales tax multiplier of 9.5 percent is applied to the construction material costs.

The cost estimate is based on a number of assumptions. The assumptions that had the most pronounced effect on the overall costs include those regarding beach nourishment within the earthwork category and those used in calculating the costs of relocating the MTLB. For 10 percent level design of each alternative plan, preliminary grading plans were created in AutoCAD to calculate a volume of rock, gabions, and sediment removed, and to calculate a volume of beach nourishment placed for each alternative plan. These volumes assume that an over-excavation of at least 1 foot would be needed in rock removal, as many of the rock structures have sunk into the base sediment over time. For certain areas of the beach habitat zones, an over-excavation of 2 to 4 feet preceding sand and gravel sediment placement is assumed.

Due to the fine sediment sizes of upland fill soils shown within the geotechnical investigation, it is assumed that spoils from upland excavation will only be used to fill holes left from gabion removal; these areas will then be covered with gravel and sand/gravel beach nourishment layers. Sediments over-excavated from the beach would be sorted by size and reused for beach nourishment where possible; all other beach nourishment would be imported from off-site. The cost for relocation of the MTLB includes not only building and utility construction, but site work contingencies for earthwork and retaining walls needed within the upland slope, as well as emergency access improvements to the new building. Stick framing as opposed to cast-in-place concrete, which is used in the current building, is assumed for the upper level of the new building; this assumption reduced the cost of building construction substantially.

Table 3-6 provides a summary of the cost estimate by alternative. Alternative 1 results in the highest cost, with a price tag of more than $14 million. Alternative 2 has an estimated cost of approximately $8.2 million. Alternatives 3 and 3A have similar costs of approximately $7.5 and $7.4 million respectively. Alternative 4 has a slightly lower cost than Alternatives 3 and 3A, with an estimated cost of about $7.0 million. Alternative 5 has the lowest estimated cost of approximately $4.8 million. Because the same contingencies and multipliers were applied to all of the construction cost estimates for each alternative, the differences between each depend on the construction costs. The highest costs within Alternative 1 are due to the high cost of relocating the MTLB into the forested upland and the substantial earthwork proposed. The construction of the building is estimated at more than $1.5 million with earthwork associated with the upland and beach nourishment construction reaching nearly $2.5 million; new utilities within this alternative account for more than half a million dollars as well. The most substantial costs within the remaining alternatives are within the earthwork category, with estimated costs ranging from $1.5 to $1.9 million between alternatives 2, 3, 3A, 4, and 5.

3.6.2.2 Real Estate Costs

Real estate costs are based on the area affected by each alternative, and the land value determined by USACE to be appropriate for the Seahurst Park site. A 10 percent contingency factor was added to this per acre real estate cost. Table 3-7 shows the land area and real estate costs estimated for each alternative. The table shows that while the real estate cost differences between all alternatives are not very high, the two "bookend" alternatives have the greatest difference. Alternative 1 has the highest real estate cost due to the increased area to relocate the MTLB, and Alternatve 5 has the lowest real estate cost because minimal upland work is proposed.

Table 3-7
Real Estate Costs

Item	Alternative 1	Alternative 2	Alternative 3	Alternative 3A	Alternative 4	Alternative 5
Land Area (Acres)	10.36	10.16	10.16	10.16	8.01	7.53
Real Estate Cost per Acre	$14,182	$14,182	$14,182	$14,182	$14,182	$14,182
Subtotal	$146,971	$144,089	$144,089	$144,089	$113,597	$106,897
10% Contingency	$14,697	$14,409	$14,409	$14,409	$11,359	$10,689
Total Real Estate Cost	$161,668	$158,498	$158,498	$158,498	$124,956	$117,586

3.6.2.3 Operation, Maintenance, Repair, Replacement and Rehabilitation Costs

The operation, maintenance, repair, replacement and rehabilitation (OMRR&R) cost estimates focused on three factors: beach renourishment costs, riparian restoration costs, and the various implications of each alternative on management of landslide debris. Infrastructure maintenance costs were also considered but were ultimately not included because differences between alternatives are minimal. These costs include maintenance of buildings, picnic shelters, and utility mains in the Project Area. Differences between infrastructure maintenance costs for the various alternatives were difficult to predict. Such predictions relied heavily on assumptions regarding the construction, materials, and methods of replacement infrastructure, which are not known at this time. Generally, infrastructure maintenance costs are not expected to vary widely from the baseline (or No Action alternative) condition.

Maintenance costs related to beach renourishment costs, riparian restoration maintenance costs, and landslide debris management were calculated as average annual costs based on a 50-year period of analysis. All costs were developed in 2010 dollars and based on opinions of probable cost from the City using standard procurement procedures (low bid public works costs). A variety of methods were used to determine costs as described below.

3.6.2.3.1 Beach Renourishment and Maintenance Costs

To develop beach renourishment costs, the one-dimensional shoreline change model GENESIS (Hansen and Kraus 1989) was employed to predict longshore sediment transport rates (littoral drift) and the annual net sediment transport volume along the entire length of the Project shoreline for existing conditions and proposed alternatives. This modeling is considered a planning level evaluation; however, it is adequate to compare alternatives and identify large-scale littoral drift issues. Input to the model includes combined topography and bathymetry, geometry of shoreline monitoring, sediment size characteristics, sediment transport parameters (calibration factors), and a wave time series representative of the wave climate for the Project Area.

The wave time series was developed through a wind-wave hindcast study using wind data records of various lengths from wind gauges at Seattle/Tacoma Airport, Alki Point Lighthouse, and Roberts Point Lighthouse. Combined topography/bathymetry surfaces used in the model were developed for each alternative (and existing conditions) based on upland survey information, appropriate navigation charts for the area, and proposed grading plans for the alternatives. Sediment transport parameters were chosen for the model based on calibration of predicted annual littoral drift rates. These parameters were chosen through comparison of model predictions of annual littoral drift rates for existing conditions compared to annual littoral drift rates calculated from monitoring surveys for the South Seahurst Park Nearshore Restoration Project. These data were considered to be the most representative available information for use at the current site. Annual littoral drift rates calculated for that site were approximately 200 cubic yards per year (Johannessen 2009).

Shoreline armoring was added to the model as follows (Hansen and Kraus 1989):

- Riprap located along the foreshore was added as hard bottom in the model. Alongshore and cross-shore width and height of riprap were included as model input.
- Vertical structures were added as seawalls into the model. Length parallel to the shoreline and the top of wall height were included as model input.
- Drift cells were added as non-diffracting groins in the model. The designation of non-diffracting groin was chosen by the model software based on the location of the seaward terminus of the groin to the surf zone location. Locations and crest elevations for the landward and seaward ends of the drift cell were included as model input.

Based on model results of average annual littoral drift and best professional judgment, an estimate was made for each alternative as to the frequency of renourishment cycles that would be required and the volume of material that would be placed in each cycle. Costs were derived based on information from other projects, including the Seahurst Park Phase 1 Shoreline Ecosystem Restoration Project.

In order to develop costs, a frequency of renourishment cycles was determined for each alternative. The number of cycles varied by alternative, and is based on one renourishment taking place after approximately 5,000 cubic yards (cy) of beach material had been lost due to littoral drift. In the case of Alternatives 1, 2, 3A, and 3, the model predicted losses of approximately 3,500 cubic yards of beach material over a 50-year timeframe. The model predicted slightly higher losses of approximately 5,000 cubic yards of material for Alternative 4 over a 50-year time frame. The increase is sediment loss compared to Alternatives 1, 2, 3A, and 3 is likely due to the shoreline armoring left on site for Alternative 4. Based on model results, one renourishment event over a 50-year time period is suggested for each of these alternatives. Alternative 5 consisted of a large beach fill that shifted the location of the shoreline quite a bit farther offshore than the other alternatives considered. This resulted in a non-equilibrium beach profile shape that responded quickly within the GENESIS model in order to reach a more natural beach shape from the constructed template. This quick response resulted in higher losses for Alternative 5 of up to 6 times higher than the other alternatives considered. Based on the estimated volume loss of placed sediment, the number of renourishment events over the 50-year life cycle for Alternative 5 is approximately 6. Under the No Action alternative, it was assumed that beach renourishment would not occur.

This would result in continued erosion of the beach, which is likely to degrade ecosystem function in the future (see Tables 3-8 and 3-9).

3.6.2.3.2 Riparian Restoration Maintenance Costs

Riparian restoration maintenance costs were derived from current operational costs to the City for weeding, plant replacement, and irrigation. Costs for each alternative are based on the total approximate square feet of wetland and new riparian planting in each alternative. Costs do not include intertidal, backshore, mature forest, or lawn areas. Alternative 3A riparian restoration costs, however, only include the proposed riparian area and not the proposed wetland area. This is because this alternative proposes no maintenance for the wetland area. The Alternative 3A wetland is a dynamic system and will be left to establish based on colonization.

Riparian restoration maintenance is not expected to be required once native vegetation has become established (after approximately 5 years). Therefore, riparian restoration costs are divided into two annual costs: a cost for years 1 through 5, and a cost for years 6 through 50.

3.6.2.3.3 Landslide Debris Maintenance Costs

Landslide debris is expected to continue to reach shoreline areas of the park. This material may end up covering trails, filling drainage ditches, and destroying riparian plantings. In the past, the City has removed the material deposited by landslides and placed it in upland locations within the park. However, as part of the Phase I Shoreline Restoration a landslide debris management document was included as an appendix to the NEPA EA prepared by the USACE (USACE 2003). This one-page document is included in Appendix G and briefly describes the intent to place landslide debris from the Phase I project into the littoral drift zone, within the elevation range described below, rather than hauling it off-site. The City is currently preparing a Stewardship and Monitoring Plan for the entire park that also addresses this issue of landslide debris management in a similar fashion as was described in the Phase I EA.

An estimate of total landslide debris delivered to the shoreline was made using the Shannon & Wilson 2008 Technical Memo for Seahurst Park (Shannon & Wilson 2008). The cost of

material removal was estimated from the City's cleanup costs for the 2001/2002 Seahurst Park landslide.

As previously mentioned, after a landslide event, the delivered landslide debris may end up covering trails, filling drainage ditches, and destroying vegetated areas. Therefore, while some of the debris may be left in place on the hillside, a portion of the delivered landslide debris would need to relocated on-site or hauled off-site. For all of the alternatives except the No Action alternative, a portion of the landslide debris could be relocated to the backshore areas of the beach between MHHW and extreme high water. In this location, wave action will eventually redistribute the material on the beach.

Therefore, for Alternatives 2, 3A, 3, and 4, it is assumed that landslide debris will either be left in place (the debris that is not hindering the pathway, ditches, or vegetated areas) on the hillside or relocated to the beach. Alternative 5 would have a similar regimen; however, because all of the beach armor is remaining in this alternative, the beach will not be as large as in the other alternatives, and excess material will need to be hauled off-site. For the No Action alternative (no proposed beach nourishment), it was assumed that all of the landslide debris will be hauled off-site, with the exception of a portion that could be left in place on the hillside.

Annual maintenance costs for the studied alternatives range from $9,760 to $45,010 for years 1 through 5, and from $4,402 to $39,550 for years 6 through 50 (see Table 3-8). Total 50-year OMRR&R costs range from $256,313 for Alternative 3A to $2,004,803 for Alternative 5 (see Table 3-9). The No Action alternative was estimated to have an annual maintenance cost at approximately $7,507 per year (for years 1 through 50) and a total 50-year cost of $487,988. The No Action alternative total 50-year cost is higher than the cost for Alternatives 1, 2, 3A, 3, and 4. This is because the cost of hauling landscape debris off-site is considerable and, over time, outweighs costs associated with beach renourishment and riparian restoration. All maintenance costs include a 30 percent contingency to address uncertainties in estimating the actual cost of maintenance at a planning level over 50 years.

It should be noted that the No Action alternative estimate does not include the cost to replace beach material that is expected to be lost to erosion. The current rate of erosion is

predicted to be higher than in any of the proposed alternatives. Therefore, total maintenance costs including maintenance of the beach using renourishment would be nearly $50,000 per year given the current conditions.

Table 3-8
Annual Maintenance Costs

Item	Annual Maintenance Costs (in dollars)						
	No Action	Alt. 1	Alt. 2	Alt 3A	Alt. 3	Alt. 4	Alt. 5
Landslide Debris*	7,507.50	536	576	603	603	603	5,273
Riparian Restoration							
Annual Cost for Years 1-5	0	10,200	11,100	4,900	8,600	3,700	4,200
Annual Cost for Years 6-50	0	0	0	0	0	0	0
Beach Renourishment*	0	2,850	2,850	2,850	2,850	3,900	25,150
Subtotal Annual Cost, Years 1-5	7,507.50	13,586	14,526	8,353	12,053	8,203	34,623
30% Contingency	2,252	4,076	4,358	2,506	3,616	2,461	10,387
Total Annual Cost, Years 1-5	9,760	17,662	18,884	10,859	15,669	10,664	45,010
Subtotal Annual Cost, Years 6-50	7,507.50	3,386	3,426	3,453	3,453	4,503	30,423
30% Contingency	2,252	1,016	1,028	1,036	1,036	1,351	9,127
Total Annual Cost, Years 6-50	9,760	4,402	4,454	4,489	4,489	5,854	39,550

Note:
* Events will likely not occur on an annual basis but rather on an event (frequency) basis.

Table 3-9
Estimate of Total 50-year OMRR&R Costs

Item	50-Year Maintenance Costs (in dollars)						
	No Action	Alt. 1	Alt. 2	Alt 3A	Alt. 3	Alt. 4	Alt. 5
Landslide Debris	375,375	26,813	28,823	30,164	30,164	30,164	263,656
Riparian Restoration	0	51,000	55,500	24,500	43,000	18,500	21,000
Beach Renourishment	0	142,500	142,500	142,500	142,500	195,000	1,257,500
Subtotal	**375,375**	**220,312**	**226,823**	**197,164**	**215,664**	**243,664**	**1,542,156**
30% Contingency	112,613	66,094	68,047	59,149	64,699	73,099	462,647
TOTAL COST	**487,988**	**286,406**	**294,870**	**256,313**	**280,363**	**316,763**	**2,004,803**

Note:
Opinion of probable cost includes riparian restoration maintenance and beach renourishment based on modeled rate of erosion. The cost for the No Action Alternative does not include any beach renourishment, which would result in continuing erosion of the beach.

Alternatives 1, 2, and 3 have very similar estimated OMRR&R costs, which is because the rate of erosion for each alternative was estimated to be equal and to require renourishment on a 50-year cycle. Additionally, the landslide debris cleanup costs for each were nearly equal because debris material can be left on the hillside or relocated onto the beach as nourishment. Riparian restoration costs are similar because these three alternatives propose comparably sized riparian areas. The riparian restoration cost after year 5 is $0 for all alternatives. Alternative 1 was estimated to cost approximately $13,586 for years 1 through 5 and $3,386 for years 6 through 10. Alternative 2 was estimated to cost approximately $14,526 for years 1 through 5 and $3,426 for years 6 through 10. Alternative 3 was estimated to cost approximately $12,053 for years 1 through 5 and $3,453 for years 6 through 10.

Alternative 3A is similar to Alternatives 1, 2, and 3 with the exception that Alternative 3A has a lower riparian restoration OMRR&R cost. As mentioned earlier, this is because Alternative 3A only provides riparian restoration costs for the proposed riparian area and not the proposed wetland area. Alternative 3A was estimated to cost approximately $8,353 for

years 1 through 5 and $3,453 for years 6 through 10. For years 6 through 10, the OMRR&R cost of Alternative 3A is identical to that of Alternative 3.

Alternative 4 is similar to Alternatives 1, 2, 3A, and 3 except that the rate of erosion for this alternative is higher and would necessitate beach renourishment on a 25-year cycle rather than a 50-year cycle. The riparian restoration costs for Alternative 4 are less than those for Alternatives 1, 2, and 3 because this alternative proposes less riparian area.

Alternative 5 has the highest maintenance costs of any of the four alternatives at $34,623 for years 1 through 5 and $30,423 for years 6 through 50. The high cost was driven primarily by a predicted rate of erosion that is six times higher than the other alternatives. That rate of erosion would necessitate beach renourishment on an 8-year cycle instead of the 50-year cycle estimated for Alternatives 1, 2, 3A, and 3, or the 25-year cycle estimated for Alternative 4.

3.6.2.4 Economic Costs

Construction costs and maintenance costs are presented by year in Table 3-10. Present Value and Average Annual Equivalent Costs are presented in Table 3-11. These costs are based on a project life of 50 years and a Federal Discount Rate of 4 3/8 percent. All construction costs are expected to occur in 2011, and the base year is 2012. As all costs, construction, and maintenance are estimated at year-end values, no interest during construction will accrue. First costs range from $0 for the No Action alternative to $14,242,668 for Alternative 1. Average annual equivalent costs range from $7,989 for the No Action alternative to $710,915 for Alternative 1.

Table 3-10
Construction and Maintenance Costs by Year

Year	Item	Costs (in thousands of dollars)						
		No Action	Alt 1	Alt 2	Alt 3	Alt 3A	Alt 4	Alt 5
2011	Construction	--	14,242.7	8,379.5	7,698.5	7,603.5	7,122.0	4,925.6
Maintenance								
2012	Riparian Restoration	--	13.3	14.4	11.2	5.3	4.8	5.5
2013		--	13.3	14.4	11.2	5.3	4.8	5.5
2014		--	13.3	14.4	11.2	5.3	4.8	5.5
2015		--	13.3	14.4	11.2	5.3	4.8	5.5
2016		--	13.3	14.4	11.2	5.3	4.8	5.5
2019	Beach Renourishment	--	--	--	--	--	--	272.5
2021	Landslide Debris	97.6	7.0	7.5	7.8	7.8	7.8	68.6
2027	Beach Renourishment	--	--	--	--	--	--	272.5
2031	Landslide Debris	97.6	7.0	7.5	7.8	7.8	7.8	68.6
2035	Beach Renourishment	--	--	--	--	--	--	272.5
2036	Beach Renourishment	--	--	--	--	--	253.5	--
2041	Landslide Debris	97.6	7.0	7.5	7.8	7.8	7.8	68.6
2043	Beach Renourishment	--	--	--	--	--	--	272.5
2051	Landslide Debris	97.6	7.0	7.5	7.8	7.8	7.8	68.6
2051	Beach Renourishment	--	--	--	--	--	--	272.5
2056	Beach Renourishment	--	185.2	185.2	185.2	185.2	--	--
2061	Landslide Debris	97.6	7.0	7.5	7.8	7.8	7.8	--

Table 3-11
Present Value and Average Annual Equivalent Costs

Alternatives	Present Value		Expected Average Annual Equivalent		
	Construction Costs (in dollars)	Maintenance Costs (in dollars)	Construction Costs (in dollars)	Maintenance Costs (in dollars)	Total Costs (in dollars)
No Action	--	161,136	--	7,989	7,989
Alternative 1	14,242,668	96,896	706,111	4,804	710,915
Alternative 2	8,379,498	102,914	415,432	5,102	420,534
Alternative 3	7,698,498	89,172	381,670	4,421	386,091
Alternative 3A	7,603,498	63,401	376,960	3,143	380,103
Alternative 4	7,121,957	157,956	353,086	7,831	360,917
Alternative 5	4,925,587	718,731	244,197	35,633	279,830

3.6.3 Cost Effectiveness/Incremental Cost Analysis

Traditional benefit-cost analysis is not appropriate for environmental preservation and enhancement projects as there is not a consistent national standard for valuation for environmental outputs. CE/ICA procedures provide an evaluation approach that is consistent with the planning framework established in Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies (U.S. Water Resources Council 1983). All CE/ICA procedures used in this report are based on the USACE Institute for Water Resources (IWR) Planning Suite User's Guide, November 2006, and are consistent with the P&G.

Cost effectiveness analysis is conducted to ensure that the lowest costing alternative is identified for each possible level of environmental output; and that for any level of investment, the maximum level of output is identified. IWR Planning Suite then identifies the subset of cost-effective plans that are superior financial investments through incremental cost analysis. These "best buys" provide the greatest increase in the value of the output for the least increased cost. The first best buy is the most efficient plan, producing output at the lowest incremental cost per unit. If a higher level of output is desired, then the next best buy is the most efficient plan for producing additional output, and so on. Each additional best buy is calculated from the previous "best buy."

For the purpose of this Project, average annual equivalent costs were compared to average annual habitat scores to determine which alternatives are cost-effective and which provide the best buy. Six alternatives and a No Action alternative were analyzed and compared to the IWR Planning Suite No Action Plan, which is made up of no costs and no outputs. Each alternative was considered to be independent and not combinable with any other alternative. The average annual equivalent cost, the average annual habitat score, and the results of the CE/ICA, to include average cost for all alternatives and incremental costs for the best buys, are presented in Table 3-12.

Table 3-12
Cost Effectiveness Analysis and Incremental Cost Analysis

Alternative	AAE Cost ($1000)	Output (AAHS)	Cost-Effective?	Average Cost ($1,000/AAHS)	Incremental Cost ($1,000)	Incremental Output (AAHS)	Incremental Cost/AAHS ($)
No Action	8	3.2	Best Buy	2.50	8	3.2	2.50
Alternative 2	421	12.9	Best Buy	32.64	413	9.7	42.58
Alternative 1	711	14.8	Best Buy	48.04	290	1.9	152.63
Alternative 3	386	11.8	Yes	32.71			
Alternative 3A	380	11.3	Yes	33.63			
Alternative 4	361	10.4	Yes	34.71			
Alternative 5	280	8.8	Yes	31.82			

Note:
AAHS – Average Annual Habitat Score

Costs and outputs differentiated by cost effectiveness are presented in Figure 19. Incremental cost and output for the best buy alternatives are presented in Figure 20.

Based on the data, all of the alternatives analyzed are cost-effective. Further, the No Action alternative and Alternatives 1 and 2 were determined to be best buys. In consideration of planning constraints, a CE/ICA with Alternatives 1 and 2 omitted was run, and the results showed the No Action alternative and Alternative 3 as the best buy plans. Only when Alternatives 1, 2, and 3 were omitted did Alternative 3A become a best buy. If the alternatives identified as best buys do not meet all of the planning objectives or other project planning criteria, other alternatives may be recommended.

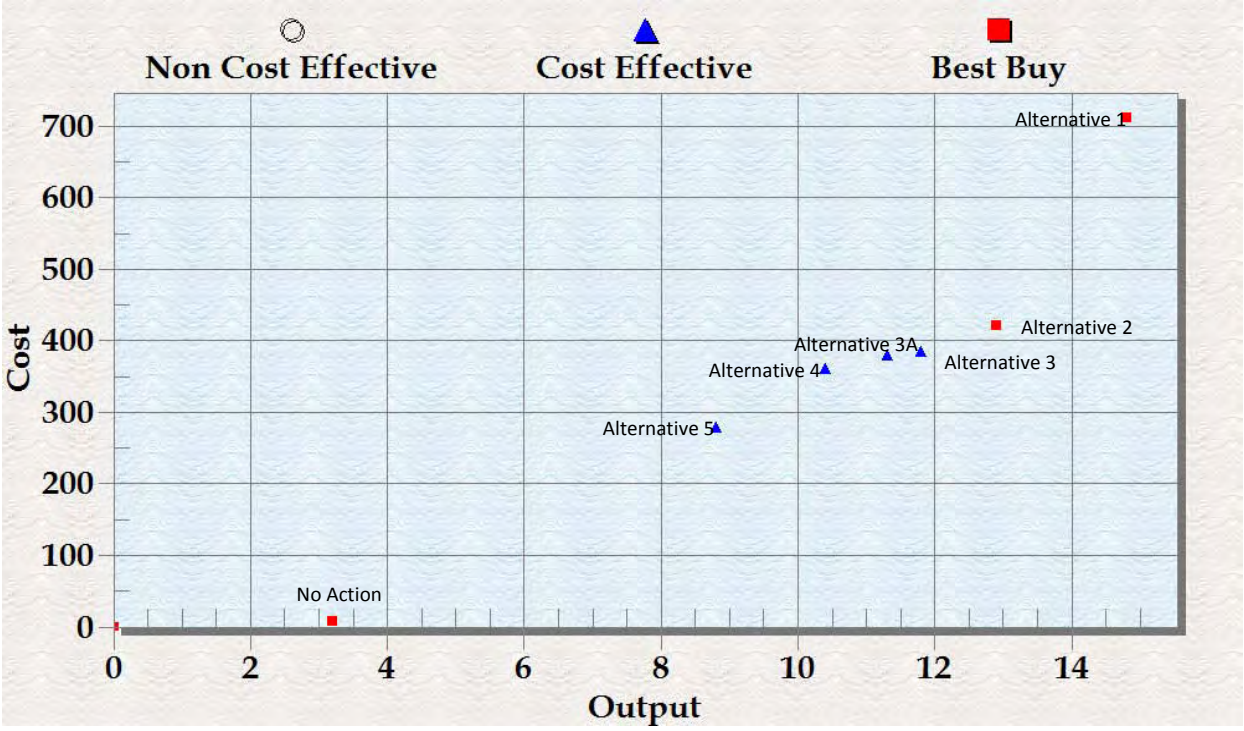


Figure 19
Seahurst Park Cost and Output – All Alternatives Differentiated by Cost Effectiveness

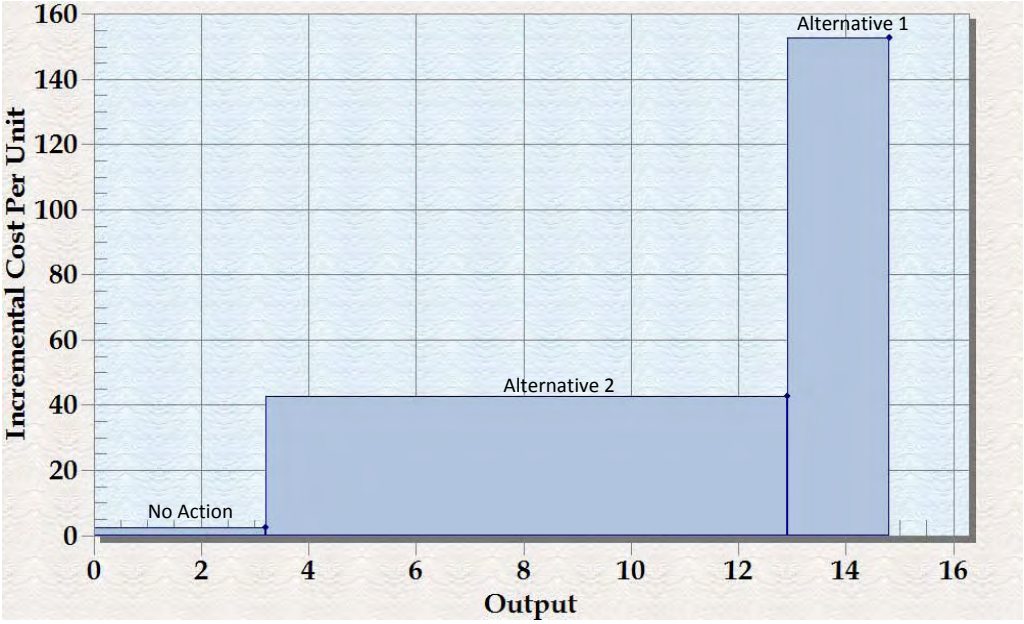


Figure 20
Seahurst Park Incremental Cost and Output – Best Buy Plan Alternatives

3.7 Comparison of Alternative Plans

The alternative plans including the No Action alternative were evaluated and compared against each other to determine their relative effectiveness in meeting planning objectives and other criteria. The plans were compared using: CE/ICA analysis, the four USACE criteria, Park and Recreation effects, permitting feasibility, funding feasibility, and risk and uncertainty. The following sections describe the comparisons and conclude with the rationale and justification of Alternative 3A as the preferred alternative.

3.7.1 Cost Effectiveness and Incremental Cost Analysis

Based on the results of the CE/ICA, all of the alternatives were considered to be cost-effective; however, only the No Action alternative and Alternatives 1 and 2 were best buys. For the action alternatives, ecological output varies as per number of measures combined and their varying scales. A summarized evaluation by alternative follows.

3.7.1.1 No Action Alternative

The No Action alternative was the first best buy coming in at an incremental cost per Average Annual Habitat Score (AAHS) of only $2.50. However, it would also lead to continued environmental degradation in the Project Area. Existing obstacles such as the armored seawall and groins would not allow for needed sediment transport to prevent continued erosion of nearshore beaches and intertidal habitat. Educational and aesthetic values of the park would decline resulting in a likely drop in attendance as well. For this alternative, the average annual equivalent (AAE) cost is $8,000 and the AAHS is 3.2.

3.7.1.2 Alternative 1

Alternative 1 is both cost-effective and is the third best buy, coming in at an incremental cost of $152.63 per AAHS. This alternative is the one that yields the maximum restoration as it will remove the entire seawall allowing full connectivity between the upper bluffs and the intertidal zone; this will result in almost full restoration of the highly desired natural sediment transport. Further ecological benefit is provided by restored North Creek channel and one smaller stream supporting a small revegetated brackish marsh. The habitat created by the marsh will provide almost immediate ecological benefits. As would be expected

considering the larger ecological output, this alternative is the most expensive. At an initial construction cost in excess of $14.2 million dollars, it is more than double what the target cost is for the Section 544 authority. This is largely due to the need to relocate the existing MTLB further upland. It is currently located close to the shoreline but protected by the existing armor wall, which under this alternative would be completely removed. The sponsor is therefore unable to support this alternative. For this alternative, the AAE cost is $711,000 and the AH score is 14.8. Because this alternative exceeds the monetary cap for the authority, it will be removed from further consideration.

3.7.1.3 Alternative 2

Alternative 2 is both cost-effective and the second best buy coming in at an incremental cost of $42.58 per AAHS. This alternative was crafted in an attempt to retain as much of the ecological benefit afforded by Alternative 1 as was possible while reducing the cost as much as possible at the same time. Because the largest expense in Alternative 1 was the need to relocate the MTLB, this alternative left the existing seawall protection for the MTLB in place. In an attempt to compensate and provide some ecological benefit, the created marsh would be made as large as site constraints would allow; the costs inherent in so doing were relatively less than the relocated building, and the expected output would be somewhat commensurate.

These changes did increase the benefits while holding down costs, as evident in the fact that it is a better buy than Alternative 1 with an incremental cost of $42.58 versus $152.63. However, despite this optimization, Alternative 2 still exceeds the cap for the authority, with an initial construction cost of $8,379,498. This cost exceeds the Section 544 cap of $7,692,307 by more than $687,000. Given the sponsor's budgetary constraints, they would not be able to support this alternative. For this alternative, the AAE cost is $421,000 and the AH score is 12.9. Because this alternative exceeds the monetary cap for the authority and the sponsor is not supporting it, it will be removed from further consideration.

3.7.1.4 Alternative 3

Alternative 3 is cost-effective but not a best buy. This alternative attempts to reduce costs further by not only leaving in the seawall portion that protects the MTLB but also leaving in

portions of the seawall that protect the North Picnic Shelter, which is immediately south of the MTLB. An attempt is made to offset the benefits lost via the reduced removal of armor by making the marsh slightly larger. This offset increased some benefits at a lower cost than having to relocate the North Picnic Shelter. This alternative was actually the best buy when the preliminary CE/ICA was performed and had been discussed as the potential recommended plan; however, the team subsequently realized that there was too much risk and uncertainty associated with the attempt to create a tidally influenced marsh. As a result, the team decided to create a freshwater marsh instead. This reduced the cost (it also reduced some benefits, as the tidal marsh habitat is more desirable and productive than the freshwater marsh habitat). The initial cost for this alternative is just below the threshold for the Section 544 authority; even with the more expensive tidal marsh, the initial cost of Alternative 3 would be $7,698,498. After a revised version of this alternative was prepared (Alternative 3A described below) and the CE/ICA was redone, this alternative, while still cost effective, was no longer a best buy. For Alternative 3, the AAE cost is $386,000 and the AH score is 11.8.

3.7.1.5 Alternative 3A

Alternative 3A is identical to Alternative 3 but with a freshwater marsh of smaller size in lieu of the larger salt marsh. While this change results in a loss of some benefits considered to be significant, it poses a greater chance of success. It does have a slightly lower cost than Alternative 3 (by $95,000), and at $7,603,498, its cost also falls slightly below the Section 544 monetary cap. For Alternative 3A, the AAE cost is $380,000, and the AH score is 11.3.

3.7.1.6 Alternative 4

Alternative 4 is an attempt to craft an alternative that is less complex, less expensive, and which would result in a more modest ecological benefit. In this alternative, more of the armor is left in place than in previous alternatives; also, there is no attempt to create any type of marsh habitat. While this does reduce the cost by close to half a million dollars, the environmental output is less and the resulting price per habitat unit is the second highest of all the alternatives. This alternative is cost effective (though not a best buy) but does very little to meet the fifth objective of diversifying and restoring intertidal habitat. For Alternative 4, the AAE cost is $361,000, and the AH score is 10.4.

3.7.1.7 Alternative 5

This alternative was crafted in an attempt to obtain limited benefits with substantially reduced costs; it is a minimum alternative with little change to the Project Area. The armor removal in this alternative was limited to two rock structures that cover buried gabion baskets. They represent only 19 percent of the total length of armoring along the Project Area. Extensive beach nourishment was added from north to south and the cross section was widened waterward. Some revegetation would occur, but it would be mostly landward, and no marsh creation or revegetation was included. The cost for this alternative is $4,925,587, the lowest of the action alternatives. The AAE cost is $280,000, and the output as measured by the AAHS is 8.8. This alternative is considered cost-effective but not a best buy. It had the lowest average cost per habitat unit at $31.82 per AAHS, but it did not do a good job in meeting project objectives. Most resource agencies did not favor this alternative and felt it was not sustainable.

3.7.2 USACE Criteria: Effectiveness, Efficiency, Completeness and Acceptability

The USACE uses four criteria in evaluating alternatives; effectiveness, efficiency, completeness, and acceptability. Effectiveness relates to how well the alternatives meet project goals and objectives; efficiency relates to costs (i.e., is it cost effective and/or a best buy?); completeness refers to whether or not the alternative addresses present and future restoration opportunities in the Project Area; and acceptability relates to how well the public, non-federal sponsor, and resource agencies find the alternative to be feasible and implementable. Table 3-13 summarizes the alternatives and how they rate with regards to these four criteria.

Table 3-13

Summary of Effectiveness, Efficiency, Acceptability, and Completeness Ratings for All Alternatives

Comparison Criteria	No-Action	Altenative 1	Alternative 2	Alternative 3	Alternative 3A	Alternative 4	Alternative 5
Effectiveness	Not effective; continued degradation of nearshore will occur	Meets all project objectives	Meets all project objectives	Meets all project objectives	Meets all project objectives	Does not meet objective to diversify marsh	Barely meets project objective to reconnect sediment supply
Efficiency	Cost-effective and a best buy	Cost-effective and a best buy	Cost-effective and a best buy	Cost-effective	Cost-effective	Cost-effective	Cost-effective
Acceptability	Not acceptable to resource agencies, sponsor nor public	The very high cost of the alternative (in excess of 100%) exceeds authority cap	The very high cost of the alternative exceeds authority cap	Viable; desired by sponsor as ideal plan	Viable; desired by sponsor as most optimal plan	Not well accepted; considered too lacking in level of outputs	Not consider an acceptable investment to sponor/public nor resource agencies
Completeness	N/A	Complete; this alternative is environmentall y preferred and is a maximum restoration with high sustainability	Complete; addresses all present aspects of deteriorated ecosystem and in a sustainable manner	Complete; addresses all present aspects of deteriorated ecosystem and in a sustainable manner	Complete; addresses all present aspects of deteriorated ecosystem and in a sustainable manner	Complete; all aspects of present and future restoration are considered to a degree	Incomplete; limited in scope and unlikely to be sustainable

3.7.3 Park and Recreation Effects

Park and recreation benefits were assessed based on the quantity, quality, and relationships between recreation elements within each alternative. The alternatives were broken up into their respective recreation elements, which included lawn areas, the play area, picnic shelter(s), beach access, trails and paths, parking, and environmental education benefits. For the environmental education benefit, the amount of habitat, the diversity of habitat, and park amenities that would support education were used to assess each alternative. For the remaining recreation categories listed above, each alternative was assessed based on the amount of each element, its accessibility, user safety, and the overall quality, which was largely dependent on views to the water. It was assumed that all of the alternatives, with the exception of No Action, would be ADA-accessible through their design, so accessibility in this context relates to the overall ease of getting to a destination and the distance to a destination. User safety was assessed through the Crime Prevention through Environmental Design (CPTED) strategy of "Natural Surveillance." Natural surveillance refers to the concept of maximizing visibility of people and places to reduce fear of and incidence of crime.

Alternatives 3, 3A, and 4 all provide the most recreation benefits, followed by Alternative 2, Alternative 1, Alternative 5, and finally, the No Action alternative. Alternatives 3, 3A, and 4 all have recreation benefits in the areas assessed that are greater than the other alternatives. Alternatives 1 and 2 also provide a high degree of benefit in a number of recreation categories, but by maximizing restoration, the lawn element was minimized and provides less benefit for recreation. Alternative 5 shows a high benefit for the trails and parking elements because all trails and parking are retained and the parking also retains the panoramic views of the water from its west side. However, the benefits from other recreation elements (play area, picnic shelter(s), beach access, and environmental education benefits) were fairly low due to the lack of improvements to existing conditions compared to other alternatives. The No Action alternative has similar benefits to those for Alternative 5, except it had fewer recreation benefits for the trails/paths elements. These reduced benefits are due to the accessibility of the trails to disabled users—although all trails would have improved ADA accessibility in the Alternative 5 design, they would not be renovated to meet ADA guidelines in the No Action alternative.

3.7.4 Compatibility with Non-Park Uses

Compatibility with non-park uses examines how each alternative does or does not contribute to the mission and operations of educational facilities and programs and utility infrastructure within the park. This analysis involved surveying stakeholders of each facility on the desirability of each alternative and assessing the compatibility for each alternative. The assessment was weighted to give more significance to the more prominent MTLB and ESC facilities in comparison to the sewer and water infrastructure, as these utilities are generally less affected by the various alternatives.

The assessment showed that Alternatives 3 and 3A were the most compatible, followed closely by Alternative 2, Alternative 4, Alternative 5, the No Action alternative, and finally, Alternative 1. While the assessment showed similar levels of compatibility for the sewer pumphouse, and the MTLB retained a similar range of compatibility between alternatives, the ESC facility scores exhibited major differences between alternatives. The value of the ESC facility as it relates to this evaluation is based on the amount and diversity of habitat and the proximity of the MTLB, with which the ESC partners. Because of this, the ESC element is most compatible with Alternative 3 and 3A where there is an abundance of habitat types and the MTLB remains nearby. Alternative 1 is least compatible with the ESC element because although this alternative contained a large amount of habitat, the MTLB was relocated far away from the ESC facilities. The loss of the lawn area and picnic shelter reduced the compatibility with Alternative 2, and the less diverse habitat (no marsh or wetland) reduced the compatibility with Alternatives 4 and 5.

3.7.5 Permitting Feasibility

Because the Project is located within the 200-foot setback from the MHHW line, and a substantial portion of the work will occur below the MHHW line, the Project is subject to a stringent environmental review process. It is anticipated that the Project will need to comply with the following federal regulations, and may be reviewed by state agencies for advisory compliance with their statutes.

- NEPA, Lead Agency: USACE
- Section 10 Rivers and Harbors Act, Lead Agency: USACE
- Section 404 and 401 Clean Water Act, Lead Agency: USACE; for Section

401,Washington State Department of Ecology review

- Construction Phase NPDES Permit, Lead Agency: Washington State Department of Ecology
- Section 7 ESA, Lead Agency: NMFS and USFWS
- Section 106 NHPA, Lead Agency: USACE; State Department of Archeology and Historic Preservation review
- Coastal Zone Management Act (CZMA), Lead Agency: USACE; State Department of Ecology review
- Advisory Permit Review: Hydraulic Project Approval (HPA), WDFW

To assess the permitting feasibility of the various alternatives for the Project, a set of five environmental sub-criteria was identified. The selection of these sub-criteria is based on the Project team's past and current experience with the environmental review of similar projects, and on Project-specific feedback received from resource agency representatives to date.

Two types of sub-criteria were generated. Whenever possible, criteria were defined as a measurable entity (e.g., length of armor removed or added or area of intertidal habitat increased or decreased). Other criteria are more assumption-based (e.g., the likelihood of encountering and affecting cultural resources). All of the sub-criteria were evaluated by assessing their permitting implications related to time, effort, and likelihood of obtaining environmental permits and approvals.

The individual environmental sub-criteria applied to evaluate the permitting feasibility for each alternative are as follows:

1. Marine Resources/ESA: The effects of the different alternatives on marine resources and ESA species were evaluated in the Ecological Benefits Section of this study. This sub-criterion utilizes the results of that evaluation to assess the permitting feasibility of the various alternatives as they relate to this resource.
2. Intertidal Area: This criterion reflects the net loss or net gain of intertidal habitat.
3. Seawall and Shoreline Armoring: This criterion is based on the length and type of seawall and shoreline armoring removed or added.

4. Cultural and Historical Resources: While this sub-criterion evaluates potential impacts to known resources, it also assumes the potential risk of encountering and disturbing cultural resources within other areas of the site.
5. Agency Feedback: This sub-criterion reflects the feedback received from various resource agency representatives during and following an interagency meeting conducted for the Project in the 2009 Feasibility Evaluation.

Only the six "action" alternatives were evaluated, as the No Action alternative would not require obtaining any permits.

Alternative 1 is considered the most feasible to permit. All sub-criteria are positive for this alternative emphasizing restoration. The only exception is sub-criterion 4, Cultural and Historical Resources. This is due to the significant amount of ground disturbance associated with this alternative, which would result in an increased risk of encountering and disturbing sensitive resources. If such resources were encountered, delays and increases in cost to obtain permits and approvals and to construct the Project are likely.

Alternatives 2, 3, 3A, and 4 have similar permitting feasibility. The main differences between these four alternatives are: a range of ecological benefit scores and an increased risk of encountering cultural and historical resources, depending on the amount of ground disturbance near the creek mouth. While all of these alternatives are feasible from a permitting standpoint, Alternative 2 would be the easiest to permit because the most shoreline armoring is removed, while Alternative 4 would involve the least amount of armoring removed, and least amount of restoration; therefore, Alternative 4 would be somewhat less easy to permit, though it is certainly still very feasible.

The alternative with the lowest permitting feasibility is Alternative 5. A significant net loss of intertidal area would result from this alternative, with the least ecological benefit to offset this impact. While the resource agency representatives looked favorably at Alternatives 1 through 4, they were less supportive of Alternative 5. They preferred the removal of the seawall, and they questioned the sustainability of Alternative 5.

3.7.6 Funding Feasibility

Funding feasibility was assessed by evaluating elements that restoration funding entities place high value on. While long-term funding for this Project will likely come from both restoration and recreation (for future local sponsor improvements) funding entities, this evaluation only addressed restoration funding. The reason is that the Project scope does not include independently funded recreation improvements by the local sponsor. Because the No Action alternative has no elements to be implemented, it would not require any funding and was thus excluded from the analysis.

A number of habitat-restoration-focused grant sources were assessed for their overall selection values. These organizations included USACE, the Puget Sound Partnership via WRIA 9, the Estuary and Salmon Restoration Program (ESRP), and the SRFB. The habitat restoration funding entities generally place a high value on the ecological benefits created through a project and its sustainability. Scores from other evaluation criteria were again used to provide a funding feasibility result; the criteria used included capital cost, operations and maintenance costs, and ecological benefit.

Alternatives 2, 3, 3A, and 4 are considered the alternatives that are the most feasible to fund. Alternative 1 followed closely behind these alternatives. Alternative 5 had the lowest feasibility for funding. Alternatives 2, 3, 3A, and 4 meet all criteria for funding feasibility. Alternative 1 meets the criteria for sustainability and ecological benefit, but its significantly higher overall cost is a real barrier to funding this alternative. Alternative 5 is not considered feasible because it does not meet the sustainability and ecological benefit criteria, even though it has a low initial cost.

3.7.7 Risks and Uncertainty of Analysis

The estimates for costs and ecological benefits both include some uncertainty. Such uncertainty is limited by the extensive expertise of the team that conducted both aspects of the analysis. Cost estimates were prepared based on best professional judgment of experienced engineers and habitat restoration experts who have completed projects of similar size in similar habitats, including the completed restoration work in the south portion of Seahurst Park. There is a high degree of confidence in the completeness and accuracy of the

cost estimates given the available site information and current rates. The cost estimates include contingency costs to account for unforeseen costs that may become apparent at the project design is further developed. The further into the future the project is constructed, the less accurate the current cost estimates will be because costs may escalate over time due to general inflation. Furthermore, future cost uncertainty results from the potential changes in cost of specific work items whose rate depends on supply-demand conditions in the marketplace. Rates are generally good at present because of the economic climate; however there is potential for change in the future. Any such change cannot be predicted with sufficient confidence to include in the cost estimate, although the cost contingencies included in the estimate can be expected to address rate changes to some extent.

The ecological benefits analysis relied on peer-reviewed literature when available and best professional judgment otherwise. Similar to the costs uncertainties, the uncertainty of the ecological benefits is minimized by the team's experience in conducting similar assessments in similar habitats. The temporal component of restoration benefits, which were quantified using "restoration trajectories," has an inherent component of uncertainty because the benefits will be affected by natural conditions (e.g., extraordinary storms) beyond the control of the project design. The long-term function of the salt marsh is particularly uncertain because much of its function depends upon maintaining a channel from the marsh to the foreshore of the beach. Concerns about keeping the outlet channel led to development of alternatives to provide larger marsh areas, which would increase the likelihood of the channel staying open. Ultimately, the awareness of the uncertainty of the long-term benefits led to the addition of Alternative 3A, which included a freshwater wetland whose function is more certain because an open outlet channel is not essential.

The uncertainty of the rate of sea-level change and the resulting impacts to beach conditions must be acknowledged. As described in Section 2.9.1, three scenarios of sea-level change were run and one was selected for planning purposes. The sea-level change scenario selected affects the engineering analysis, cost estimation, and ecological benefits analysis. To address these uncertainties, the scenario used in this study was the same as that selected previously by the PSNERP study. The selected scenario provides the most challenging conditions for which to engineer a design and estimate ecological benefits. In this way, the design and

analysis considered the greatest change forecast in order to provide conservative outputs that maximize the certainty of a sustainable design for future conditions.

The risk associated with the uncertainties of the cost and ecological benefits analyses is that the results of the analyses determine the preferred alternative. As described above, these uncertainties were acknowledged and taken into consideration, but the expertise of the team and the detailed description of the techniques and decisions minimizes the potential for error. The ecological benefits analysis is more subjective than the cost estimates, as different techniques could have been developed to quantify the benefits. The use of peer-reviewed literature when available and the professional judgment of experienced scientists provide confidence that the relative benefits between alternatives are correctly characterized.

3.8 Plan Selection

Although, Alternative 3A is not a best buy, it is cost-effective and was selected as the preferred alternative after careful considerations. These considerations include the following:

1. Risk and Uncertainty: Alternative 3A has less risk and uncertainty than other alternatives that include a salt marsh habitat. The freshwater marsh in Alternative 3A does not rely on daily tidal inundation and maintenance of a channel for tidal inundation to function as designed. As described previously, there is a risk with tidal channels that sediment transport will fully or partially close the channel mouth and render the tidal marsh less functional than intended, or non-functional. Freshwater hydrology to support this freshwater wetland has a low risk of failure since it is supported by multiple streams all of which have perennial flow and watersheds entirely or mostly in the park boundaries. Therefore this alternative has less risk and more certainty of providing the ecological functions it is designed to provide.
2. Cost: Alternative 3A has a lower cost than alternatives 1, 2, and 3. The cost of this alternative is within a range that the USACE and the local sponsor can fund.
3. Constraints: Alternative 3A addresses park use constraints better than alternatives 1, and 2 by providing more useable lawn area and keeping the north picnic shelter in its current location.

4. Ecological Benefits: Alternative 3A provides more ecological benefits than Alternatives 4 and 5.

4 PREFERRED ALTERNATIVE/RECOMMENDED PLAN

This section describes the selection of the preferred alternative, refinements, costs, and implementation considerations.

4.1 Selection and Justification of Preferred Alternative Plan

Alternative 3A focuses on improving intertidal habitat by addressing shoreline armoring impacts to sediment transport and restoring natural slopes and substrate sizes, reconnecting feeder bluffs to the intertidal zone, enhancing stream mouths, and enhancing marsh and riparian vegetation conditions. The completion of these restoration activities in the Project Area will complete the shoreline restoration at Seahurst Park. Given the park's location, size, and importance to sediment supply to beaches extending north, this Project represents a significant step in the region's ecosystem restoration efforts. The Project Area shoreline, nearly 3,000 linear feet, is large compared to others in central Puget Sound. This is especially true when coupled with the Seahurst Phase I project that has been completed by the City and USACE. The completion of the Project would result in approximately 4,500 linear feet of restored shoreline in the park.

The restoration of Project Area shoreline presents a unique opportunity because much of the central Puget Sound shoreline is privately owned and the parcels tend to include only short portions of the shoreline. As a result, restoration opportunities on the scale of Alternative 3A are very limited, and very few have been completed elsewhere in central Puget Sound, due to the costs and logistics of working with a large number of landowners or finding appropriately large sites.

The restoration of sediment recruitment and transport conditions as proposed in Alternative 3A would benefit shoreline processes and nearshore habitats far beyond Seahurst Park. Seahurst Park is situated near the "up-drift" end of the longest drift cell in Central Puget Sound (Schwartz et al. 1991). In fact, the drift cell extends north more than 10 miles to Duwamish Head in Seattle. As a result, restoration of sediment recruitment and transport in the Project Area can benefit shoreline areas for up to 10 miles to the north of the site.

Alterntive 3A will restore suitable high intertidal habitats for forage fish spawning, improve aquatic and terrestrial-origin prey productivity for juvenile salmon and other aquatic and terrestrial animals, and improve rearing conditions for juvenile salmon through increased accessibility of shallow water habitats and reduced wave energy along the shoreline. Alternative 3A is consistent with the fish restoration goals of NMFS and the State of Washington as required by WRDA 2000, Section 544 paragraph (c)(2)(B). The creation of backshore habitats designed to match natural conditions in Puget Sound will significantly enhance the long-term sustainability of the restored beach areas. The backshore areas provide not only increased volume of appropriately sized beach material, but these areas recruit large woody debris that acts to further stabilize the beach by retaining sediment behind logs and providing a stable area for the growth of native beach grass and herbaceous vegetation.

Alternative 3A creates a restored North Creek mouth with a freshwater wetland of a small scale. The freshwater wetland would further enhance the Project's ability to achieve the restoration objectives of restoring connectivity between upland and shallow water intertidal habitats and diversify habitat at the saltwater/freshwater interface. The freshwater wetland would provide important nearshore functions and habitat that have been lost in many other areas around Puget Sound. The freshwater wetland would contribute to the detritus-based Puget Sound estuarine and nearshore food web through the decay of vegetative material.

The expanded areas of riparian vegetation will enhance the production of terrestrial-origin prey in the diet of juvenile salmon. Riparian trees in close proximity to the shoreline contribute insects and other invertebrates to aquatic habitats. A recent study of juvenile salmon use of nearshore habitats in Central Puget Sound, including Seahurst Park, found that terrestrial-origin prey were the most numerous prey items in the stomachs of juvenile Chinook salmon (Brennan et al. 2004). Leaves, branches, and other vegetative material from the planted riparian vegetation will also fuel the detritus-based Puget Sound estuarine and nearshore food web.

The restoration actions proposed in Alternative 3A would provide significant improvements to the ecological function of the Project Area. Compared to future without project conditions, it is estimated that 3.5 times the ecological function would be provided by

Alternative 3A over the 50-year project period. These ecological benefits would include providing more than 3.6 acres of new low intertidal habitat and nearly 1 acre of new high intertidal habitat. In addition, 2.8 acres of new backshore habitat and nearly 0.5 acre of new riparian habitat adjacent to the backshore would be created.

Alternative 3A also supports City Master Plan objectives for shoreline public access, user safety, educational uses, and recreational uses. These park uses are fully compatible with Alternative 3A, and it is a study purpose to optimally combine restoration and park uses. Figure 21 shows the preferred alternative/recommended plan.

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ANCHOR QEA

Figure 21
Preferred Alternative: Recommended Plan
Seahurst Phase II Shoreline Ecosystem Restoration
Detailed Project Report / Environmental Assessment

4.2 Recommended Refinements

The 35 percent design represents a more detailed level of design than the 10 percent designs developed for the alternative plans. Refinements in the 35 percent design cover the following items for the recommended Alternative 3A plan:

- Grading design of beach: Refinements to the grading design of the beach, and freshwater wetland were made; these refinements address the beach coastal processes and affect the design of the wetland.
- Design of stream mouths and freshwater wetland: Refinements include grading and materials selection to provide for stability of the streams, and minimize the cost of the wetland.
- Design of fish ladder, holding pond, and water/sediment management facilities: These refinements include relocations and addressing operational issues at the MTLB for these facilities; these issues include the ability to manage sediment from North Creek and to provide a diversion of low stream flows from this creek to the fish ladder and holding pond during the fall when adult coho salmon are returning to spawn. This spawning period is relatively brief (2 to 3 weeks); therefore, the diversion of the stream low flows will not adversely impact the freshwater wetland at the mouth of North Creek. Water and sediment management facilities will consist of a vault in line with North Creek, and two low-flow outlets (one to the reconstructed lower end of North Creek, and the other to the fish ladder and holding pond), and one high-flow bypass for managing sediment. The fish ladder and holding pond need to be relocated due to the reconstruction of the North Creek mouth into a more natural channel. The relocation is also needed to place the bottom of the fish ladder at an elevation similar to the current bottom level for tidal accessibility.
- Replacement park improvements: Refinements were made to address the scope of park improvements addressed by this Project; these park improvements are limited to replacement items affected by the restoration.
- Tidepools: The 35% design shows tidepools of a specific size and elevation range. The tidepools are shown as approximately 4 by 6 feet, and 1 to 2 feet deep. They are shown as having water surface elevations between +10 feet MLLW, and +4 feet MLLW. The tidepools will be grouted to ensure water retention between tides. The

pools will add habitat diversity to the rock for toe protection and the south drift sill. The main purpose of the tidepools is educational to support the ESC and MTLB programs.

4.3 Estimated Cost of Preferred Alternative Plan

The estimated cost for the preferred plan is based on the 35 percent level of design. These costs are included in Table 4-1. A more detailed version of the 35 percent opinion of probable cost is included in Appendix E.

4.4 Design Considerations for Recommended Plan

The recommended plan needs to consider all of the items described below under final design and preparation of bid package. These include engineering considerations involving structures, utilities, and water management elements, habitat restoration considerations, emergency access, and park use and recreation facilities that are affected by the restoration. In addition, both short-term and long-term methods of protecting vulnerable habitats, such as protecting the freshwater marsh from trampling by park visitors, will be explored. Use of chain link or other obvious fencing will be avoided as it conflicts with the underlying park use. However, more subtle methods, such as well-defined walking paths with raised and partially buried log edging, viewpoints with railings, and interpretive signage, are anticipated. Some refinements in all these are anticipated as the Project proceeds through more detailed levels of design.

As the Project proceeds through the permitting and value engineering process, there may be additional conditions that affect its design.

4.5 Real Estate Requirements

(This section is in preparation by USACE Real Estate staff.)

4.6 Implementation

Implementation involves final design, bidding, construction, and monitoring. There are important scheduling and sequencing issues affecting construction of this Project.

4.6.1 Final Design and Preparation of Bid Package

The recommended plan will require further design beyond 35% prior to construction. Preparation of the final design and bid package will occur following completion of this feasibility study. It will include all the elements in the 35% design, but will be developed to fully support accurate bids. Items requiring considerably more design and engineering include:

- Engineering design of new walls and wall penetrations: This item includes the return wall south of the picnic shelter. It also includes modifications to the existing seawall

where the new fish ladder is proposed. These modifications will require structural engineering and other engineering design.

- Engineering design of the fish ladder, holding pond, and water/sediment vault: There is a water resources engineering design component that is required for these improvements. This element also includes new water conveyance lines to the fish ladder holding pond, North Creek, and replacement of any water supply lines to the MTLB affected by the Project.
- Utilities engineering design: The design of the SPU water main relocation, storm drainage, power, and communications line will be required by a variety of engineering disciplines. Some design work may be required to be performed by the utility providers.
- Coordination of design with SWSSD: Design of the sewer line will, new utilities, and culverts crossing the sewer line will require close coordination with the SWSSD design engineering team.
- Emergency access design: Coordination with the Burien Fire Department will continue and further refinements to the design of the emergency access terminus will be required.
- Final design of restoration: This item includes the design of the beach, backshore, riparian areas, and freshwater wetland.
- Final design of park elements affected by the restoration: These elements include trails, parking, play area, and lawn areas that are removed for restoration and need to be replaced as part of the Project. ADA access will continue to be refined in the final design.
- Response to Value Engineering (VE) Comments: Any VE recommendations that are to be carried out in final design will need to be incorporated. As these VE recommendations are not developed, it unclear how many or what type of recommendations will need to be responded to.
- Final specifications and costs: These documents will be developed as part of the final design deliverables.

4.6.2 Construction Phasing and Scheduling

Construction phasing will be determined by the final costs and cost sharing between USACE and the local sponsor. It is possible that some elements of the Project may need to be deferred to a future phase if available funding does not allow for full implementation of the Project as currently defined.

Construction scheduling will be affected by two major factors in addition to available funding. These include fish migration closures, and the SWSSD project. It is recommended that the Project be constructed from July 16 to February 14 of 2011 to avoid primary fish migration closure is for juvenile salmon. This timing will give the contractor maximum flexibility to complete the work.

A second construction scheduling issue is construction in the Project Area of the SWSSD improvements. This work is scheduled to begin in summer of 2010 and extend through late winter/early spring of 2011. There are two coordination and sequencing items that USACE and SWSSD overlap on that require further discussion. These include the removal of the north groin, and the North Creek culvert crossing. There are construction efficiency and sequencing issues associated with these two items. Other utilities issues may also require further coordination.

4.6.3 Monitoring

Monitoring will fall into two categories. First is monitoring required by USACE as part of the environmental review and permitting process. Second is discretionary monitoring funded by grants and overseen by the local sponsor. Required monitored will include baseline pre-construction monitoring and post construction monitoring. Both of these types of required monitoring would be conducted by USACE. The specific monitoring parameters will be determined through the environmental review and permitting process. Discretionary monitoring will extend longer and will likely include physical beach monitoring and biological monitoring similar to what has occurred on the Seahurst Phase I project. A Stewardship and Monitoring Plan (Anchor 2010 in preparation) prepared by the local sponsor lays out further detail on this topic.

4.6.4 Permitting

USACE will lead the permitting effort which will address all the requirements in Section 3 under Permitting Feasibility. The completion of the NEPA EA as part of this document is the first step in initiating the permitting process.

4.6.5 Operation and Maintenance

The primary operation and maintenance activities for the restoration are described in Section 3. They include beach nourishment, landslide debris management, and establishment of riparian and other native vegetation. The costs for these activities are described in Section 3. Further detail regarding operation and maintenance is also found in the Stewardship and Monitoring Plan prepared by the local sponsor (Anchor 2010 in preparation).

5 ENVIRONMENTAL EFFECTS OF THE NO ACTION AND RECOMMENDED ALTERNATIVES*

5.1 No Action Alternative

Under the "No Action Alternative," shoreline armor, rock and fill removal would not take place. No additional substrate would be placed at Seahurst Park. Damage to existing armoring structures would continue and the beach conditions, over time, would continue to be degraded and net shore drift impeded. The beach would gradually steepen and the area and value of intertidal habitat reduced as a result. Maintenance costs to repair the armoring structured and shoreline would increase over time. Intertidal habitat loss would continue through lack of material normally provided by littoral drift. The "No Action Alternative" does not represent any changes to the baseline conditions concerning physical characteristics, water quality, vegetation, wetlands, cultural resources, noise, and air quality conditions at the site, and represents a potential negative impact on forage fish and listed salmonid critical habitat by continuing to limit forage fish spawning opportunities.

5.2 Recommended Alternative

5.2.1 Physical Characteristics

With the Recommended Alternative (Alternative 3A) the removal of the armoring structures would result in a change in current erosion patterns at Seahurst Park. Wave protection at the toe of the bluff afforded by the armoring structures would be eliminated, allowing access to the bluffs by wave action. This would occur at extreme high tides and is likely to increase local erosion at the base of the bluff. Erosion rates, however, are not likely to increase substantially. The rate of loss and the subsequent occurrence of landslides appear to be driven by upslope instabilities rather than toe erosion (City of Burien 2002). Littoral drift of material is likely to be restored with removal of the armoring structures and placement of beach material. It is unlikely that the substrate placement at Seahurst Park will affect alluvial dynamics at the creek mouth.

5.2.2 Water Quality

Substrate placed on the beach after seawall removal will be free from any pollutants or contamination. Some increased turbidity would likely occur for one or two high tides following placement, but the effects of the turbidity are expected to be minimal due to their localized and temporary nature. Material placed for beach restoration will be sorted from clean materials and free of excessive fines. Waves, tides, and currents would likely rapidly disperse any resultant turbidity. During construction, equipment operating on the beach would work in the dry and would be inspected daily for leaks or petroleum contamination prior to commencing work. Barge operations have been planned such that prop disturbance to sediments is minimized through a reduction of barge movements and a single material loading site. A spill prevention control and containment plan designed to reduce the impacts from potential spills (fuel, hydraulic fluid, etc) would be in place prior to the start of construction. Accordingly, impacts to water quality parameters are expected to be minimal.

5.2.3 Vegetation

Upland vegetation will not be impacted significantly; however, some trimming or removal may be necessary to provide equipment access. All disturbed areas will be replanted with native plants in keeping with park goals and to increase plant diversity, reduce disturbance, and improve water quality. Some park-sponsored revegetation of the backshore is planned for shortly after project completion as an early phase of the City's upland trail reconstruction.

5.2.4 Wetlands

While there are areas that appear to be capable of supporting a wetland community, the heavy use of the Project Area by human visitors and the heavy vegetative maintenance of the park have effectively kept them from forming. There is a potential area for wetland development within a flat depression adjacent to the tributary. Some small wetland pockets and seeps may exist on the forested hillside associated with small depressions and local drainage. Top of bluff development and surrounding infrastructure may have decreased the amount of runoff to the bluff. This decrease may have reduced the number and diversity of any wetlands, as well as had an affect on the volume of freshwater influencing the beach. No wetlands will be impacted by the Project.

5.2.5 Natural Resources

5.2.5.1 Macroalgae and SeaGrasses

Long-term investigations of eelgrass and macroalgae abundance or distribution have not been undertaken at the Project Area. Recently, a reconnaissance-level survey of eelgrass presence was conducted to provide insight into spatial constraints and likelihood of impacts from project construction. Beach material placed under this proposal is expected to be placed and finish-graded by tides between elevations +15 feet and +4.0 feet MLLW with a strong placement bias towards the upper elevations. Eelgrass beds offshore of the Project Area lie between +2.0 feet and approximately –2.0 feet MLLW. Bull kelp was not seen during the survey but may be present under the surface at bottom elevations between –6.0 feet and –15 feet MLLW. No eelgrass or kelp occurs in the project footprint. The barge is not expected to ground fully on the bottom as it delivers beach material.

During construction, a barge would be stationed at the beach to remove fill and rock material for upland disposal. Construction would be timed during the fall to coincide with relatively calm weather and high daytime tides that would allow the barge to access staging areas in the high intertidal or supratidal zone with no grounding in eelgrass or kelp beds. A temporary loading ramp would be provided to facilitate barge loading. A second barge may be provided upon completion of fill removal (or near completion) to deliver gravel directly to the beach with a conveyor belt. The barge offloading material would not rest on the bottom below an elevation of –2 feet MLLW and would be positioned to avoid any grounding on eelgrass. Construction activities would likely disturb the upper edge of the intertidal zone where *Ulva* spp. have been observed. Substantial impacts to eelgrass are not anticipated due to extremely low eelgrass density in the immediate work zone and minimized need for tug movement and resultant prop wash. Any impacts to algae would be temporary and expected to recover quickly. The community dynamics of the algal species in the area should not be affected by the Project. Post-construction, material placed to restore the intertidal beach profiles are expected to move along the littoral drift cell and not downslope into elevations occupied by eelgrass.

5.2.5.2 Fish

Juvenile salmonids use the shoreline of Seahurst Park for feeding and refuge from predators. (Nearby monitoring of the beach at Lincoln Park following initial construction found that the overall density of important salmonid prey items along the disturbed beach was similar to a control beach [Pentec 1993]). By burying the existing beach surface, the proposed work would temporarily decrease populations of epibenthic organisms within the project footprint. Potential adverse effects would be minimal because the work would occur in the fall, as epibenthic production seasonally decreases and the project footprint represents only a small proportion of the available foraging habitat in the vicinity. Any dip in epibenthic abundance would be short-term. Peak abundance of juvenile salmonids at the Project Area occurs in the spring, allowing for partial recovery of epibenthic communities. Adult salmon may occur in the vicinity of the Project when the work would occur, but these fish are larger and not as directly dependent upon the upper intertidal nearshore environment.

The proposed construction would occur just prior to the peak of the migration of adult coho salmon returning to nearby creeks and rivers. Although adult coho may orient along the shoreline during their migration, they are not specifically dependent upon the nearshore during migration. Coho may stage near the creek prior to their terminal migration but the Project is likely too far from the nearest utilized creek mouth to be considered an important staging area. In-water disturbance during construction would be minimal. Sand lance and surf smelt are known to spawn on beaches located within the general Project Area (WDFW 2010). The forage fish prefer areas of finer gravels and sand substrate than those found in front of the armoring structures. A main purpose for providing additional substrate following removal of the armoring structures is to provide forage fish spawning habitat. The limited amount of habitat presently available will be covered with new beach material. Adverse effects to other marine fish are not anticipated as the work will occur at high tidal elevations and the disturbance would be temporary.

5.2.5.3 Wildlife

The proposed construction would slightly increase activity over ambient levels. Some displacement of birds may occur. Due to the small size of the Project, construction disturbance would be limited in size and duration. Birds moving from the vicinity of the

Project would not be displaced from locally important habitat. The completed Project would not change habitat features important to bird life. Overall, adverse impacts to birds are not anticipated as a result of the proposed work.

5.2.5.4 Invertebrates

Monitoring following the 1988 beach nourishment at nearby Lincoln Park found no effect on shellfish resources from nearshore substrate placement (Antrim et al. 1993). The proposed work at Seahurst Park would be much smaller in scope and should not represent long term affects to shellfish occurring in the vicinity. Some discrete and isolated short-term impacts from direct coverage may occur at the upper intertidal elevations as nourishment is placed, but recolonization is expected to occur rapidly. Shellfish populations at Seahurst Park appear to be highly degraded due to harvest and heavy human intertidal use.

Some degree of invertebrate impact is likely from removal of the non-native angular rock in the mid intertidal elevations above +1.0 foot MLLW. Close examination of the rocks shows colonization by snails, limpets, shore crabs, hermit crabs, anemone, polychaete worms, gunnels, starfish, and other organisms not commonly found in the sand and eelgrass communities of Seahurst Park. When removed, organisms attached to or reliant upon the rock substrate between the elevations affected will be displaced from the intertidal zone. The large quantity of rocks remaining below +1.0 foot MLLW will be undisturbed. The transition from rock to sand in the upper intertidal is necessary for full function of the mi- and upper intertidal elevations.

5.2.6 Federally Threatened and Endangered Species

Due to the small size of the Project, the timing and short duration of construction, and the restorative nature of the Project, we have concluded that the Project is not likely to adversely affect marbled murrelets, Steller sea lions, Southern Resident killer whales, humpback whales, leatherback sea turtles, bull trout, Chinook salmon, or steelhead. Likewise, the Project would have no effect on critical habitat for any of these species. To avoid adverse effects to these species, construction would occur between the months of September and October. Additional conservation measures taken to avoid impacts to salmonids include management of the construction barge to avoid grounding, allowing work

during daylight hours only, and replacement of all beach logs removed during construction. A BE has been completed that contains more details about the Project's potential effects on threatened, endangered, and sensitive species (see Appendix D for concurrence letters). A summarization of the analysis and effects determinations of the BE is given in the following subsections.

Table 5-1
Effects of Plan on Listed Species and their Habitat

Species	Determination	Critical Habitat Determination
Marbled murrelet	May affect, not likely to adversely affect	No effect
Bull trout	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Chinook	May affect, not likely to adversely affect	May affect, not likely to adversely affect
steelhead	May affect, not likely to adversely affect	No designated
Killer whale	May affect, not likely to adversely affect	No effect
Steller sea lion	No effect	Not in project area
Humpback whale	No effect	No effect
Leatherback sea turtle	No effect	May affect, not likely to adversely affect

5.2.6.1 Marbled Murrelet

Because construction activities would have no effect on nesting habitat or the murrelet food base, and the effects of any noise disturbance during construction are expected to be insignificant, the Project may affect, but is not likely to adversely affect, the marbled murrelet. The Project would have no effect on designated critical habitat for marbled murrelets because no critical habitat is located near the Project.

5.2.6.2 Steller Sea Lion

This Project will have no effect on the Steller sea lion because the potential for significant sound disturbance or impacts to water quality and prey abundance are highly unlikely and discountable, and because of the implementation of the conservation measures listed in the BE. There is no designated critical habitat for this species within the Project Area.

5.2.6.3 Southern Resident Killer whales

As killer whales are highly mobile animals, dislocation from the Project Area due to noise disturbance and due to prey movement is expected to be a minor temporary effect. Because of the likelihood that killer whales and their salmonid prey could avoid the Project Area, and because the potential for significant sound disturbance or impacts to water quality and prey abundance are highly unlikely and discountable, the proposed action may affect, but is not likely to adversely affect, killer whales. The Project is concentrated within relatively shallow intertidal zones and, therefore, would have no effect on designated critical habitat for this species.

5.2.6.4 Humpback Whale and Leatherback Sea Turtle

The likelihood that a humpback whale or leatherback sea turtle would occur along the eastern shore of East Passage, particularly in the shallow nearshore area where work would occur, is extremely low. Given their distribution, USACE has determined that the Project would have no effect on these species or on the designated critical habitat of leatherback sea turtle.

5.2.6.5 Coastal/Puget Sound Bull Trout

The Project may affect, but is not likely to adversely affect. Puget Sound/Coastal bull trout. This determination is made based upon the limited scope and duration of the Project, the low likelihood that bull trout would be present in the action area during construction, and the temporary and minor nature of project impacts. The shoreline restoration would be wholly beneficial; therefore, the Project would have no effect on designated critical habitat for bull trout.

5.2.6.6 Puget Sound Chinook Salmon

The Project may affect, but is not likely to adversely affect, Puget Sound Chinook salmon. This determination is made based upon the limited scope and duration of the Project, the low likelihood that Chinook would be present in the action area during construction, and the temporary and minor nature of project impacts. The shoreline restoration would be wholly

beneficial; therefore, the Project would have no adverse effect on designated Chinook critical habitat.

5.2.6.7 Puget Sound Steelhead

The Project may affect, but is not likely to adversely affect, Puget Sound steelhead. This determination is made based upon the limited scope and duration of the Project, the low likelihood that steelhead would be present in the action area during construction, and the temporary and minor nature of project impacts. Critical habitat has not been designated for steelhead.

5.2.7 Archaeological and Historical Cultural Resources

Section 106 of the NHPA as amended requires that federal agencies identify, evaluate, and assess the effects of undertakings on sites, buildings, structures, or objects listed in or eligible for listing on the NRHP. USACE has determined that the Project is a federal undertaking of the type that could affect properties eligible for the NRHP.

USACE archaeologists completed a cultural resource inventory of the entire APE for the preferred alternative in November of 2009. The inventory consisted of a pedestrian survey at 15-meter intervals and the excavation of eight shovel test pits. A previously recorded site is located within the APE. USACE archaeologists revisited and rerecorded the site and determined that the site is not eligible for the NRHP under any criteria. No additional cultural resources were located during the inventory. The USACE has determined, and the State Historic Preservation Officer (SHPO) has concurred, that the preferred alternative will not affect any cultural resources eligible for listing on the NRHP.

If a different alternative is selected, a cultural resource inventory would be completed, a professional report prepared, and the Corps would consult with the SHPO and affected tribes. If any eligible cultural resources are located, the City and USACE would be required to redesign the Project to avoid the eligible property. If avoidance is not possible, USACE, affected tribes, SHPO, and the City as the project sponsor would need to agree on a data recovery plan and its implementation. This agreement would be negotiated through a memorandum of agreement.

USACE sent letters soliciting knowledge or concerns for the Project Area to both the Muckleshoot and Suquamish tribes on June 3, 2009. USACE also sent a copy of the cultural resource inventory report to the aforementioned tribes for their review and comment on February 23, 2010. As of the date of this EA, the tribes have not expressed any concerns.

Section 304, of the NHPA, prohibits federal agencies from publically disclosing specific information about cultural resources that could lead to their harm through vandalism or looting regardless of their eligibility. Subsequently, specific information about the site has been redacted from the correspondence with the tribes and consultation letters included in Appendix B. The cultural resource report, *A Cultural Resource Inventory of the Seahurst Park Restoration Project, Phase II*, and correspondence is on file at the USACE Seattle District Office and at the Washington State Department of Archaeology and Historic Preservation.

5.2.8 Noise and Air Quality

None of the action (construction) alternatives is expected to result in significant air quality degradation. During construction, there would be temporary and localized reduction in air quality due to emissions from heavy machinery. Construction vehicles and heavy equipment would generate gasoline and diesel exhaust fumes, carbon dioxide (CO2), carbon monoxide (CO), nitrogen and sulfur oxides, hydrocarbons, unburned carbon particles and dust on roadways.

Construction activities will occur during daylight hours, 5 days a week. The nearest residence is located outside of the park approximately 300 yards from the Project Area. There will be a temporary increase in noise during construction; however, the effect of construction noise will be minimal given the distance the residences are from the Project Area. Emissions from construction activities such as excavation and hauling are anticipated to be below the U.S. Environmental Protection Agency's (EPA's) de minimis threshold levels (100 tons/year from CO and 50 tons/year from ozone). In addition, equipment such as dump trucks, excavator, and dozers will have mufflers and exhaust systems in accordance with state and federal standards. Any effects to air quality will be short-term, only happening during

construction. The construction-phase air quality effects are not expected to exceed the standards of 93.153(b)(1) for applicable criteria pollutants, and a conformity determination is therefore not required. Following construction, there will be no change in air quality, noise, or light parameters. Using the No Action alternative as a benchmark for the existing environment in comparison to construction effects, impacts to air quality and noise will be less than significant.

5.2.9 Cumulative Effects

NEPA defines cumulative effects as the impact on the environment that results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions (40 CFR §1508.7). The passing of the Seahurst Park Master Plan by the City of Burien City Council institutes a series of potential changes that could be concluded as occurring in the foreseeable future. These actions are designed to improve park use and are not inconsistent with the intent of the Project. The actions proposed at the northern beach are specifically mentioned in the Master Plan such that future work should not degrade restoration work.

Actions that may add cumulative environmental impacts from the Project or adversely affect restoration benefits are minimal. Although the northern beach will receive substrate to restore slope and provide additional beach spawning habitat, future renourishment by the City is not completely ruled out. The Project is not intended as a long-term nourishment program, and unforeseen weather events or extended beach recovery periods may require additional material to be placed at Seahurst Park. In this event, temporary environmental impacts associated with material transport, placement, and nearshore colonization may add cumulatively to the affects of the restoration project. Some temporal impacts to invertebrates and algae will be associated with additional nourishment. Upland trail construction and additional pedestrian use may be a foreseeable event should the south beach become more heavily used following the Project. These trails would be designed to be consistent with the Master Plan, striving to avoid adverse impacts to homeowner, wetland, and aesthetic values. The Project has been designed to control and minimize adverse use of the north beach by pedestrians by providing for formal access points and trails.

One additional project in the foreseeable future is the replacement of the existing sewer line by SWSSD, including a forced main pump house, which is planned for the area between the parking lot and the vehicle turn around area. This replacement is planned to be accomplished regardless of the current restoration project, but would likely be coordinated with the restoration, if the Project is initiated. SWSSD is not relying on NEPA review or any permitting from the Seahurst Phase II Shoreline Restoration Project. SWSSD is undergoing its own environmental review and permitting process. No other cumulative impacts are anticipated.

6 COORDINATION AND COMPLIANCE*

6.1 National Environmental Policy Act

Section 1500.1(c) and 1508.9(1) of NEPA, as amended, requires federal agencies to "provide sufficient evidence and analysis for determining whether to prepare an environmental impact statement or a finding of no significant impact" on actions authorized, funded, or carried out by the federal government to insure such actions adequately address "environmental consequences, and take actions that protect, restore, and enhance the environment." This assessment evaluates environmental consequences from the proposed placement of substrate along the shoreline of Seahurst Park at Burien, Washington.

6.2 Endangered Species Act

In accordance with Section 7(a)(2) of ESA, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species. The potential effects of the Project and conservation measures taken to reduce those effects are summarized in Section 5.6 and are addressed in greater detail in the BE for the Project. USACE will address its responsibilities under the ESA prior to the start of project construction.

6.3 Clean Water Act Compliance

The proposed work was evaluated pursuant to Section 404(b)(1) of the Clean Water Act (CWA) in accordance with the guidelines promulgated by the EPA (40 CFR 230) for evaluation of the discharge of dredged or fill material into waters of the United States. In addition, consideration has been given to the need for the work, and to such water quality standards as are appropriate and applicable by law. The proposed discharge represents the least environmentally damaging practicable alternative and would include all appropriate and practicable measures to minimize adverse effects on the aquatic environment. The work would not result in the unacceptable degradation of the aquatic environment. The proposed action represents the least environmentally damaging, practicable alternative. The discharges and methods specified in the proposed work are in accordance with the Section 404(b)(1) guidelines (see Appendix H). The Corps of Engineers will coordinate with the Washington Department of Ecology and obtain a CWA Section 401 water quality certification to ensure compliance with state water quality standards.

6.4 Fish and Wildlife Coordination Act

The U.S. Fish and Wildlife Coordination Act (FWCA, 16 USC 470) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. Formal reporting requirements of the FWCA are not applicable for small restoration projects; the USFWS will be solicited for input during planning process as part of compliance with ESA.

6.5 Essential Fish Habitat

In accordance with the Essential Fish Habitat (EFH) requirements of the Magnuson-Stevens Fishery Conservation and Management Act, USACE has determined that the proposed work would impact approximately 6 acres of EFH used by Pacific salmon, groundfish, and coastal pelagic species. USACE has determined that the proposed action would not adversely affect EFH for federally managed fisheries in Washington waters. The BE for the Project provides supporting documentation for this determination. USACE is consulting with the NMFS to include conservation measures adequate to avoid, minimize, or otherwise offset adverse impacts to EFH.

6.6 Bald and Golden Eagle Protection Act

On August 9, 2007, bald eagles were removed from the federal list of threatened and endangered species and, therefore, they are not protected under ESA. However, bald eagles remain protected under the Bald and Golden Eagle Protection Act. The Eagle Act prohibits anyone from "taking" bald eagles. Among other actions, "take" includes disturbance of bald eagles. "Disturb" is the form of take that is most likely to occur and is the most ambiguous. Therefore, USFWS prepared National Bald Eagle Management Guidelines. These Guidelines are voluntary and were prepared to help avoid disturbing bald eagles. The guidelines list the following recommendations, which have been incorporated into the Seahurst Phase II Shoreline Ecosystem Restoration Project:

- Maintain a buffer of at least 330 feet (100 meters) between activities and any nest (including active and alternate nests), unless a similar activity is closer than 330 feet, then you may maintain a distance buffer as close to the nest as the existing tolerated activity.

- Restrict all clearing, external construction, and landscaping activities within 660 feet of any nest to outside the nesting season.
- Maintain established landscape buffers that screen the activity from any nest.

6.7 National Historic Preservation Act

Section 106 of the NHPA requires that federal agencies identify, evaluate, and assess the effects of undertakings on sites, buildings, structures, or objects listed in or eligible for listing in the NRHP. Eligible properties must generally be at least 50 years old, possess integrity of physical characteristics, and meet at least one of four criteria for significance. Regulations implementing Section 106 (36 CFR Part 800) encourage maximum coordination with the environmental review process required by NEPA and with other statutes. Recently-amended Washington State laws also apply on non-federal lands, including the Archaeological Sites and Resources Act (RCW 27.53), Indian Graves and Records Act (27.44 RCW), and the Abandoned and Historic Cemeteries and Historic Graves Act (68.60 RCW).

In order to comply with Section 106, USACE has conducted a cultural resource inventory, prepared a report detailing the results of that inventory, and has submitted the report to the SHPO. The SHPO has concurred with USACE's determination that the preferred alternative will not affect any properties eligible for the NRHP. The USACE is consulting with the Muckleshoot and Suquamish tribes.

6.8 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act (NAGPRA) (25 U.S.C. 3001) addresses processes and requirements for federal agencies regarding the discovery, identification, treatment, and repatriation of Native American and Native Hawaiian human remains and cultural items (associated funerary objects, unassociated funerary objects, sacred objects, and objects of cultural patrimony). Consistent with procedures set forth in applicable federal laws, regulations, and policies, USACE will proactively work to preserve and protect natural and cultural resources, and establish NAGPRA protocols and procedures.

6.9 Clean Air Act

The Clean Air Act requires states to develop plans, called State Implementation Plans (SIPs), for eliminating or reducing the severity and number of violations of National Ambient Air Quality Standards (NAAQS) while achieving expeditious attainment of the NAAQS. The Act also requires federal actions to conform to the appropriate SIP. An action that conforms with a SIP is defined as an action that will not: 1) cause or contribute to any new violation of any standard in any area; 2) increase the frequency or severity of any existing violation of any standard in any area; or 3) delay timely attainment of any standard or any required interim emission reductions or other milestones in any area. USACE has determined that emissions associated with the Project Area will not exceed EPA's de minimis threshold levels (100 tons/year for carbon monoxide and 50 tons/year for ozone). The Project Area is in a maintenance area of provisional attainment status. Emissions of pollutants from the construction equipment would be negligible.

6.10 Environmental Justice

Executive Order 12898 directs federal agencies to identify and address disproportionately high and adverse human health or environmental effects of agency programs and activities on minority and low-income populations. No tribal resources would be harmed. No adverse effects to minority or low-income populations would result from the implementation of the Project.

6.11 Coastal Zone Management Act

CZMA, as amended, requires federal agencies to carry out their activities in a manner, which is consistent to the maximum extent practicable with the enforceable policies of the approved Washington Coastal Zone Management Program.

USACE conducted a review of the King County Shoreline Master Program (SMP). The SMP is the State of Washington's application of the CZMA. Based on a thorough review, USACE has determined that the Project is consistent to the maximum extent practicable with enforceable policies of both counties shoreline management programs. The CZMA consistency statement has been submitted to the Washington State Department of Ecology.

6.12 Public Involvement

Extensive public involvement occurred as part of the 2002 Master Plan and is documented in the Master Plan report (Anchor 2002). In 2009, as part of the City's feasibility study process, a stakeholder group consisting of the USACE, City, and other habitat funding agencies, and the MTLB, ESC, and SWSSD was convened to provide input to this study. In addition, two public meetings were held during the 2009 feasibility study.

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APPENDIX A
IMPLEMENTATION GUIDANCE FOR SECTION 544 OF THE WATER RESOURCES DEVELOPMENT ACT OF 2000

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
441 G STREET NW
WASHINGTON, D.C. 20314-1000

CECW-PB

02 OCT 2006

MEMORANDUM FOR Commander, Northwestern Division

SUBJECT: Clarification of Implementation Guidance for Section 544 of the Water Resources Development Act of 2000

1. Reference is made to CECW-PM memorandum dated 29 December 2003, subject: Implementation of Section 544 of the Water Resources Development Act (WRDA) of 2000.

2. This memorandum serves to clarify and restate the guidance provided in the referenced guidance related to the cost sharing of the projects studied and implemented under this authority.

3. Section 544 of WRDA 2000 distinguishes between the requirements for a feasibility study and the requirements for implementation of projects considered under this authority. Therefore, studies to determine feasibility of a section 544 project are subject to the cost sharing requirements of Section 105(a) of WRDA 1986. Consequently, to clarify the guidance stated in paragraph 3 of the referenced implementation guidance, any feasibility studies conducted under section 544 require 50 percent Federal and 50 percent non-Federal cost sharing. The study will be initially federally funded up to $100,000. Any remaining feasibility study costs will be shared equally (50/50) with the non-Federal sponsor pursuant to the terms of a FCSA.

4. Paragraph 4 of the referenced guidance indicates that projects may be implemented in accordance with the general procedures for Section 206 Continuing Authorities Program. This reference applies only to the processes used to formulate studies, recommend projects, and approve projects at the MSC level as is done under the Continuing Authorities Program, not to the cost sharing of Section 206 projects.

5. Additional guidance will be forthcoming on the overall implementation of programmatic ecosystem restoration authorities as a result of recent directives from OMB and ASA(CW).

FOR THE COMMANDER:

Thomas W. Waters

THOMAS W. WATERS, P.E.
Chief, Policy and Policy Compliance Division
Directorate of Civil Works

DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS
WASHINGTON, D.C. 20314-1000

REPLY TO
ATTENTION OF:

CECW-PM

DEC 2 9 2003

MEMORANDUM FOR Commander, Northwestern Division

SUBJECT: Implementation of Section 544 of the Water Resources Development Act of 2000

1. Purpose. The purpose of this memorandum is to provide implementation guidance for section 544 of the Water Resources Development Act of 2000, PL 106-541 (WRDA 2000).

2. Section 544 of WRDA 2000 directs the Secretary to conduct studies and implement critical restoration projects in the area of Puget Sound, Washington and adjacent waters, including the watersheds that drain directly into Puget Sound, Admiralty Inlet, Hood Canal, Rosario Strait, and the Strait of Juan de Fuca to Cape Flattery. The projects will produce, consistent with Federal programs, projects, and activities, immediate and substantial ecosystem restoration, preservation and protection benefits. Section 544 authorizes the Secretary, in consultation with the Secretary of Commerce, the Secretary of the Interior, the Governor of the State of Washington, tribal governments, and the heads of other appropriate Federal, State, and local agencies, to develop criteria and procedures for prioritizing projects. Additionally, project selection criteria and procedures must be consistent with fish restoration goals of the National Marine Fisheries Service and the State of Washington. In prioritizing projects for implementation, the Secretary shall consult with and consider the priorities of public and private entities that are active in Puget Sound watersheds, including the Salmon Recovery Funding Board, the Northwest Straits Commission, the Hood Canal Coordinating Council, county watershed planning councils and salmon enhancement groups. Selection of critical projects for review and approval shall consider studies and plans in existence at the time of WRDA 2000 enactment, as well as after enactment. The authorized appropriation for section 544 is $40,000,000. The Federal share for a single restoration project is limited to $5,000,000.

3. Studies under section 544 are subject to the cost sharing requirements of section 105 of WRDA 1986, as amended. Projects implemented under section 544 will be cost shared 65 percent Federal and 35 percent non-Federal, and up to 50 percent of the non-Federal share of project implementation costs can be in in-kind services. Operation and maintenance of projects is a non-Federal responsibility. Further, a Project Cooperation Agreement (PCA) must be signed with an appropriate non-Federal interest in accordance with section 221 of the Flood Control Act of 1970 (42 U.S.C. 1962-5b).

4. Projects under section 544 may be implemented in accordance with the general procedures for the Section 206 Continuing Authorities Program (see Appendix F of ER 1105-2-100). It is recognized that land values in the Puget Sound, Washington, area generally are high and that the market value of the lands, easements, rights-of-way, relocations, and dredged material disposal

areas (LERRD) required for a specific critical restoration project may exceed the non-Federal sponsor's 35 percent share of total project costs for that project. Therefore, a non-Federal sponsor may agree to waive reimbursement for the value of LERRD that exceeds its 35 percent share of total project costs. The amount of LERRD value for which reimbursement is waived by the non-Federal sponsor shall not be included in total project costs for cost sharing purposes. Notwithstanding that a non-Federal sponsor may agree to waive reimbursement for the value of LERRD as stated above, compliance with the following principles must continue:

a. The estimated value of all project LER must be considered in comparison of alternatives for plan selection;

b. The project must be formulated so that only the lands necessary to implement the project are required for the project;

c. The non-Federal sponsor must comply with all applicable provisions of P.L. 91-646 (as amended) and implementing regulations, for all LER that it must acquire to implement the project; and

d. The project decision document must document that the non-Federal sponsor has voluntarily agreed to waive any reimbursement for the value of project LERRD as stated above, and the PCA must be appropriately revised and approved.

5. The district shall provide to Headquarters annual reports indicating accomplishments under this authority.

FOR THE COMMANDER:

WILLIAM R. DAWSON, P.E.
Chief, Planning and Policy Division
Directorate of Civil Works

11-Sept-06

Puget Sound and Adjacent Waters Restoration Program
Sec. 544, WRDA 2000
Status of Project Work Elements

Separable Element	Status	Schedule
Nooksack River Dam Removal	Awaiting sponsor letter-of-intent	Letter expected 15-Sept-06
Nisqually Estuary Restoration	Sponsor & USFW introductory meeting	Meeting tentatively scheduled 22-Sept-06
Comprehensive Feasibility Study	Coastal American (Federal Stakeholder) Meeting	Meeting scheduled 25-Sept-06
Lake Washington Gravel Nourishment	PCA approval pending resolution of USACE comments	Sign PCA 2-Oct-06
Seahurst Beach Restoration	Construction complete; completing real-estate appraisal for constructed site; discussing potential Phase II with sponsor	Appraisal evaluation due 1-Nov-06
Derelict Gear Restoration	Decision Document preparation underway	Decision Document submittal 15-Dec-06
Skokomish Estuary Restoration	Re-scoping project for island site	Decision Document submittal 1-Feb-07
Snohomish Estuary Restoration	Scoping project with sponsor	Decision Document 1-July-07

APPENDIX B
CULTURAL RESOURCES COORDINATION CORRESPONDENCE

STATE OF WASHINGTON

DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION

1063 S. Capitol Way, Suite 106 • Olympia, Washington 98501
Mailing address: PO Box 48343 • Olympia, Washington 98504-8343
(360) 586-3065 • Fax Number (360) 586-3067 • Website: www.dahp.wa.gov

March 4, 2010

Mr. Chris Jenkins
Regulatory Branch
Seattle District, Corps of Engineers
PO Box 3755
Seattle, Washington 98124-3755

Re: Seahurst Park Restoration Project / Phase II
Log No: 080404-11-COE-S

Dear Mr. Jenkins:

Thank you for contacting our department. We have reviewed the professional archaeological survey report you provided for the proposed Seahurst Park Restoration Project / Phase II, Burien, King County, Washington.

We concur with your initial Determination of No Historic Properties Affected but request you reconfirm that Determination once the design is finalized. We concur with the proposed stipulation for professional archaeological monitoring (c.f. page 2 and 13). Please provide the monitoring report when available.

We would appreciate receiving any correspondence or comments from concerned tribes or other parties that you receive as you consult under the requirements of 36CFR800.4(a)(4).

In the event that archaeological or historic materials are discovered during project activities, work in the immediate vicinity must stop, the area secured, and the concerned tribes and this department notified.

These comments are based on the information available at the time of this review and on the behalf of the State Historic Preservation Officer in conformance with Section 106 of the National Historic Preservation Act and its implementing regulations 36CFR800. Should additional information become available, our assessment may be revised. Thank you for the opportunity to comment and a copy of these comments should be included in subsequent environmental documents.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist
(360) 586-3080
email: rob.whitlam@dahp.wa.gov

DEPARTMENT OF ARCHAEOLOGY & HISTORIC PRESERVATION
Protect the Past, Shape the Future

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental Resources Section

FEB 23 2010

Allyson Brooks, Ph.D.
State Historic Preservation Officer
Department of Archaeology and Historic Preservation
Post Office Box 48343
Olympia, Washington 98504-8343

SUBJECT: Seahurst Park Restoration Phase II request for concurrence with a determination of no historic properties affected

Dear Dr. Brooks:

The U.S. Army Corps of Engineers (Corps) in partnership with the City of Burien is proposing to restore the natural functions and historic estuarine habitat along the Puget Sound shoreline within Seahurst Park. The project proposal focuses on the northern 2,875 feet of shoreline, 2000 of which are armored with a concrete wall and a riprap toe. All of the current alternatives being analyzed include removing all or part of the following features: concrete seawall, rip-rap, gabions, and any other unnatural rock on the shoreline. After the features are removed, appropriate ratios of sand, gravel and cobbles would be used to backfill the area, and it would be graded back to natural beach contours. All existing large woody debris would be replaced.

This project is the second phase of restoration activities along the shoreline of Seahurst Park. In 2004, the City of Burien and the Corps partnered to complete similar restoration activities along the southern 1400 feet of shoreline. At that time, two previously recorded archaeological sites, 45KI42 and 45KI43, were relocated. The northern site, 45KI42, was outside of the 2004 area of potential effect (APE), and the southern site, 45KI43, was flagged for avoidance and monitored. Neither of the sites were evaluated for eligibility at that time.

The final design for the current restoration project has not been selected; hence, a cultural resource inventory was completed of the entire shoreline throughout the intertidal zone. The APE includes the location of the previously recorded site 45KI42. [redacted] 45KI42 was reexamined during the 2009 inventory. [redacted] The site could not be associated with any know villages, legends, myths, rituals, historical events, or important historical tribal figures. Consequently the site is not eligible under Criteria A or B. Furthermore, the site does not contain any constructed features that warrant evaluation of the site under Criterion C. Despite the fact that shell bearing

sites often have the potential to address research themes such as chronology, subsistence strategies, or settlement patterns, site 45KI42 is a very diffuse site with a limited artifact assemblage. The site area has seen some disturbance and its proximity [redacted] Overall, the site cannot be clearly dated, and its research potential is limited. The Corps has determined that the site is not eligible under Criterion D.

Site 45KI43 was not rerecorded or evaluated for eligibility because it is outside of the APE. The Corps has determined that the project will result in no historic properties affected. We invite you to concur with our determination. If you have any questions or need additional information, please contact Danielle Storey of my staff at (206) 746 4466 or by email at Danielle.L.Storey@usace.army.mil

Sincerely,

Evan Lewis, Acting Chief
Environmental Resources Section

Enclosures

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental Resources Section

FEB 23 2010

Melissa Calvert
Muckleshoot Tribe of Indians
Preservation Department
39015 172nd Ave SE
Auburn, WA 98092

SUBJECT: Section 106 Coordination for the Seahurst Park Restoration Phase II project

Dear Ms. Calvert:

The U.S. Army Corps of Engineers (Corps) in partnership with the City of Burien is proposing to restore the natural functions and historic estuarine habitat along the Puget Sound shoreline within Seahurst Park. The project proposal focuses on the northern 2,875 feet of shoreline, 2000 of which are armored with a concrete wall and a riprap toe. All of the current alternatives being analyzed include removing all or part of the following features: concrete seawall, rip-rap, gabions, and any other unnatural rock on the shoreline. After the features are removed, appropriate ratios of sand, gravel and cobbles would be used to backfill the area, and it would be graded back to natural beach contours. All existing large woody debris would be replaced.

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The final design for the current restoration project has not been selected; hence, a cultural resource inventory was completed of the entire shoreline throughout the intertidal zone. The APE includes the location of the previously recorded site 45KI42. [redacted] 45KI42 was reexamined during the 2009 inventory. [redacted] The site could not be associated with any know villages, legends, myths, rituals, historical events, or important historical tribal figures. Consequently the site is not eligible under Criteria A or B. Furthermore, the site does not contain any constructed features that warrant evaluation of the site under Criterion C. Despite the fact that shell bearing sites often have the potential to address research themes such as chronology, subsistence strategies, or settlement patterns, site 45KI42 is a very diffuse site with a limited artifact assemblage. The site area has seen some disturbance and its proximity [redacted]

[redacted] Overall, the site cannot be clearly dated, and its research potential is limited. The Corps has determined that the site is not eligible under Criterion D.

Site 45KI43 was not rerecorded or evaluated for eligibility because it is outside of the APE. The Corps has determined that the project will result in no historic properties affected.

In June of 2009, the Corps sent you a letter detailing the general scope of the project and asked for assistance in identifying properties of religious or cultural significance that could be affected by the project. To date, no such properties have been identified. Government to Government consultation is an ongoing process and we are once again asking for any concerns that you may have about the second phase of the Seahurst Park restoration project. If you have any comments, concerns, or additional information about either the findings contained within the cultural resource report or about the project in general, please contact me at (206) 746-4466 or via e-mail at Danielle.L.Storey@usace.army.mil.

Sincerely,

Danielle, Storey
Environmental Resources Section

Enclosures

Cc: (with enclosures)
Laura Murphy, Archaeologist
The Muckleshoot Tribe of Indians
Preservation Department
39015 172nd Ave SE
Auburn, WA 98092

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental Resources Section

Melissa Calvert, Cultural Resources
Muckleshoot Tribal Council
39015 172nd Avenue Southeast
Auburn, Washington 98092-9763

JUN 03 2009

Subject: Section 106 Coordination for Proposed Nearshore Restoration at Seahurst Park Phase II

Dear Ms. Hogerhuis:

The U.S. Army Corps of Engineers (Corps) and the City of Burien, as the project's sponsor, propose to restore approximately 3,000 linear feet of Puget Sound shoreline in Seahurst Park, City of Burien, King County, Washington (see attached figures). Seahurst is a wooded 153-acre park that was transferred from King County to the City of Burien upon its incorporation in 1972. The park is used for community recreation and includes beach access, picnic structures, educational features and walking paths. The proposed Nearshore Restoration at Seahurst Park, Phase II Project continues shoreline restoration that began in 2004 in the southern portion of the park. The remaining seawall and riprap currently lining the shoreline in the northern portion of the park significantly impairs sediment recruitment and transport processes. This has resulted in erosion and loss of sediment supply that has significantly lowered the upper beach. The removal of sediment supply and transport changes have impaired the functions of important habitat for nearshore aquatic fauna and flora. The completion of Phase II restoration activities will complete shoreline restoration within the park.

The shoreline restoration activities include removing approximately 3110 cubic yards (cy) of gabion and toe stone and 5085 cy of path fill material in the form of the existing gabion and fill structure located between elevations +18 and +9 feet. When structural and intertidal rock removal is completed, approximately 4000 cy of washed coarse gravel (2.5 inch to 3/4 inch) will be used to create an underlying beach surface on a 5:1 slope from the backshore between +14 feet and +5 feet. A second layer of fine gravel and coarse sand containing particle widths between 1mm and 8mm (ca. 5000 cy) will be placed on a 6:1 slope to mimic reference beach surface substrates. Final grading will be conducted by wave action and is expected to be approximately 7:1. All existing and available woody debris found at the site will be replaced in the backshore. The work is currently scheduled for October of 2010.

In 2004 I sent you a similar letter addressing the Seahurst Park Phase I project. In that letter I described two recorded archaeological sites[redacted]
During Phase I in 2004 site 45-KI-43 was flagged-off and periodically monitored to insure that there would be no disturbance from construction. The proposed Phase II activities are north of

45-KI-43 and have no potential to cause effects to the site. The northern site 45-KI-42[redacted] The project designers and managers are committed to avoiding all potential effects to the northern site and are studying possible ways to incorporate shoreline erosion protection into the project. [redacted] The Corps recently completed a minus tide survey of the intertidal area and the adjacent upland, which is all fill material placed between the steep bluff and the Sound. [redacted]

If you have any questions or information concerning the proposed Seahurst Park Phase II shoreline restoration project, please contact me at (206) 764-3576, or e-mail me (ronald.j.kent@usace.army.mil).

Sincerely,

Ronald J. Kent

Ronald J. Kent, Senior Archaeologist
Environmental Resources Section

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental Resources Section

FEB 23 2010

Dennis E. Lewarch
Tribal Historic Preservation Officer
The Suquamish Tribe
Cultural Resource Department
Post Offic Box 498
Suquamish, Washington 98392-0498

SUBJECT: Section 106 Coordination for the Seahurst Park Restoration Phase II project

Dear Ms. Calvert:

The U.S. Army Corps of Engineers (Corps) in partnership with the City of Burien is proposing to restore the natural functions and historic estuarine habitat along the Puget Sound shoreline within Seahurst Park. The project proposal focuses on the northern 2,875 feet of shoreline, 2000 of which are armored with a concrete wall and a riprap toe. All of the current alternatives being analyzed include removing all or part of the following features: concrete seawall, rip-rap, gabions, and any other unnatural rock on the shoreline. After the features are removed, appropriate ratios of sand, gravel and cobbles would be used to backfill the area, and it would be graded back to natural beach contours. All existing large woody debris would be replaced.

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The final design for the current restoration project has not been selected; hence, a cultural resource inventory was completed of the entire shoreline throughout the intertidal zone. The APE includes the location of the previously recorded site 45KI42. [redacted] 45KI42 was reexamined during the 2009 inventory. [redacted] The site could not be associated with any know villages, legends, myths, rituals, historical events, or important historical tribal figures. Consequently the site is not eligible under Criteria A or B. Furthermore, the site does not contain any constructed features that warrant evaluation of the site under Criterion C. Despite the fact that shell bearing sites often have the potential to address research themes such as chronology, subsistence strategies, or settlement patterns, site 45KI42 is a very diffuse site with a limited artifact

assemblage. The site area has seen some disturbance and its proximity [redacted] Overall, the site cannot be clearly dated, and its research potential is limited. The Corps has determined that the site is not eligible under Criterion D.

Site 45KI43 was not rerecorded or evaluated for eligibility because it is outside of the APE. The Corps has determined that the project will result in no historic properties affected.

In June of 2009, the Corps sent you a letter detailing the general scope of the project and asked for assistance in identifying properties of religious or cultural significance that could be affected by the project. To date, no such properties have been identified. Government to Government consultation is an ongoing process and we are once again asking for any concerns that you may have about the second phase of the Seahurst Park restoration project. If you have any comments, concerns, or additional information about either the findings contained within the cultural resource report or about the project in general, please contact me at (206) 746-4466 or via e-mail at Danielle.L.Storey@usace.army.mil.

Sincerely,

Danielle Storey

Danielle, Storey
Environmental Resources Section

Enclosures

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX 3755
SEATTLE, WASHINGTON 98124-3755

REPLY TO
ATTENTION OF

Environmental Resources Section

JUN 03 2009

Marilyn Jones, Cultural Resources
Suquamish Tribal Council
Post Office Box 498
Suquamish, Washington 98392-0498

Subject: Section 106 Coordination for Proposed Nearshore Restoration at Seahurst Park Phase II

Dear Ms. Jones:

The U.S. Army Corps of Engineers (Corps) and the City of Burien, as the project's sponsor, propose to restore approximately 3,000 linear feet of Puget Sound shoreline in Seahurst Park, City of Burien, King County, Washington (see attached figures). Seahurst is a wooded 153-acre park that was transferred from King County to the City of Burien upon its incorporation in 1972. The park is used for community recreation and includes beach access, picnic structures, educational features and walking paths. The proposed Nearshore Restoration at Seahurst Park, Phase II Project continues shoreline restoration that began in 2004 in the southern portion of the park. The remaining seawall and riprap currently lining the shoreline in the northern portion of the park significantly impairs sediment recruitment and transport processes. This has resulted in erosion and loss of sediment supply that has significantly lowered the upper beach. The removal of sediment supply and transport changes have impaired the functions of important habitat for nearshore aquatic fauna and flora. The completion of Phase II restoration activities will complete shoreline restoration within the park.

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In 2004 I sent your Tribe a similar letter addressing the Seahurst Park Phase I project. In that letter I described two recorded archaeological sites, [redacted]. During Phase I in 2004 site 45-KI-43 was flagged-off and periodically monitored to insure that there would be no disturbance from construction. The proposed Phase II activities are

north of 45-KI-43 and have no potential to cause effects to the site. The northern site 45-KI-42 [redacted]. The project designers and managers are committed to avoiding all potential effects to the northern site and are studying possible ways to incorporate shoreline erosion protection into the project. [redacted]. The Corps recently completed a minus tide survey of the intertidal area and the adjacent upland, which is all fill material placed between the steep bluff and the Sound. [redacted]

If you have any questions or information concerning the proposed Seahurst Park Phase II shoreline restoration project, please contact me at (206) 764-3576, or e-mail me (ronald.j.kent@usace.army.mil).

Sincerely,

Ronald J. Kent

Ronald J. Kent, Senior Archaeologist
Environmental Resources Section

APPENDIX C
DETAILED SUMMARY OF HABITAT SCORING

Appendix C
Detailed Summary of Ecological Benefit

	Beach Restoration	Beach Nourishment Only	No Action	Salt Marsh Creation	Freshwater Wetland	Groin Removal	Revegetation	Total Habitat Score
Alternative 1: Full (100 Percent) Armor Removal / Small Marsh	684	0	0	22	0	28	7	**741**
Alternative 2: 92 Percent Armor Removal / Maximum Marsh	574	0	0	49	0	11	11	**645**
Alternative 3: 84 Percent Armor Removal / Medium Marsh	532	0	0	40	0	11	8	**590**
Alternative 3A: 84 Percent Armor Removal / Freshwater Wetland	532	0	0	0	16	11	8	**567**
Alternative 4: 77 Percent Armor Removal / No Marsh	514	0	0	0	0	0	8	**521**
Alternative 5: Very Limited (19 Percent) Armor Removal / Beach Nourishment Only	0	432	0	0	0	0	6	**439**
No Action: Future Without Project	0	0	161	0	0	0	0	**161**

APPENDIX D
ENVIRONMENTAL COMPLIANCE CONCURRENCE LETTERS

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northwest Region
7600 Sand Point Way N.E., Bldg. 1
Seattle, Washington 98115

NMFS Tracking No:
2010/01688

May 17, 2010

Evan Lewis
Chief, Environmental Resources Section
U.S. Army Corps of Engineers, Seattle District
Post Office Box 3755
Seattle, Washington 98124-3755

Re: Endangered Species Act Section 7 Informal Consultation and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation for the Seahurst Park Shoreline Restoration Phase II, King County, Washington, (HUC 1711001904, Puget Sound – East Passage), COE No.: PL-1-08

Dear Mr. Lewis:

This correspondence is in response to your request for Section 7 informal consultation under the Endangered Species Act (ESA). Additionally, this letter serves to meet the requirements for consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSA).

Endangered Species Act

The National Marine Fisheries Service (NMFS) has reviewed the Biological Evaluation (BE) submitted by the Army Corps of Engineers (COE) for the above-referenced project, which arrived in our office on April 19, 2010. The COE requested NMFS' concurrence with their determinations that the proposed action "may affect, not likely to adversely affect:" Puget Sound (PS) Chinook (*Oncorhynchus tshawytscha*) salmon; PS steelhead (*O. mykiss*); and, designated critical habitat for PS Chinook salmon. PS Chinook salmon was listed as threatened under the ESA on March 24, 1999 (50 CFR 223 and 224). The PS steelhead Distinct Population Segment (DPS) was listed as threatened under the ESA on June 11, 2007 (72 FR 26722). Critical habitat for PS Chinook salmon was designated on September 2, 2005 (70 FR 52630). This consultation is conducted under section 7(a)(2) of the ESA, and its implementing regulations, 50 CFR 402.

The COE proposes to conduct shoreline restoration action at Seahurst Park in the City of Burien in King County, Washington, Section 13, Township 23N, Range 3E. This action includes: (1) remove existing shoreline protection structures such as bulkheads and rock revetments; (2) restore beach slopes and substrates using reference conditions found nearby and replenish substrate lost to erosion with suitable material;

(3) restore and protect the natural delivery paths of sediment, particularly sand and gravel, to the beach; and (4) protect and restore native vegetation that overhangs the water and provides nearshore riparian ecological functions.

This is Phase II of a long-term shoreline restoration project at Seahurst Park. Phase I was completed in 2005 with the restoration of 1500 linear feet of shoreline, and Section 7 informal consultation on this project was completed in August 2003 (NMFS Tracking No. 2003/00907). With the completion of Phase II, a total of 4500 linear feet of important Puget Sound shoreline habitat and function will be restored at the park.

The action area is nearshore marine areas, adjacent shorelines and riparian areas along 3000 linear feet of marine shoreline on the east shore of East Passage, Puget Sound at Seahurst Park. The shoreline of the park was extensively armored in the early 1970s, which disconnected terrestrial and marine interactions and caused a drop in beach elevations in the area of 3 to 4 feet. Direct and indirect effects from proposed construction activities are expected to be confined to this area within +15.0 and +1.0 MLLW (mean lower low water).

The in-water work window is August 15 – February 15 when aquatic species are at least risk. Following all BMPs and Conservation Measures as outlined in the BE and the HPA will ensure that potential effects on listed species and their habitats are minimized.

Species Determination

Puget Sound Chinook Salmon
Puget Sound Steelhead

NMFS analyzed the potential effects of the project on PS Chinook salmon and PS steelhead and determined that they will be discountable and insignificant. Construction activities have the potential to affect listed PS Chinook salmon and PS steelhead: include those caused by noise from heavy equipment; impaired water quality including turbidity during revetment and sediment removal, sediment augmentation and other construction activities; and, site disturbance so great as to result in disruption of normal feeding and migration behaviors by anadromous fishes.

The effects will be discountable because PS Chinook salmon and PS steelhead are not expected to be present while in-water construction activities are conducted. Although some juvenile PS Chinook salmon may occur in the action area during their emigration to the Pacific Ocean, construction will be timed when juveniles have generally expanded their forage range into offshore areas. PS steelhead juveniles will likely have entirely emigrated out of the area when construction begins.

If listed salmon occur in the project area during construction, NMFS expects potential effects to be insignificant. The project site is several miles (5 miles from the Green/Duwamish and 18 miles from the Puyallup/White Rivers) from any large natal river (of any species) and only larger juveniles of PS Chinook salmon and PS steelhead (greater than 100 mm in size), or sub-adults

(PS steelhead) would be found. These larger juveniles and sub-adults would have greater swimming speed to avoid construction disturbances. In addition, abundance of PS Chinook salmon or PS steelhead is expected to be extremely low in the action area during the project-specific in-water work window.

Burying of existing beach surface with new substrate will likely temporarily decrease abundance of epibenthic prey organisms within the project footprint. This decrease in abundance of salmonid food resources will likely be of short duration, will occur in a very small proportion of available foraging habitat and will occur at a time when epibenthic production seasonally decreases and few juvenile salmonids are occupying the area.

Because all potential effects on PS Chinook salmon and PS steelhead are discountable or insignificant, NMFS concurs with the COE determination of *"may affect, not likely to adversely affect"* PS Chinook salmon and PS steelhead.

Critical Habitat Determination

Puget Sound Chinook Salmon

Critical habitat for PS Chinook salmon consists of six Primary Constituent Elements (PCEs). Nearshore marine areas (PCE 5) occurs within the action area and are defined as "Nearshore marine areas free of obstruction and excessive predation with water quality and quantity conditions and forage, including aquatic invertebrates and fishes, supporting growth and maturation, and natural cover such as submerged and overhanging large wood, aquatic vegetation, etc."

The Habitat Limiting Factors Report (Kerwin 2000) for Water Resource Inventory Area (WRIA) 9 (the Green/Duwamish and central Puget Sound watersheds) states that there has been "alteration/destruction of significant amounts of nearshore habitat, interruption of critical habitat forming processes and fragmentation/destruction of marine riparian corridors." This project addresses all of these salmon habitat restoration issues and supports the goals of the PS Chinook salmon recovery plan. NMFS analyzed the potential effects of the project on salmon critical habitat and determined that the effects will be insignificant or beneficial, with the conservation values of the PCE improved substantially over existing conditions.

No eelgrass or bull kelp will be affected by this action because of its location in the upper intertidal area. A barge used to remove old fill and rock and bring in new beach materials will not ground out and will not affect eelgrass located in the +2.0' MLLW to -2.0' MLLW area or kelp located between -6.0' and -15' MLLW.

No documented forage fish spawning areas will be affected by project activities, and NMFS expects forage fish (Pacific sand lance (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus*) to reoccupy the area for spawning after the project is completed. Nearshore migratory corridors will be improved upon project completion. There may be temporary elevated levels of turbidity during removal of bank armoring and replacement of sediments, but these are expected to be of short duration with negligible exposure to listed species.

Therefore, NMFS concurs with the COE determination that this project *"may affect, but is not likely to adversely affect"* salmon critical habitat.

Magnuson-Stevens Fishery Conservation and Management Act

Federal agencies are required, under section 305(b)(2) of the MSA and its implementing regulations (50 CFR 600 Subpart K), to consult with NMFS regarding actions that are authorized, funded, or undertaken by that agency that may adversely affect Essential Fish Habitat (EFH). The MSA section 3 defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." If an action would adversely affect EFH, NMFS is required to provide the Federal action agency with EFH conservation recommendations (section 305(b)(4)(A)). This consultation is based, in part, on information provided by the Federal agency and descriptions of EFH for Pacific coast groundfish, coastal pelagic species, and Pacific salmon contained in the Fishery Management Plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

The proposed action is described in the BE. The project area includes habitat which has been designated as EFH for various life stages of 46 species of groundfish, four species of coastal pelagics, and three species of Pacific salmon (see Table 1 enclosure).

The Essential Fish Habitat Conservation Recommendations: Because the conservation measures that the COE included as part of the proposed action to address ESA concerns are adequate to avoid, minimize, or otherwise offset potential adverse effects to the EFH of the species, conservation recommendations pursuant to MSA (section 305(b)(4)(A)) are not necessary. Since NMFS is not providing conservation recommendations at this time, no 30-day response from the COE is required (MSA section 305(b)(4)(B)).

This concludes consultation under the MSA. If the proposed action is modified in a manner that may adversely affect EFH the COE will need to reinitiate consultation in accordance with the implementing regulations for EFH at 50 CFR 600.920(1).

Thank you for your efforts to protect and restore ESA-listed species and EFH. If you have any questions, please contact Randy McIntosh of my staff at (360) 534-9309 or via email at randy.mcintosh@noaa.gov.

Sincerely,

for Barry A. Thom
Acting Regional Administrator

cc: Kevin McKeag, COE
Karen Walter, Muckleshoot Tribe
Laura Arber, WDFW
Steve Roemer, City of Burien

Table 1. Species of fishes with designated EFH occurring in Puget Sound.

Groundfish Species	redstripe rockfish *S. proriger*	Dover sole *Microstomus pacificus*
spiny dogfish *Squalus acanthias*	rosethorn rockfish *S. helvomaculatus*	English sole *Parophrys vetulus*
big skate *Raja binoculata*	rosy rockfish *S. rosaceus*	flathead sole *Hippoglossoides elassodon*
California skate *Raja inornata*	rougheye rockfish *S. aleutianus*	petrale sole *Eopsetta jordani*
longnose skate *Raja rhina*	sharpchin rockfish *S. zacentrus*	rex sole *Glyptocephalus zachirus*
ratfish *Hydrolagus colliei*	splitnose rockfish *S. diploproa*	rock sole *Lepidopsetta bilineata*
Pacific cod *Gadus macrocephalus*	striptail rockfish *S. saxicola*	sand sole *Psettichthys melanostictus*
Pacific whiting (hake) *Merluccius productus*	tiger rockfish *S. nigrocinctus*	starry flounder *Platichthys stellatus*
black rockfish *Sebastes melanops*	vermilion rockfish *S. miniatus*	arrowtooth flounder *Atheresthes stomias*
bocaccio *S. paucispinis*	yelloweye rockfish *S. ruberrimus*	
brown rockfish *S. auriculatus*	yellowtail rockfish *S. flavidus*	**Coastal Pelagic Species**
canary rockfish *S. pinniger*	shortspine thornyhead *Sebastolobus alascanus*	anchovy *Engraulis mordax*
China rockfish *S. nebulosus*	cabezon *Scorpaenichthys marmoratus*	Pacific sardine *Sardinops sagax*
copper rockfish *S. caurinus*	lingcod *Ophiodon elongatus*	Pacific mackerel *Scomber japonicus*
darkblotch rockfish *S. crameri*	kelp greenling *Hexagrammos decagrammus*	market squid *Loligo opalescens*
greenstriped rockfish *S. elongatus*	sablefish *Anoplopoma fimbria*	**Pacific Salmon Species**
Pacific ocean perch *S. alutus*	Pacific sanddab *Citharichthys sordidus*	Chinook salmon *Oncorhychus tshawytscha*
quillback rockfish *S. maliger*	butter sole *Isopsetta isolepis*	coho salmon *O. kisutch*
redbanded rockfish *S. babcocki*	curlfin sole *Pleuronichthys decurrens*	Puget Sound pink salmon *O. gorbuscha*

United States Department of the Interior

FISH AND WILDLIFE SERVICE

Washington Fish and Wildlife Office
510 Desmond Dr. SE, Suite 102
Lacey, Washington 98503

JUL - 6 2010

In Reply Refer To:
13410-2010-I-0281
X Ref. 1-3-03-1-1942

Evan Lewis, Chief Environmental Resources Section
Seattle District, Corps of Engineers
ATTN: McKeag
P.O. Box 3755
Seattle, Washington 98124-3755

Dear Mr. Lewis:

Subject: Project: Seahurst Park Phase II Restoration Project

This is in response to your undated letter requesting our concurrence with your determination that the proposed action in Puget Sound, near Burien in King County, Washington, would "not likely adversely affect" federally listed species. We received your letter on April 16, 2010. A photocopy from your transmittal document(s) describing the proposed action is enclosed.

Specifically, you requested informal consultation pursuant to section 7(a)(2) of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) for the federally listed species identified below (only those species that have been checked are addressed in this consultation request (See Enclosure).

☒ Bull trout (*Salvelinus confluentus*)

☒ Bull trout critical habitat

☒ Marbled murrelet (*Brachyramphus marmoratus*)

If you requested consultation for the bald eagle, please note that the bald eagle was removed from the Federal List of Threatened and Endangered Wildlife, effective August 8, 2007. Given that your project will be implemented after that date, consultation under section 7(a)2 of the Endangered Species Act is not required. We have therefore not provided concurrence on your effect determination for the bald eagle.

TAKE PRIDE IN AMERICA

Based on the information provided in and/or with your cover letter and any additional information, we have concluded that effects of the proposed action to the above-identified federally listed resources would be insignificant and/or discountable. Therefore, for the reasons identified in the enclosures to this letter, we concur with your determination that the proposed action is "not likely to adversely affect" the above-identified federally listed resources. This letter and its enclosures constitute a complete response of the U.S. Fish and Wildlife Service to your request for informal consultation.

This concludes consultation pursuant to the regulations implementing the Endangered Species Act (50 CFR 402.13). This project should be re-analyzed if new information reveals effects of the action that may affect listed species or critical habitat in a manner, or to an extent, not considered in this consultation. The project should also be re-analyzed if the action is subsequently modified in a manner that causes an effect to a listed species or critical habitat that was not considered in this consultation, and/or a new species is listed or critical habitat is designated that may be affected by this project.

Our review and concurrence with your effect determination is based on the implementation of the project as described. It is the responsibility of the Federal action agency to ensure that projects that they authorize or carry out are in compliance with the regulatory permit and/or the ESA, respectively. If a permittee or the Federal action agency deviates from the measures outlined in a permit or project description, the Federal action agency has the obligation to reinitiate consultation and comply with section 7(d).

If you have any questions about this letter or our joint responsibilities under the Endangered Species Act, please contact the consultation biologist identified below, of this office.

U.S. Fish and Wildlife Service Consultation Biologist(s):

☒ Karen Myers (360 / 753-9098)

Sincerely,

Martha L. Jensen

for Ken S. Berg, Manager
Washington Fish and Wildlife Office

Enclosures
Appendix 1 Checklist(s)

cc:
☒ WDFW, Region 4, Mill Creek, WA
☒ WDOE, Bellevue, WA (R. Padgett)

U.S. FISH AND WILDLIFE SERVICE
WASHINGTON FISH AND WILDLIFE OFFICE

BULL TROUT
ENDANGERED SPECIES ACT
SECTION 7 INFORMAL CONSULTATION CONCURRENCE RATIONALE

Project Name: Seahurst Park Phase II Restoration Project

DIRECT EFFECTS

1. Bu ll trout may be in the action area despite the application of an in-water work window. The proposed action would occur during the following in-water work window (August 16 to February 15) when bull trout are expected to occur in low numbers. The timing restriction reduces but does not eliminate the potential for exposure of bull trout to project effects. However, direct effects of the proposed project to bull trout are expected to be insignificant because of the following:

   ☒ The proposed project would result in the suspension of a relatively minor amount of sediment. Although bull trout may be exposed to the sediment and increased turbidity, the concentration and duration of this exposure are not at levels that would result in a measurable effect to bull trout.

INDIRECT EFFECTS

1. Bull trout may or may not occur in the action area; however, effects to bull trout via their prey resources would be insignificant because of the following:

☒ The proposed action would impact documented or potential forage fish spawning areas. However, the proposed action would include surveys for forage fish spawn using the attached protocol, which would avoid direct impacts to forage fish during the spawning season. Additionally, no long-term impacts to forage fish spawning habitat would occur as a result of the proposed action, and the project is expected to improve forage fish spawning habitat over the long-term. Therefore, effects to bull trout via reduced forage fish abundance are not expected to be measurable.

Consulting Biologist: Karen Myers, FWS Project Biologist — Date: June 28, 2010

Concurrence approved by: Marna L. Tenge, Federal Activities Branch Supervisor — Date: Jul 5, 10

Note: The rationale expressed in this informal section 7 concurrence rationale checklist represents our current understanding of the effects of some commonly permitted federal actions to bull trout. This document does not express all possible rationale for insignificant or discountable effects to bull trout. This document is subject to change at any time due to the collection of new information or the need to clarify our rationale. However, any future changes to this concurrence rationale document would not be expected to necessitate reinitiation on previously completed consultations. Please see the "reinitiation" paragraph of the cover letter for a discussion of reinitiation triggers.

U.S. FISH AND WILDLIFE SERVICE
WASHINGTON FISH AND WILDLIFE OFFICE

BULL TROUT CRITICAL HABITAT
ENDANGERED SPECIES ACT
SECTION 7 INFORMAL CONSULTATION CONCURRENCE RATIONALE

Project Name: Seahurst Park Phase II Restoration Project

BULL TROUT CRITICAL HABITAT

The final rule designating bull trout critical habitat (70 FR 56212 [September 26, 2005]) identifies eight Primary Constituent Elements (PCEs) essential for the conservation of the species. We have examined the anticipated effects of the proposed action on the applicable PCEs below.

☒ The proposed action would impact bull trout critical habitat; however, effects to the Primary Constituent Elements (PCE) applicable to the action area are expected to be insignificant based on the following rationale:

Water temperatures that support bull trout use.

☒ The proposed action would not include any activities that would directly or indirectly alter water temperature, such as the release of heated or cooled water, the extraction or addition of water, the increase or decrease of water depth, or the removal of shading vegetation. Therefore, no effects are anticipated to this PCE.

Complex stream channels with features such as woody debris, side channels, pools, and undercut banks to provide a variety of depths, velocities, and instream structures.

☒ The proposed project site is located in marine waters. This PCE is not present in the action area for the project.

Substrates of sufficient amount, size, and composition to ensure success of egg and embryo overwinter survival, fry emergence, and young-of-the-year and juvenile survival. This should include a minimal amount of fine substrate less than 0.25 inch (0.63 centimeter in diameter).

☒ The proposed project site is located in marine waters. Bull trout spawning and early rearing are not expected to occur in this habitat; therefore, this PCE is not present in the action area for the project.

A natural hydrograph, including peak, high, low, and base flows within historic ranges or, if regulated, currently operate under a biological opinion that addresses bull trout, or a hydrograph that demonstrates the ability to support bull trout populations by minimizing daily and day-to-day fluctuations and minimizing departures from the natural cycle of flow levels corresponding with seasonal variations.

☒ The proposed project site is located in marine waters. This PCE is not present in the action area for the project.

Springs, seeps, groundwater sources, and subsurface water to contribute to water quality and quantity as a cold water source.

☒ The proposed project site is located in marine waters. This PCE is not present in the action area for the project.

Migratory corridors with minimal physical, biological, or water quality impediments between spawning, rearing, overwintering, and foraging habitats, including intermittent or seasonal barriers induced by high water temperatures or low flows.

☒ The proposed action may temporarily impact the migratory corridor as a result of suspended sediment releases, diversion of flows, and/or isolation of the work area during construction; however, impacts to the migratory corridor would be short-term and are not expected to measurably affect bull trout migration or movement through the action area. No other physical, biological, and/or water quality barriers to the migratory corridor are anticipated as a direct or indirect result of the proposed action. Therefore, effects to this PCE are expected to be insignificant.

An abundant food base including terrestrial organisms of riparian origin, aquatic macroinvertebrates, and forage fish.

☒ The proposed action may impact the food base of the bull trout through a small reduction of prey individuals, degradation of freshwater or marine habitat, and/or removal or alteration of riparian vegetation. However, the impacts are not expected to be appreciable due to the inclusion of Best Management Practices, conservation measures, mitigation, and/or other components of the project design that are expected to avoid or minimize the effects from these impacts. Upon completion of the proposed action, the food base in the action area would be improved through habitat enhancement activities, such as native riparian and/or emergent vegetation plantings, removal of shoreline stabilization structures, placement of large wood or other habitat features, creation of pools, and/or creation of shallow nearshore habitat. Therefore, long-term effects to this PCE are expected to be beneficial.

Permanent water of sufficient quantity and quality such that normal reproduction, growth, and survival are not inhibited.

☒ The proposed action may impact water quantity and/or water quality via the addition/extraction of water, introduction of contaminants or other pollutants (e.g., suspended sediments), high water temperatures, or other pathways. However, the impacts are not expected to be appreciable due to the inclusion of Best Management Practices, conservation measures, and/or other components of the project design that are expected to avoid, reduce, or compensate for the effects from these potential impacts. Therefore, effects to this PCE are expected to be insignificant.

Consulting Biologist: Karen Myers, FWS Project Biologist — Date: June 28, 2010

Concurrence approved by: Martha C. Jensen, Federal Activities Branch Supervisor — Date: Jul 5, 10

Note: The rationale expressed in this informal section 7 concurrence rationale checklist represents our current understanding of the effects of some commonly permitted federal actions to bull trout critical habitat. This document does not express all possible rationale for insignificant or discountable effects to bull trout critical habitat. This document is subject to change at any time due to the collection of new information or the need to clarify our rationale. However, any future changes to this concurrence rationale document would not be expected to necessitate reinitiation on previously completed consultations. Please see the "reinitiation" paragraph of the cover letter for a discussion of reinitiation triggers.

U.S. FISH AND WILDLIFE SERVICE
WASHINGTON FISH AND WILDLIFE OFFICE

MARBLED MURRELET AND MARBLED MURRELET CRITICAL HABITAT ENDANGERED SPECIES ACT SECTION 7 INFORMAL CONSULTATION CONCURRENCE RATIONALE

Project Name: Seahurst Park Phase II Restoration Project

MARBLED MURRELET CRITICAL HABITAT

☒ The proposed project, including indirect effects, will not occur within marbled murrelet critical habitat.

DIRECT EFFECTS

Nesting Marbled Murrelets

The project will not result in the destruction or modification of suitable marbled murrelet nesting habitat and

☒ The project is more than 0.25 mile from suitable marbled murrelet nesting habitat and does not include blasting, low-elevation (< 500 ft) aircraft operations, impact pile driving, or other activities that could produce sound above 92 dB. Thus, nesting marbled murrelets and their young are extremely unlikely to be exposed to project stressors (sound and visual disturbance) while on the nest or in the nest stand. Therefore, the effects of the proposed action to nesting marbled murrelets would be insignificant and discountable.

Foraging

☒ The proposed project is not expected to result in sound pressure levels that would measurably affect marbled murrelets. Therefore, effects to marbled murrelets would be insignificant.

Turbidity and Other Environmental Contaminants

☒ Project activities will cause prolonged/temporary periods (during removal of armored structures) of elevated turbidity. Marbled murrelets are diving seabirds that rely on eyesight when hunting fish underwater. Because foraging efficiencies are appreciably reduced by high levels of turbidity, it is likely that marbled murrelets will avoid the area during dredging/construction. However, the area of impact is relatively small/or isolated (in the vicinity of Seahurst Park) and/or there are ample foraging opportunities adjacent to the project site and effects to foraging marbled murrelets are not expected to be measurable. Therefore, effects to marbled murrelets are considered insignificant.

INDIRECT EFFECTS

Disturbance (Foraging)

☒ The indirect effects associated with operation of the completed action and use of the facility are not expected to result in sound pressure levels above background; therefore, disturbance of marbled murrelets is not anticipated to be measurable. Thus, effects to marbled murrelets would be insignificant.

Prey Resources[1]

☒ The proposed project is located in a documented or potentially suitable forage fish spawning area and/or eelgrass bed. However, because construction and operation of the proposed action and use of the project will not result in appreciable or long-term effects to forage fish habitat, effects to marbled murrelets via their prey resources would be insignificant.

Contaminants

☒ Operation of the proposed action and use of the facility are not expected to release or introduce environmental contaminants into or adjacent to the aquatic environment. Therefore, effects to marbled murrelets via exposure and/or uptake of contaminants will not occur.

Consulting Biologist: Karen Myers, FWS Project Biologist — Date: June 28, 2010

Concurrence approved by: Martha L. Jensen, Federal Activities Branch Supervisor — Date: Jul 5, 10

Note: The rationale expressed in this informal section 7 checklist represents our current understanding of the effects of some commonly permitted federal actions to marbled murrelet. This document does not express all possible rationale for insignificant or discountable effects to marbled murrelet. This document is subject to change at any time due to the collection of new information or the need to clarify our rationale. However, any future changes to this concurrence rationale document would not be expected to necessitate reinitiation on previously completed consultations. Please see the "reinitiation" paragraph of the cover letter for a discussion of reinitiation triggers.

[1] Many areas of Puget Sound contain high-value spawning habitat for marbled murrelet prey resources such as surf smelt (*Hypomesus pretiosus*), sand lance (*Ammodytes hexapterus*), and Pacific herring (*Clupea harengus*). This determination may not be appropriate for projects that would have significant, long-term negative effects to marbled murrelet prey resources.

Jun. 10, 2010

Draft- Seahurst Park Phase II Pre-Construction Forage Fish Monitoring Plan

The purpose of the forage fish monitoring plan is to conduct surveys prior to construction activities in order to locate any spawning fish and/or eggs. This would be accomplished in an attempt to avoid impacts from construction activities at the Seahurst Park restoration site.

For the project site, a field biologist with WDFW forage fish survey certification will conduct surveys for the presence of forage fish spawning activities along approximately 1,400 linear feet of shoreline at the proposed beach restoration site. Surveys will encompass the entire proposed project footprint where potential affects to intertidal habitats may occur. Surveys will be conducted in accordance with WDFW protocols (Moulton and Penttila 2001), by a biologist certified by WDFW for conducting such surveys. Two species of forage fish are potentially present, surf smelt (*Hypomesus pretiosus*) and Pacific sand lance (*Ammodytes hexapterus*), both of which spawn in the upper intertidal zone on sand-gravel beaches, between +5 feet MLLW and mean higher high water (MHHW). Populations of surf smelt spawn principally from October through March, while sand lance spawn from November through February (Moulton and Penttila 2001).

In accordance with the WDFW protocols (Moulton and Penttila 2001), the beaches to be surveyed will each be divided into 2 to 4, 100-foot transects (depending on length) in areas of suitable spawning substrates between +5 feet MLLW and MHHW. During each survey, four to six subsamples within the upper 1 to 2 inches of beach substrate will be collected at evenly spaced intervals within each transect and composited for laboratory analysis. Transects will be measured to encompass the entire project area where potential affects to the upper intertidal zone may occur and within areas where spawn has been observed in past surveys. Transect locations will be marked with a global positioning system and displayed on either a 1:24,000 scale U.S. Geological Survey topographic map or an aerial photograph. In the laboratory, composited beach samples will be condensed with Nalgene screens, and winnowed to separate and remove forage fish eggs from the beach substrate. Samples of observed eggs, if any, will be placed in a sample jar and preserved with Stockard's Solution. Eggs will be examined under a dissecting microscope to identify species. Spawning surveys will be conducted prior to construction activities and any other major disturbances within the intertidal zone.

Surveys would be conducted at least three weeks prior to any construction activities within the intertidal zone at the project site, and surveys would continue during construction at least every 3 weeks from mid-November through March, spanning the typical spawning period. This sampling interval was selected to take into account the incubation times of both species during the winter and spring months. The incubation time of winter-spawning sand lance eggs is 4 weeks. Surf smelt, which can spawn over a longer period, have incubation times that are related to the ambient temperatures of the season. Surf smelt eggs can hatch in 2 weeks during the summer and 4 weeks during the winter, with intermediate times during the spring and fall. Conducting surveys every 3 weeks ensures a slight overlap between sampling events and the

winter/spring incubation period, so that if the project site is used by forage fish, the chance of finding spawn is maximized. The sampling sites have yet to be selected and should be approved by the Corps habitat biologist prior to the beginning of the surveys. Monitoring reports will be submitted to the USFWS Point of contact for the project following the end of the survey period.

LITERATURE CITED

Moulton, L.L. and D.E. Penttila, 2001. Field Manual for Sampling Forage Fish Spawn in Intertidal Shore Regions. San Juan County Forage Fish Assessment Project. MJM Research. Lopez Island, Washington. Washington Department of Fish and Wildlife. LaConner, Washington.

1.0 INTRODUCTION AND BACKGROUND

Section 7(a)(2) of the Endangered Species Act of 1973 (as amended) requires all federal agencies to review actions authorized, funded, or carried out by the federal government to insure such actions do not jeopardize the continued existence of listed species. This assessment evaluates potential effects on listed species, critical habitat, proposed species and candidate species from implementation of management actions carried out by the U.S. Army Corps of Engineers (Corps).

1.1 Effects Determination Summary

This assessment has determined that the Seahurst Park Restoration Phase II project **may affect, but is not likely to adversely affect** Puget Sound (PS) Chinook (*Oncorhynchus tshawytscha*), PS steelhead (*O. mykiss*), coastal/PS bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and southern resident killer whale (*Orcinus orca*). The project will have **no effect** on Steller sea lion (*Eumetopias jubatus*), humpback whale (*Megaptera novaeangliae*), and leatherback sea turtle (*Dermochelys coriacea*). The project **may affect, but is not likely to adversely affect** critical habitat for Chinook, bull trout, and leatherback sea turtles. The project will have **no effect** on designated critical habitat for the marbled murrelet, Steller sea lion, or killer whale.

1.2 Project Location

The project area is located on the east shore of Central Puget Sound 15 miles south of downtown Seattle, within the City of Burien, King County, Washington (SE¼, Section 13, Township 23 North, Range 3 East, Willamette Meridian). The proposed project is authorized under Section 544 of the Water Resources Development Act of 2000 (public Law 106-541), which authorizes implementation of critical restoration projects in the watershed that drain directly into Puget Sound.

1.3 Background

This project is the second phase of an environmental restoration intended to restore the natural functions and historic estuarine habitat of the Puget Sound nearshore at Seahurst Park. Phase I of the project occurred at the southern end of the park in the winter of 2004-2005. Phase I consisted of removal of 1,400 feet of gabion structure and associated riprap fill materials between +9-+14 feet MLLW. Beach substrate was used to backfill the removal area, natural drainages were reconnected to the beach area and some of the removed materials were used as base materials for construction of a footpath. The project restored natural beach processes and littoral drift allowing the beach to function more naturally by restoring connections between the upper hillside and nearshore.

Informal consultation with both US Fish and Wildlife Service and National Marine Fisheries Service (Services) was completed for Phase I in August 2003. The Services concluded that with incorporation of all of the Conservation Measures stipulated in the Biological Evaluation and one additional condition pertaining to the control of temporary erosion and sedimentation, the project "may affect, but is not likely to adversely affect"

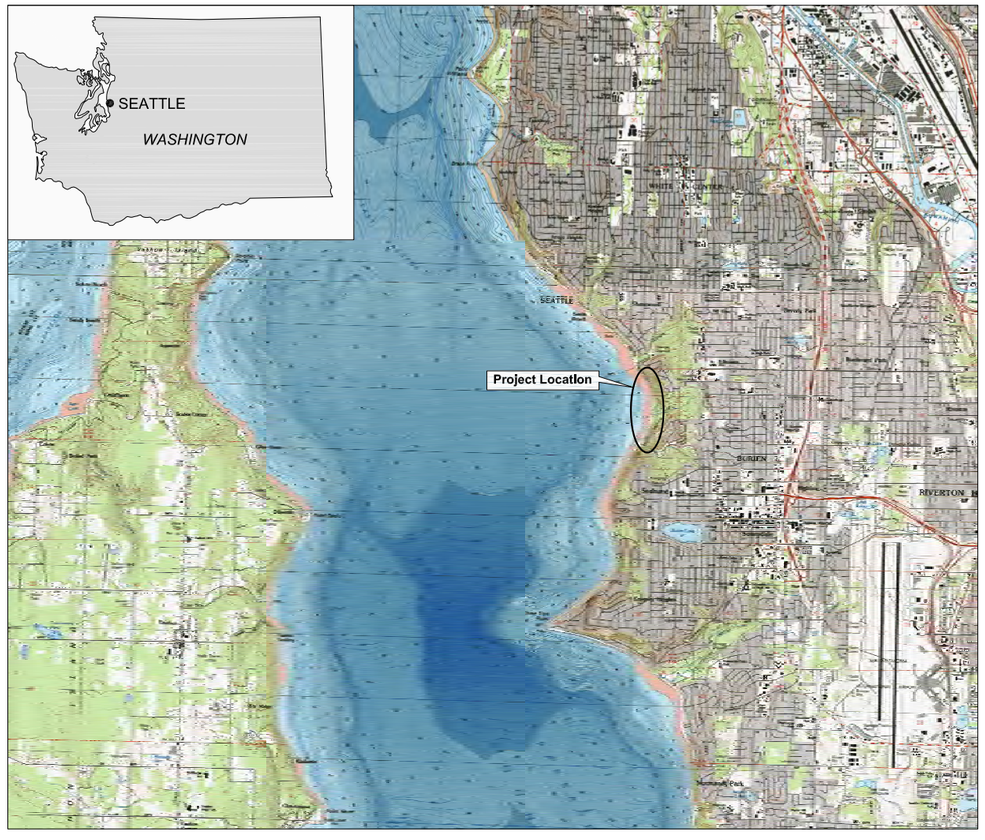
APPENDIX E
35% DESIGN DRAWINGS AND OPINION OF PROBABLE CONSTRUCTION COST

35% DESIGN SUBMITTAL

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

US ARMY CORPS OF ENGINEERS - SEATTLE DISTRICT

VICINITY MAP



NOTE: BASE MAP PREPARED FROM TERRAIN NAVIGATOR PRO USGS 7.5 MINUTE QUADRANGLE MAP(S) OF BURIEN AND SEATTLE SOUTH, WASHINGTON.

N

0 4000 8000
SCALE IN FEET

DRAWING INDEX

SHEET SEQUENCE	SHEET NO.	SHEET TITLE
1	G-1	COVER SHEET
2	G-2	PLAN LAYOUT
3	G-3.0	COMPOSITE SITE PLAN
4	G-3.1	COMPOSITE SITE PLAN
5	G-3.2	COMPOSITE SITE PLAN
6	G-4.0	EXISTING CONDITIONS PLAN (SURVEY)
7	G-4.1	EXISTING CONDITIONS PLAN (SURVEY)
8	G-4.2	EXISTING CONDITIONS PLAN (SURVEY)
9	G-4.3	EXISTING CONDITIONS LEGEND
10	D-1.0	DEMOLITION AND CLEARING PLAN
11	D-1.1	DEMOLITION AND CLEARING PLAN
12	D-1.2	DEMOLITION AND CLEARING PLAN
13	C-1.0	GRADING PLAN
14	C-1.1	GRADING PLAN
15	C-1.2	GRADING PLAN
16	C-2.0	GRADING CROSS SECTIONS
17	C-2.1	GRADING CROSS SECTIONS
18	C-2.2	GRADING CROSS SECTIONS
19	C-2.3	GRADING CROSS SECTIONS
20	C-2.4	GRADING CROSS SECTIONS
21	C-3.0	CONSTRUCTION LAYOUT AND MATERIALS PLAN
22	C-3.1	CONSTRUCTION LAYOUT AND MATERIALS PLAN
23	C-3.2	CONSTRUCTION LAYOUT AND MATERIALS PLAN
24	C-3.3	PLAY AREA DETAIL PLAN
25	C-4.0	UTILITIES PLAN
26	C-4.1	UTILITIES PLAN
27	C-4.2	UTILITIES PLAN
28	C-5	NORTH CREEK/FISH LADDER DETAIL PLAN
29	S-1	STRUCTURAL DETAIL PLAN & SECTION
30	L-1.0	PLANTING PLAN
31	L-1.1	PLANTING PLAN
32	L-1.2	PLANTING PLAN
33	L-2	PLANTING SCHEDULE

Prime Consultant

ANCHOR QEA

1423 3rd Avenue Suite 300
Seattle, WA 98101 (206) 287-9130

US Army Corps of Engineers

CITY OF BURIEN

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

35% DESIGN SUBMITTAL

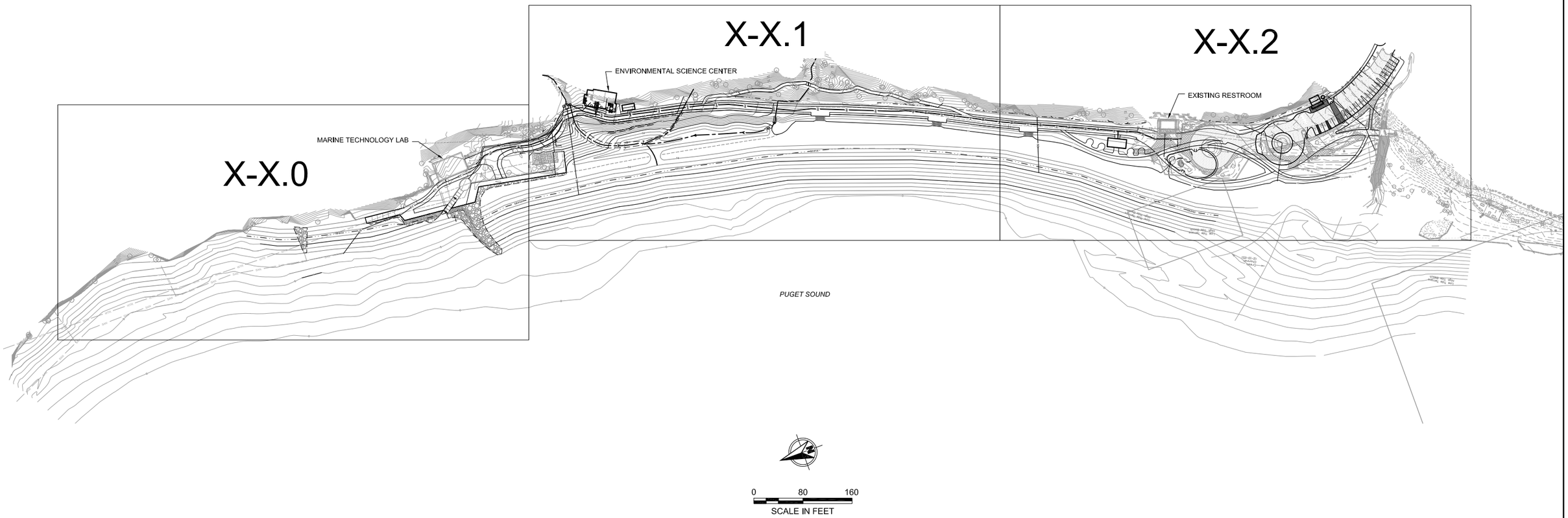
ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

G-1

SHEET NO. 1 OF 33

Apr 20, 2010 2:04pm bberminghamK:\Jobs\0702202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL01-G01.dwg G-1



35% DESIGN - NOT FOR CONSTRUCTION

ONE INCH
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US Army Corps of Engineers

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLAN LAYOUT

G-2

SHEET NO. 2 OF 33

Apr 20, 2010 2:06pm bberminghamK:\Jobs\070202\2-Puget Sound Nearshore\070202\0135 Percent\070202\01-PL\02-G\02.dwg 02 G-2

LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- COMPACTED CRUSHED ROCK PATH
- GRAVEL STREAMBED
- PLAY AREA SURFACING
- PERVIOUS ASPHALT
- LOG EDGE
- ROCKERY
- SHEETPILE WALL
- PROJECT LIMIT LINE
- EXISTING MEAN HIGHER HIGH WATER LINE (MHHW = EL. 11.6' MLLW DATUM)
- PROPOSED MEAN HIGHER HIGH WATER LINE (MHHW = EL. 11.6' MLLW DATUM)
- NATIVE TREES MEDIUM TO TALL
- NATIVE SHRUBS - MEDIUM TO TALL
- NATIVE LOW SHRUBS & GROUNDCOVER
- EMERGENT
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

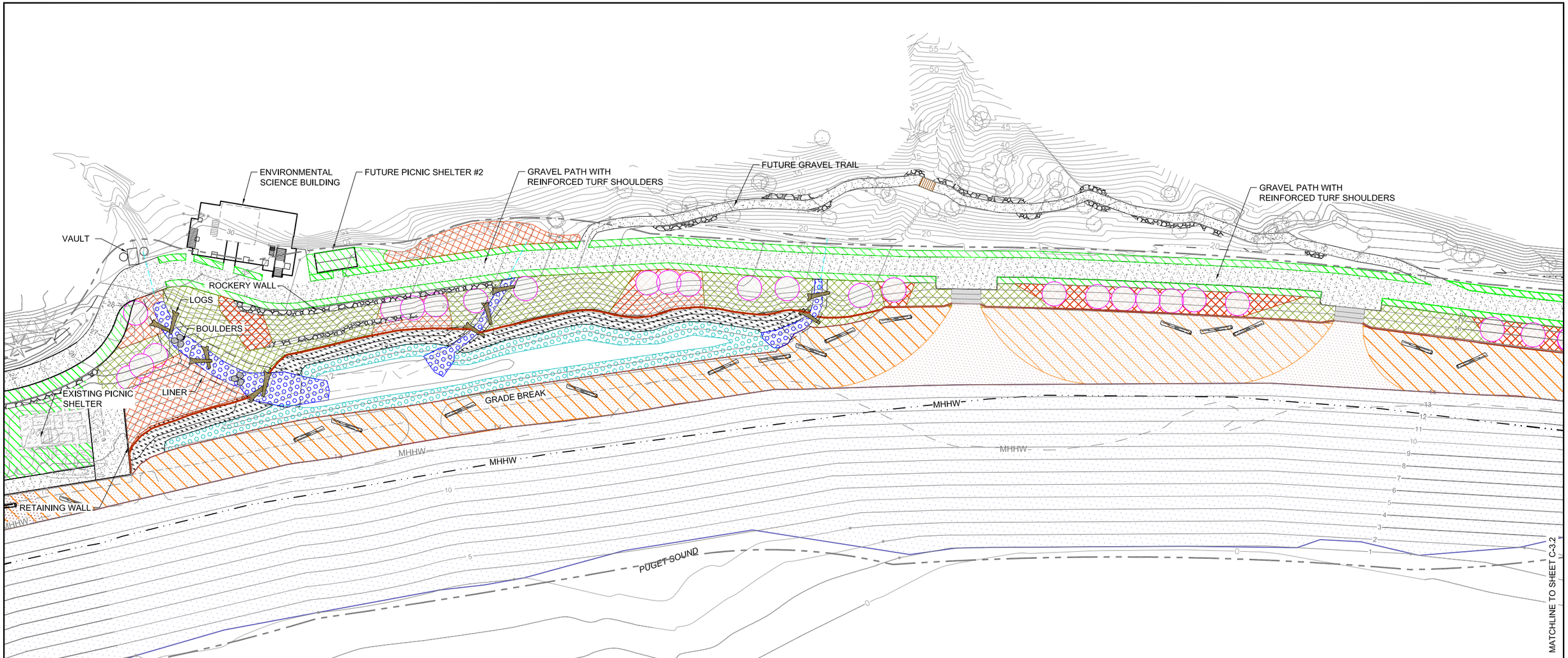
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

COMPOSITE PLAN (1 OF 3)

G-3.0

SHEET NO. 3 OF 33

Apr 21, 2010 12:09pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\070202013\35 Percent\070202013-PL03-G03.dwg 3 G-3.0



LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- COMPACTED CRUSHED ROCK PATH
- GRAVEL STREAMBED
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- PERVIOUS ASPHALT
- LOG EDGE
- LARGE WOODY DEBRIS
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- EMERGENT
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

ONE INCH
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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

COMPOSITE PLAN (2 OF 3)

G-3.1

SHEET NO. 4 OF 33

Apr 21, 2010 12:09pm bbermingham:K:\Jobs\0702\02\Puget Sound Nearshore\07020201135 Percent\07020201-PL03-G03.dwg 4 G-3.1

LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- COMPACTED CRUSHED ROCK PATH
- GRAVEL STREAMBED
- PLAY AREA SURFACING
- PERVIOUS ASPHALT
- PERVIOUS PAVERS
- LOG EDGE
- ROCKERY
- SHEETPILE WALL
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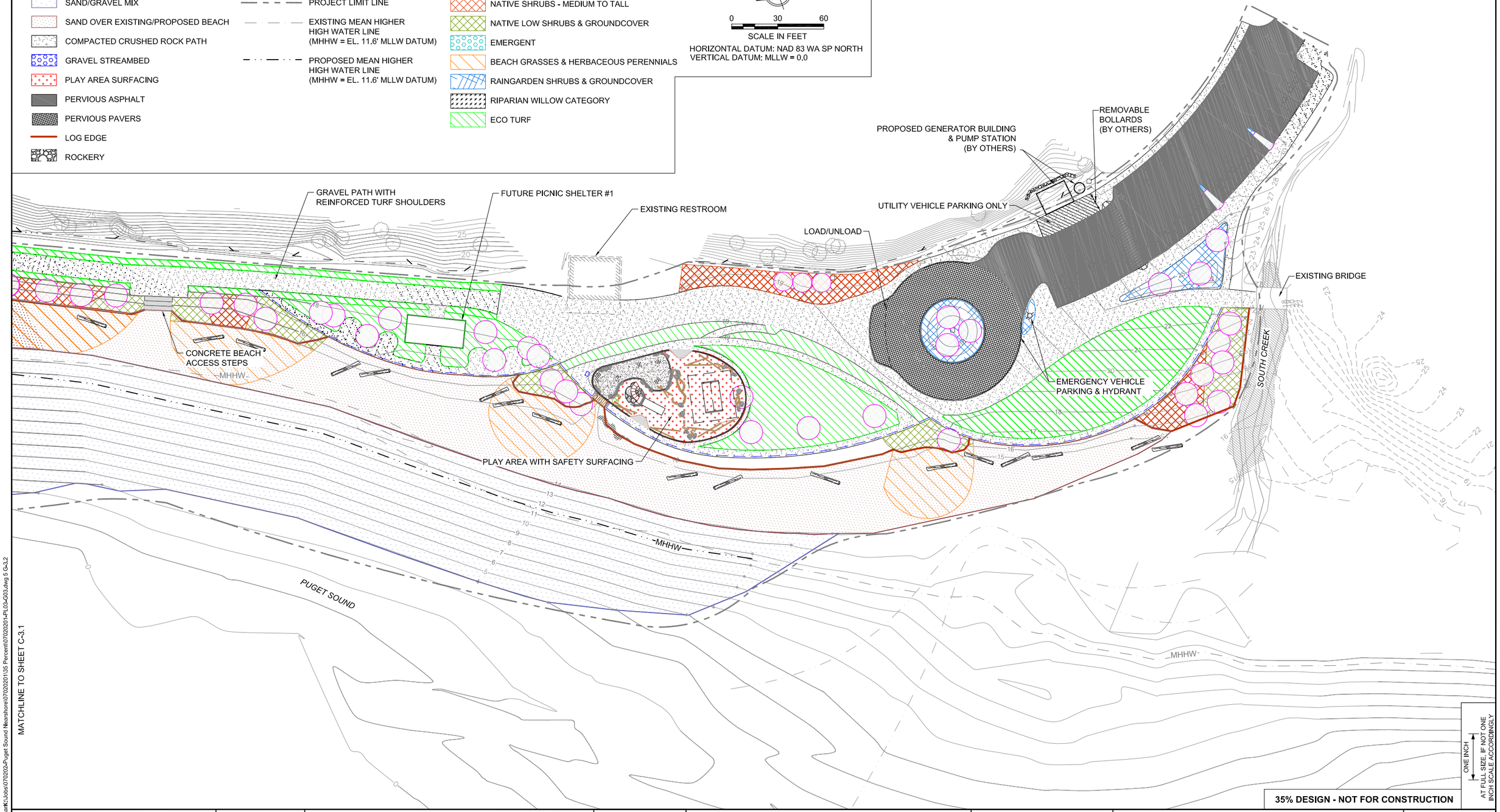
- PROPOSED MEAN HIGHER HIGH WATER LINE (MHHW = EL. 11.6' MLLW DATUM)
- NATIVE TREES MEDIUM TO TALL
- NATIVE SHRUBS - MEDIUM TO TALL
- NATIVE LOW SHRUBS & GROUNDCOVER
- EMERGENT
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF

0 30 60
SCALE IN FEET
HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



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US Army Corps of Engineers

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REV	DATE	BY	APP'D	DESCRIPTION

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

COMPOSITE PLAN (3 OF 3)

G-3.2

SHEET NO. 5 OF 33

Apr 21, 2010 12:09pm bbermingham K:\Jobs\0702202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL03-G03.dwg 5 G-3.2

LEGEND

	EELGRASS DATA POINT PER REFERENCE #2
CB	CATCH BASIN
SM	STORM MANHOLE
SI	STORM INVERT
MH	SANITARY MANHOLE
CO	CLEAN OUT
WV	WATER VALVE
WE	WATER WELL
FH	FIRE HYDRANT
WM	WATER METER
GM	GAS METER
GM	GAS VALVE
UP	UTILITY POLE
GA	GUY ANCHOR
PO	POST
SSP	SPRINKLER STAND PIPE
	EDGE OF GRAVEL
	EDGE OF PAVEMENT
	CONCRETE EXTRUDED CURB
X	FENCE
	TOPOGRAPHY BREAKLINE
SS	SANITARY SEWER
SAN	SANITARY SEWER, SCALED FROM RECORD DRAWINGS
SSU	SANITARY SEWER LOCATES
SD	STORMDRAIN
OHU	OVERHEAD UTILITY
G	GAS LOCATES
P	POWER LOCATES
W	WATER LOCATES
WTR	WATER LINE, SCALED FROM RECORD DRAWINGS
COM	TELE-COMMUNICATION LOCATES
	EDGE OF CLEARING
	ROCKERY
	HEDGE
PWR	POWER UTILITY BOX
CV	CONCRETE VAULT
COM	COMMUNICATION UTILITY BOX
UB	UTILITY BOX
IC	IRRIGATION CONTROL BOX
TM	TELE-COMMUNICATION MANHOLE
PM	POWER METER
TV	TV UTILITY BOX
PT	POWER TRANSFORMER
	WETLAND AND/OR CENTERLINE TRAIL FLAG

DS	DECIDUOUS
CF	CONIFEROUS
AR	ALDER
AP	APPLE
AH	ASH
AS	ASPEN
BI	BIRCH
CY	CHERRY
CT	CHESTNUT
CW	COTTONWOOD
DW	DOGWOOD
EM	ELM
HN	HAWTHORN
HZ	HAZELNUT
LT	LOCUST
MP	MAPLE
OK	OAK
PE	PEAR
PM	PLUM
PR	POPLAR
WT	WALNUT
WW	WILLOW
CE	CEDAR
CP	CYPRESS
FR	DOUGLAS FIR
HK	HEMLOCK
HY	HOLLY
MD	MADRONA
PI	PINE
RW	REDWOOD
SP	SPRUCE
SQ	SEQUOIA
SY	SYCAMORE

NOTES:

1) THIS SURVEY WAS PERFORMED BY CONVENTIONAL FIELD TRAVERSE WITH THE FINAL RESULTS MEETING OR EXCEEDING THE STANDARDS CONTAINED IN W.A.C. 332-130.

2) FIELD SURVEY WAS CONDUCTED ON SEPTEMBER 10-12, 17-18, AND 23-25, 2008.

3) THE PRECISION RATIO FOR THIS SURVEY MEETS OR EXCEEDS 1: 5,000 MINIMUM FOR RESIDENTIAL CLASSIFICATION PER WAC 332-130-090-1 (B).

4) THE UNDERGROUND UTILITIES SHOWN HAVE BEEN COMPILED FROM LOCATED FIELD SURVEY MEASUREMENTS, UTILITY LOCATE PAINT MARKS AS PROVIDED BY PARKER FIBER SERVICES LOCATING COMPANY, AND RECORD DRAWINGS PROVIDED BY ANCHOR ENVIRONMENTAL, LLC AND UTILITY PURVEYORS. THE SURVEYOR MAKES NO GUARANTEE THAT THE UNDERGROUND UTILITIES SHOWN COMPRISE ALL SUCH UTILITIES IN THE AREA, EITHER IN SERVICE OR ABANDONED. THE SURVEYOR FURTHER DOES NOT WARRANT THAT THE UNDERGROUND UTILITIES ARE IN THE EXACT LOCATION INDICATED. THE SURVEYOR HAS NOT PHYSICALLY LOCATED ALL OF THE UNDERGROUND UTILITIES.

EQUIPMENT USED

THIS SURVEY WAS PERFORMED WITH A LEICA 1200 SERIES ROBOTIC TOTAL STATION AND CARLSON SURVCE ALLEGRO DATA COLLECTOR AND MAINTAINED IN ADJUSTMENT TO MANUFACTURERS SPECIFICATIONS AS REQUIRED BY WAC 332-130-100.

REFERENCES

1) TOPOGRAPHIC SURVEY PREPARED BY DUNCANSON COMPANY DATED JANUARY 29, 2007
2) EELGRASS DATA PROVIDED BY ANCHOR ENVIRONMENTAL, LLC
3) CORPS NEARSHORE LIDAR DATA (FROM -10 MLLW TO 0 MLLW) PROVIDED BY ANCHOR ENVIRONMENTAL, LLC
4) WETLANDS, ORDINARY HIGH WATER LINE, AND APPROX. CENTERLINE PROPOSED ADA TRAIL SHOWN HEREON AS DELINEATED BY ANCHOR ENVIRONMENTAL, LLC SEPTEMBER 2008

CONTOUR DATA NOTE

TOPOGRAPHIC AND CONTOUR DATA FROM 0 FEET MLLW TO 55 FEET MLLW ONLY WAS COLLECTED BY ROTH HILL DURING THIS SURVEY. CONTOUR AND OTHER DATA FROM -10 MLLW TO 0 MLLW WAS PROVIDED BY ANCHOR ENVIRONMENTAL, LLC

CONTROL

THIS SURVEY UTILIZES CONTROL AS SHOWN BY DUNCANSON COMPANY IN REFERENCED SURVEY (SHOWN ON SHEET 4) .

DCI CONTROL POINT (#20000)	NORTHING 178331.99
REBAR AND RED PLASTIC	EASTING 1262245.40
CAP FOUND	ELEV=20.98
DCI CONTROL POINT (#20001)	NORTHING 178099.38
REBAR AND RED PLASTIC	EASTING 1262164.09
CAP FOUND	ELEV=18.56

BASIS OF BEARING: N 19°16'02" E BETWEEN FOUND DUNCANSON COMPANY CONTROL POINTS (SEE SHEET 4)

DATUM

HORIZONTAL: "REFERENCED TO NAD 83 CITY OF BURIEN CONTROL POINTS" AS DEVELOPED BY DUNCANSON COMPANY PER REFERENCED SURVEY

VERTICAL: MEAN LOWER LOW WATER "MLLW" AS DEVELOPED BY DUNCANSON COMPANY PER REFERENCED SURVEY

SURVEY PREPARED BY:

ROTH HILL ENGINEERING PARTNERS, L.L.C
2600 116TH AVE. NE
SUITE 100
BELLEVUE, WA 98004
(425) 896-9448

SURVEY PREPARED FOR:

ANCHOR ENVIRONMENTAL, LLC
1423 3RD AVENUE, SUITE 300
SEATTLE, WA 98101
(206) 287-9130

UTILITY PURVEYORS OF RECORD

WATER	SEATTLE PUBLIC UTILITIES	700 5TH AVENUE, SUITE 4900, SEATTLE, WA 98124-1018	(206)386-1800
POWER	SEATTLE CITY LIGHT	700 5TH AVENUE, SUITE 3200, PO BOX 34023, SEATTLE, WA 98124	(206)684-3000
SEWER	SW SUBURBAN SEWER DISTRICT	431 SW AMBAUM BLVD, BURIEN, WA 98166-2462	(206)244-9575
TELEPHONE	QWEST	400 PINE ST, SEATTLE, WA 98101	(800)833-0825

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

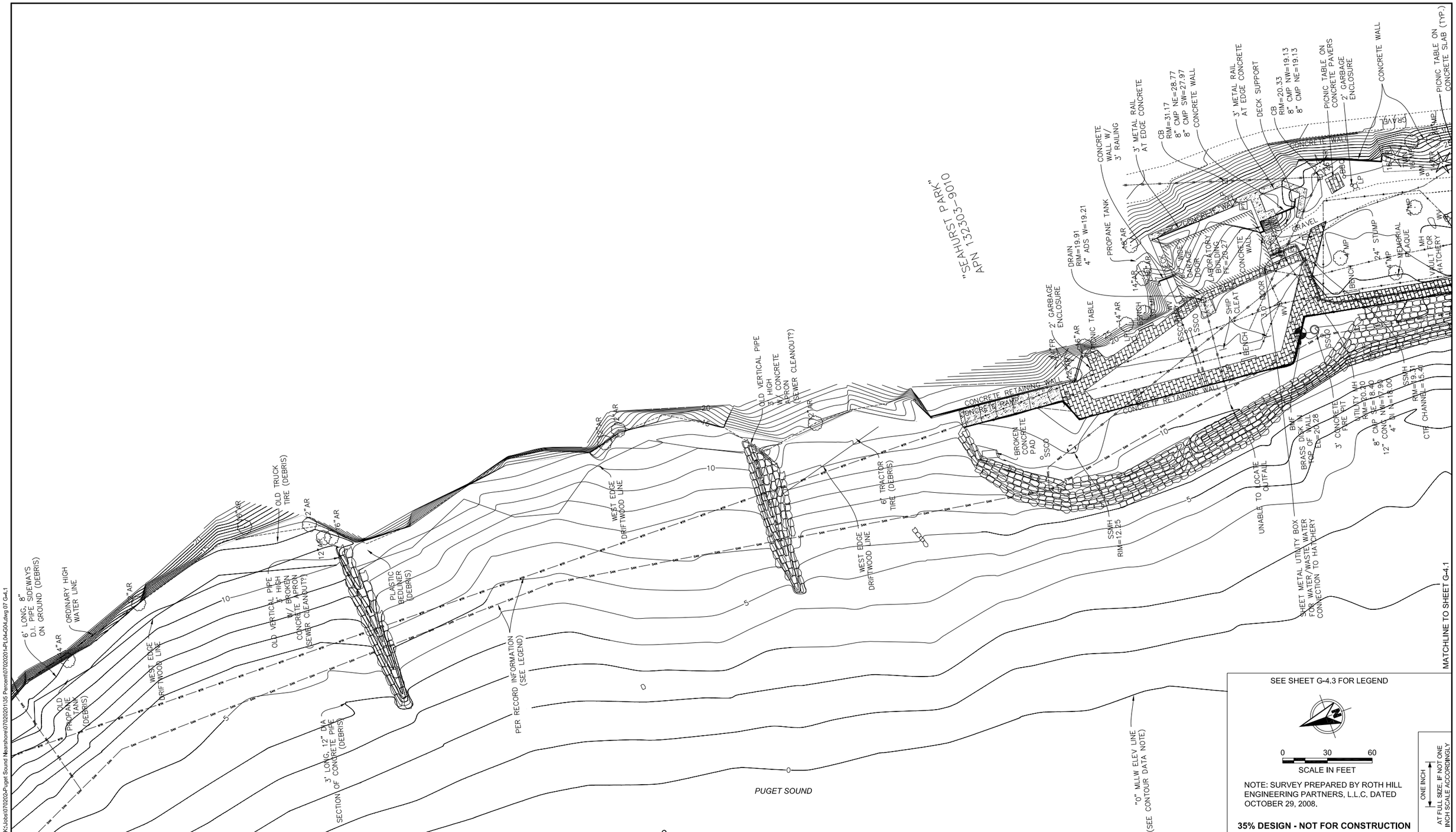
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

EXISTING CONDITIONS LEGEND

G-4.0

SHEET NO. 6 OF 33

Apr 21, 2010 3:26pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202\01\35 Percent\070202\01-PL\04-G04.dwg 06 G-4.0



ANCHOR QEA

US Army Corps of Engineers

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

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DATE: APRIL 2010

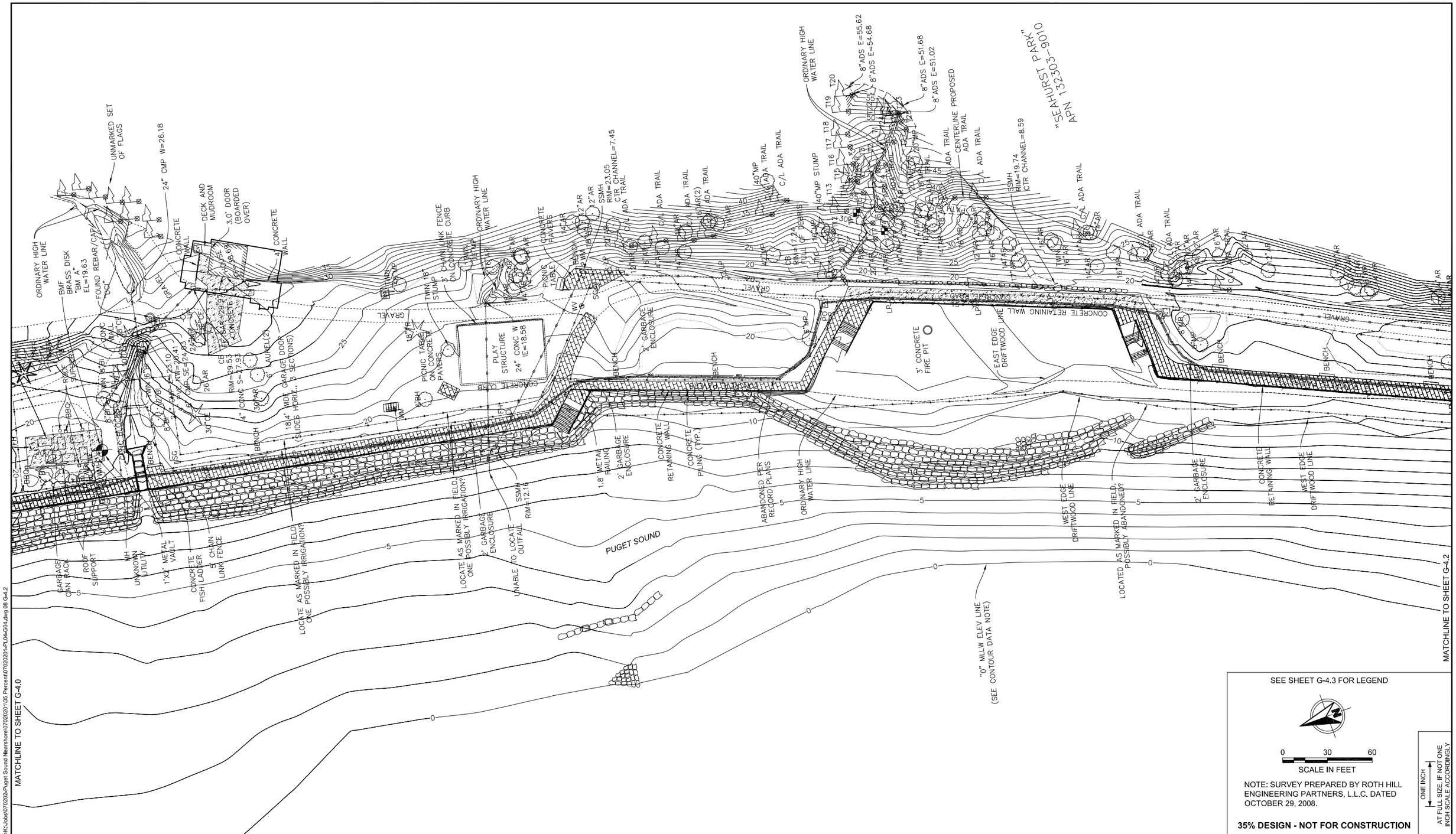
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

EXISTING CONDITIONS (1 OF 3)

G-4.1

SHEET NO. 7 OF 33

Apr 21, 2010 3:31pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201135 Percent\07020201-PL04-G04.dwg 07 G-4.1



NOTE: SURVEY PREPARED BY ROTH HILL ENGINEERING PARTNERS, L.L.C. DATED OCTOBER 29, 2008.

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

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CHECKED BY:
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

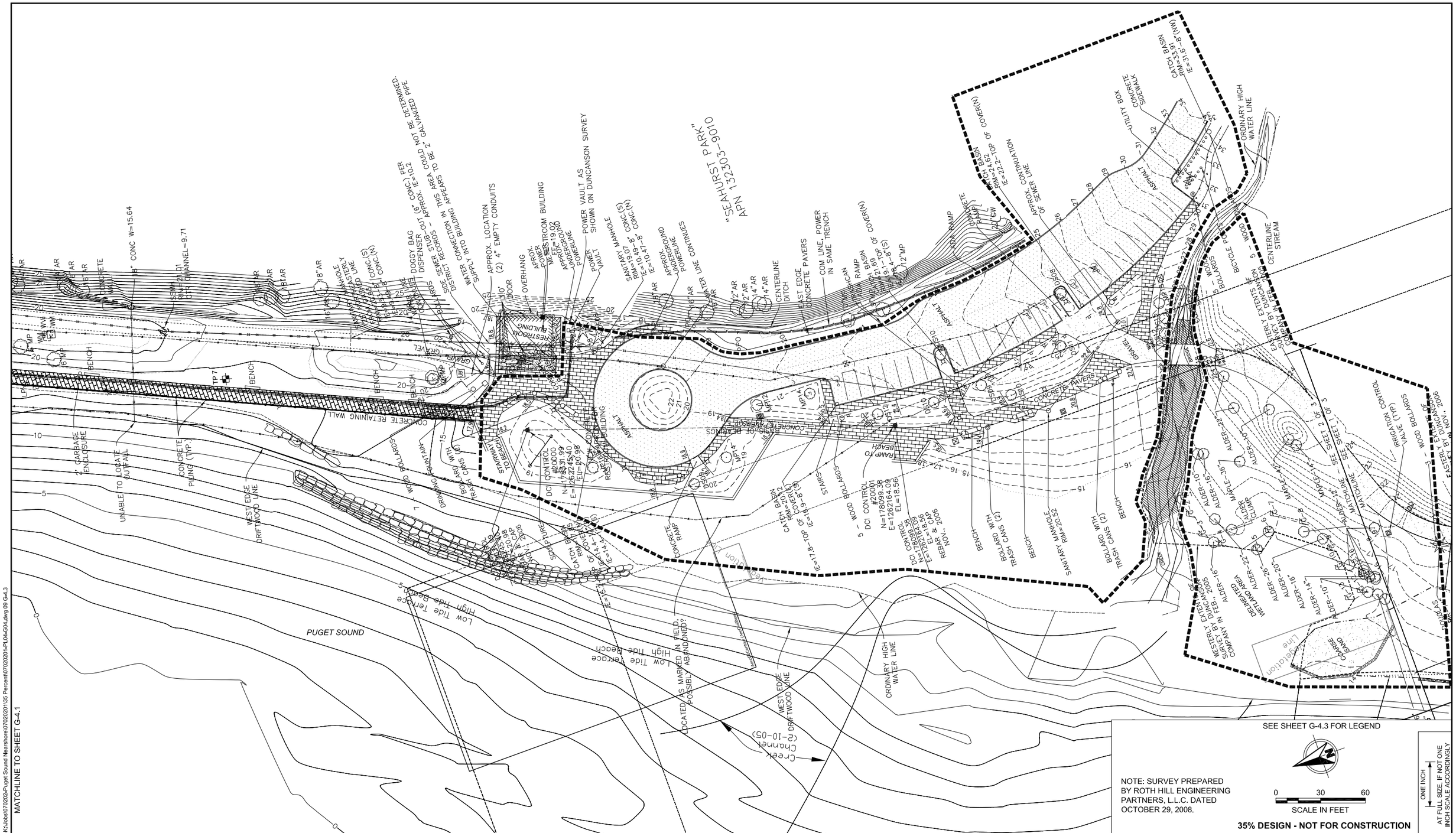
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

EXISTING CONDITIONS (2 OF 3)

G-4.2

SHEET NO. 8 OF 33

Apr 21, 2010 3:27pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\0702020135 Percent\0702020-PL04-G04.dwg 08 G-4.2



ANCHOR QEA

US Army Corps of Engineers

REVISIONS				
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DESIGNED BY:
DRAWN BY:
CHECKED BY:
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

EXISTING CONDITIONS (3 OF 3)

G-4.3

SHEET NO. 9 OF 33

Apr 21, 2010 3:28pm bbermingham K:\Jobs\0702202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL04-204.dwg 09 G-4.3

LEGEND:

- BULKHEAD REMOVAL
- TREE REMOVAL
- SITE FURNISHING AND UTILITY FEATURE REMOVAL
- CLEAR AND GRUB
- ROCK RIP-RAP REMOVAL (NOTE 2)
- CONCRETE PAVING REMOVAL
- PAVER REMOVAL
- ASPHALT PAVING REMOVAL
- GRAVEL SURFACING REMOVAL
- UTILITY LINE REMOVAL
- PROJECT LIMIT

0 30 60
SCALE IN FEET

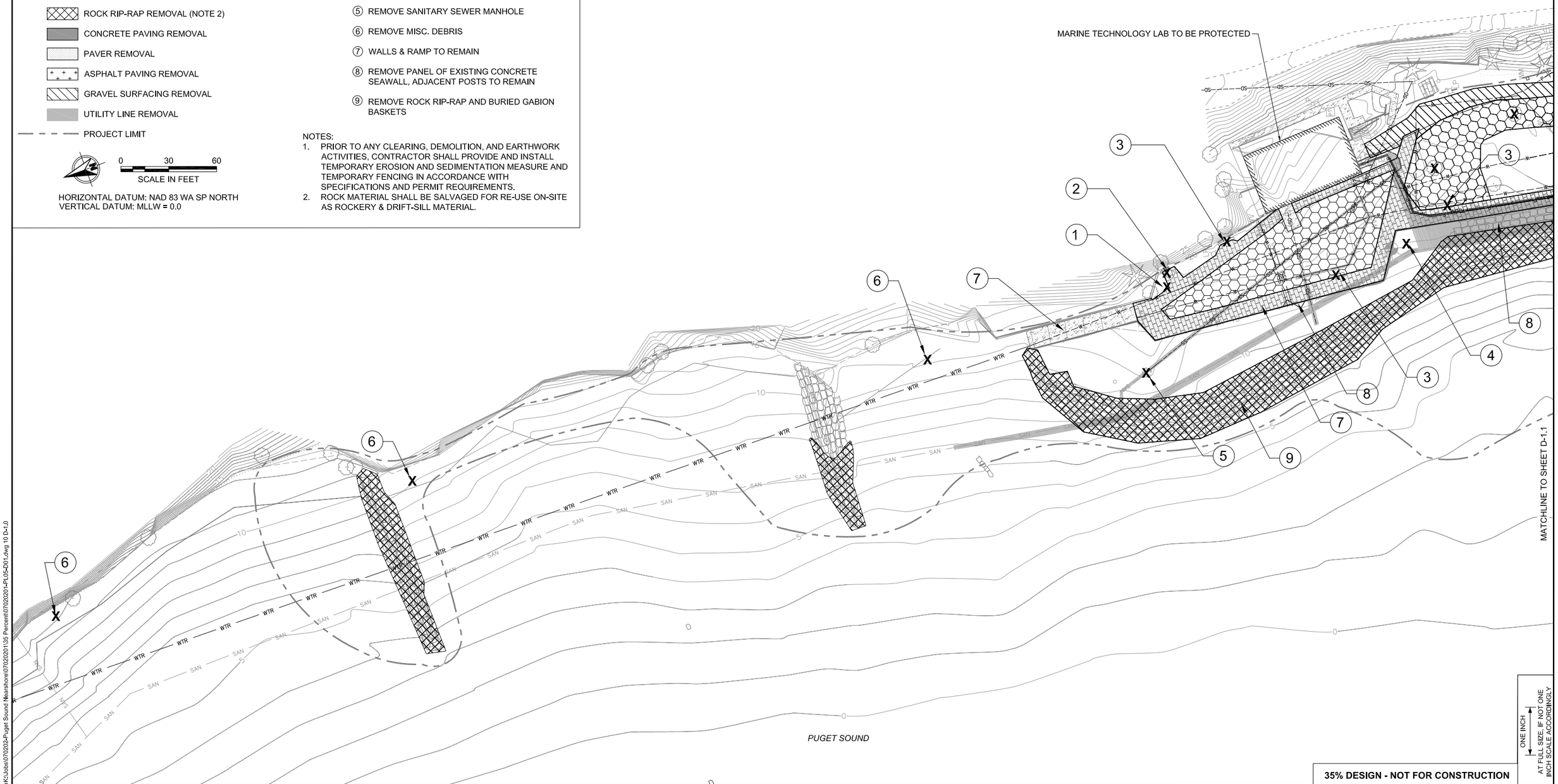
HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

DEMOLITION NOTES:

1. REMOVE GARBAGE ENCLOSURE
2. REMOVE PICNIC TABLE
3. REMOVE BENCH
4. REMOVE FIREPIT
5. REMOVE SANITARY SEWER MANHOLE
6. REMOVE MISC. DEBRIS
7. WALLS & RAMP TO REMAIN
8. REMOVE PANEL OF EXISTING CONCRETE SEAWALL, ADJACENT POSTS TO REMAIN
9. REMOVE ROCK RIP-RAP AND BURIED GABION BASKETS

NOTES:

1. PRIOR TO ANY CLEARING, DEMOLITION, AND EARTHWORK ACTIVITIES, CONTRACTOR SHALL PROVIDE AND INSTALL TEMPORARY EROSION AND SEDIMENTATION MEASURE AND TEMPORARY FENCING IN ACCORDANCE WITH SPECIFICATIONS AND PERMIT REQUIREMENTS.
2. ROCK MATERIAL SHALL BE SALVAGED FOR RE-USE ON-SITE AS ROCKERY & DRIFT-SILL MATERIAL.



35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

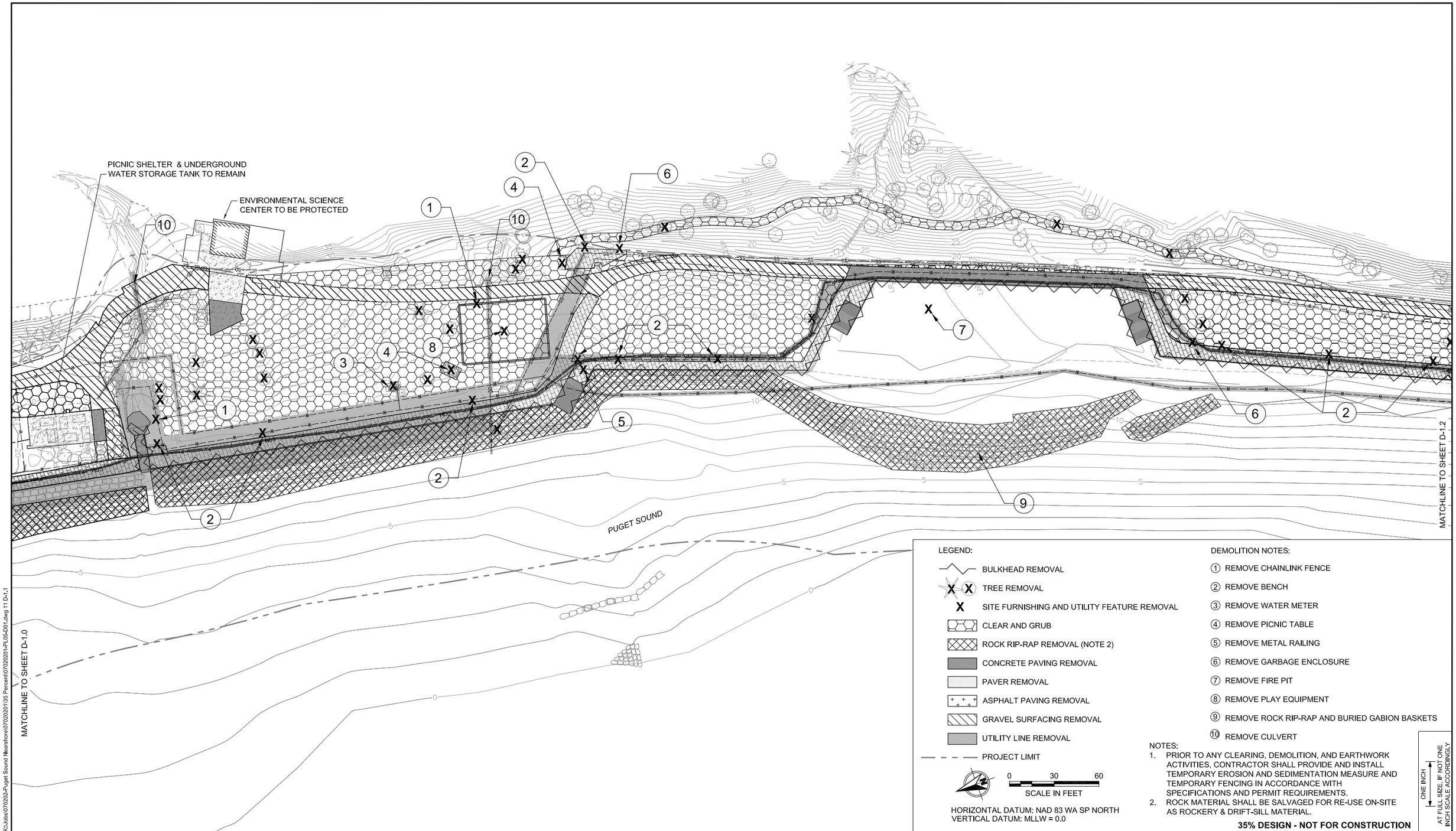
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

DEMOLITION PLAN (1 OF 3)

D-1.0

SHEET NO. 10 OF 33

Apr 21, 2010 3:09pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202\01135 Percent\070202\01-PL05-D01.dwg 10 D-1.0



LEGEND:

- BULKHEAD REMOVAL
- TREE REMOVAL
- SITE FURNISHING AND UTILITY FEATURE REMOVAL
- CLEAR AND GRUB
- ROCK RIP-RAP REMOVAL (NOTE 2)
- CONCRETE PAVING REMOVAL
- PAVER REMOVAL
- ASPHALT PAVING REMOVAL
- GRAVEL SURFACING REMOVAL
- UTILITY LINE REMOVAL
- PROJECT LIMIT

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

DEMOLITION NOTES:

1. REMOVE CHAINLINK FENCE
2. REMOVE BENCH
3. REMOVE WATER METER
4. REMOVE PICNIC TABLE
5. REMOVE METAL RAILING
6. REMOVE GARBAGE ENCLOSURE
7. REMOVE FIRE PIT
8. REMOVE PLAY EQUIPMENT
9. REMOVE ROCK RIP-RAP AND BURIED GABION BASKETS
10. REMOVE CULVERT

NOTES:

1. PRIOR TO ANY CLEARING, DEMOLITION, AND EARTHWORK ACTIVITIES, CONTRACTOR SHALL PROVIDE AND INSTALL TEMPORARY EROSION AND SEDIMENTATION MEASURE AND TEMPORARY FENCING IN ACCORDANCE WITH SPECIFICATIONS AND PERMIT REQUIREMENTS.
2. ROCK MATERIAL SHALL BE SALVAGED FOR RE-USE ON-SITE AS ROCKERY & DRIFT-SILL MATERIAL.

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

DEMOLITION PLAN (2 OF 3)

D-1.1

SHEET NO. 11 OF 33

Apr 21, 2010 3:10pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL05-D01.dwg 11 D-1.1

LEGEND:

- BULKHEAD REMOVAL
- TREE REMOVAL
- SITE FURNISHING AND UTILITY FEATURE REMOVAL
- CLEAR AND GRUB
- ROCK RIP-RAP REMOVAL (NOTE 2)
- CONCRETE PAVING REMOVAL
- PAVER REMOVAL
- ASPHALT PAVING REMOVAL
- GRAVEL SURFACING REMOVAL
- UTILITY LINE REMOVAL
- PROJECT LIMIT

DEMOLITION NOTES:

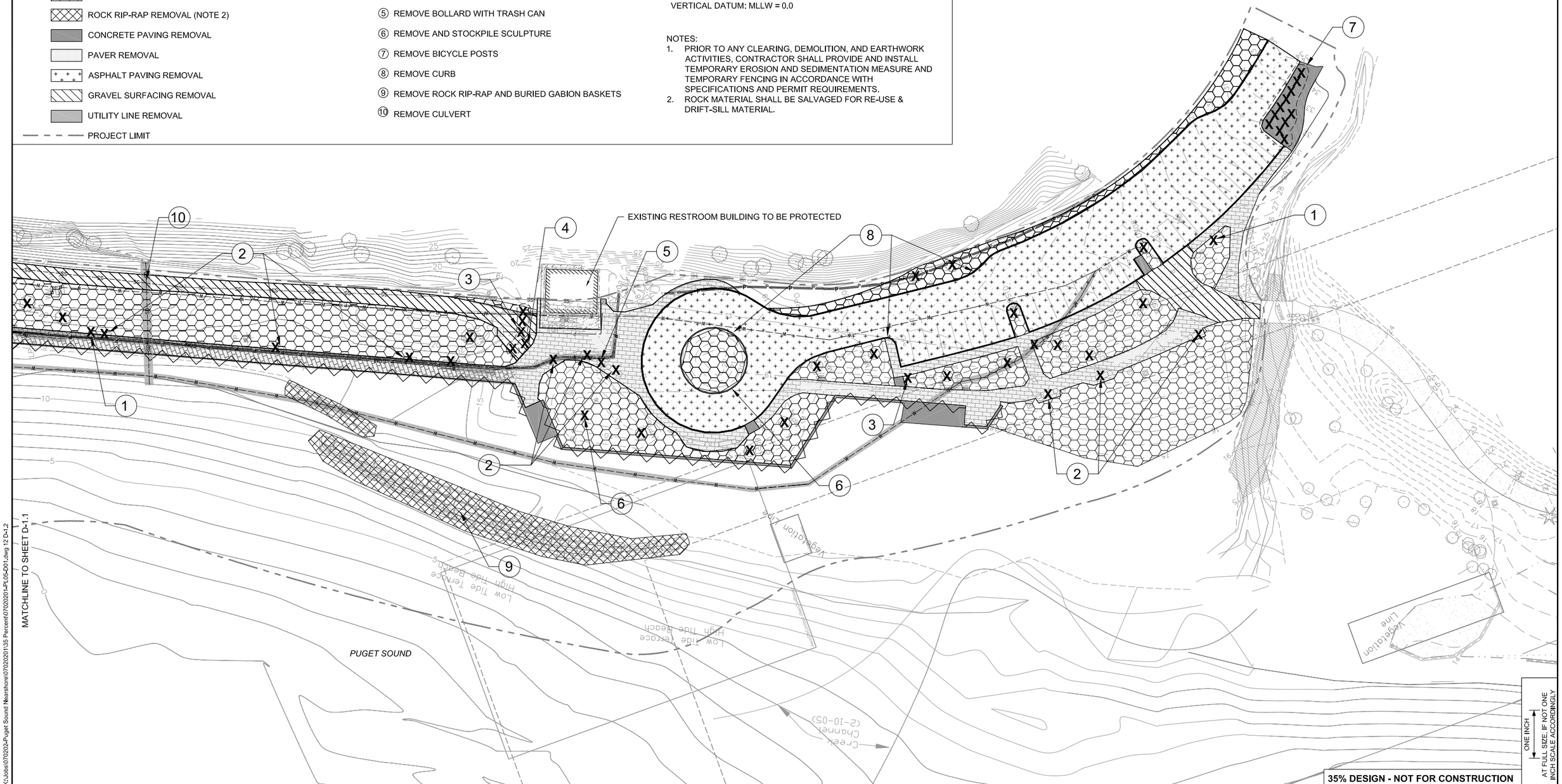
1. REMOVE GARBAGE ENCLOSURE
2. REMOVE BENCH
3. REMOVE BOLLARD
4. REMOVE DRINKING FOUNTAIN
5. REMOVE BOLLARD WITH TRASH CAN
6. REMOVE AND STOCKPILE SCULPTURE
7. REMOVE BICYCLE POSTS
8. REMOVE CURB
9. REMOVE ROCK RIP-RAP AND BURIED GABION BASKETS
10. REMOVE CULVERT

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

NOTES:

1. PRIOR TO ANY CLEARING, DEMOLITION, AND EARTHWORK ACTIVITIES, CONTRACTOR SHALL PROVIDE AND INSTALL TEMPORARY EROSION AND SEDIMENTATION MEASURE AND TEMPORARY FENCING IN ACCORDANCE WITH SPECIFICATIONS AND PERMIT REQUIREMENTS.
2. ROCK MATERIAL SHALL BE SALVAGED FOR RE-USE & DRIFT-SILL MATERIAL.



35% DESIGN - NOT FOR CONSTRUCTION

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ANCHOR QEA

US Army Corps of Engineers

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APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

DEMOLITION PLAN (3 OF 3)

D-1.2

SHEET NO. 12 OF 33

Apr 21, 2010 3:11pm bberminghamK:\Jobs\070202-Puget Sound Nearshore\070202\01\35 Percent\070202\01-PL05-D01.dwg 12 D-1.2

LEGEND:

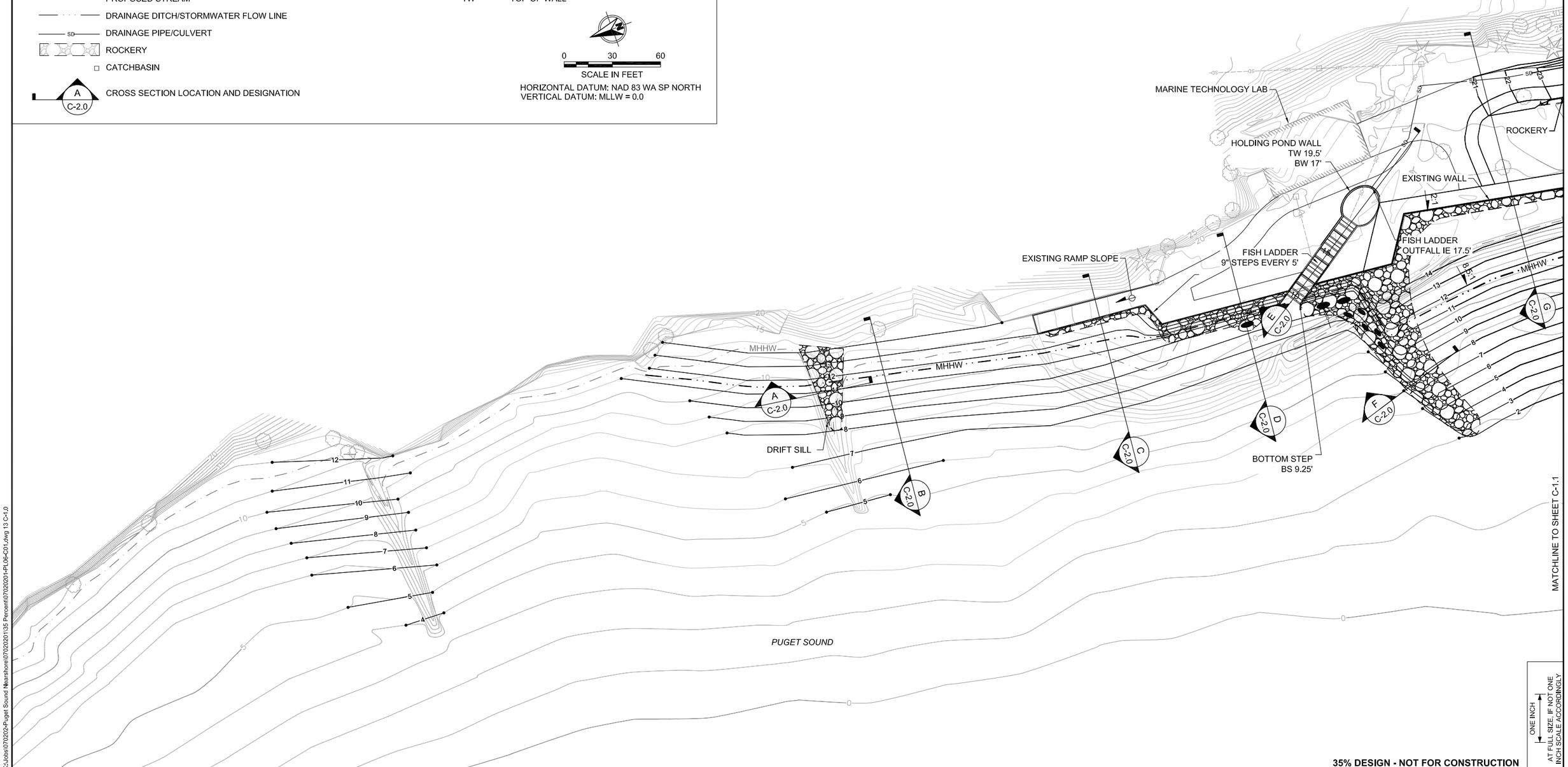
- PROJECT LIMIT
- 20 EXISTING CONTOURS IN FEET
- EXISTING MEAN HIGHER HIGH WATER LINE (MHHW = ELV. 11.6 MLLW DATUM)
- 0 2 PROPOSED CONTOURS IN FEET
- PROPOSED MEAN HIGHER HIGH WATER LINE (MHHW = ELV. 11.6 MLLW DATUM)
- PROPOSED STREAM
- DRAINAGE DITCH/STORMWATER FLOW LINE
- SD DRAINAGE PIPE/CULVERT
- ROCKERY
- CATCHBASIN
- A C-2.0 CROSS SECTION LOCATION AND DESIGNATION

ABBREVIATION DEFINITIONS:

ADA	AMERICANS WITH DISABILITIES ACT COMPLIANT
BS	BOTTOM OF STEP
BW	BOTTOM OF WALL
EL	ELEVATION (IN FEET)
FFE	FINISHED FLOOR ELEVATION
IE	PIPE INVERT ELEVATION
IN EL	INLET ELEVATION
MHHW	MEAN HIGHER HIGH WATER
OUT EL	OUTLET ELEVATION
RIM EL	STORM DRAIN RIM ELEVATION
TW	TOP OF WALL

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



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ANCHOR QEA

US Army Corps of Engineers

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

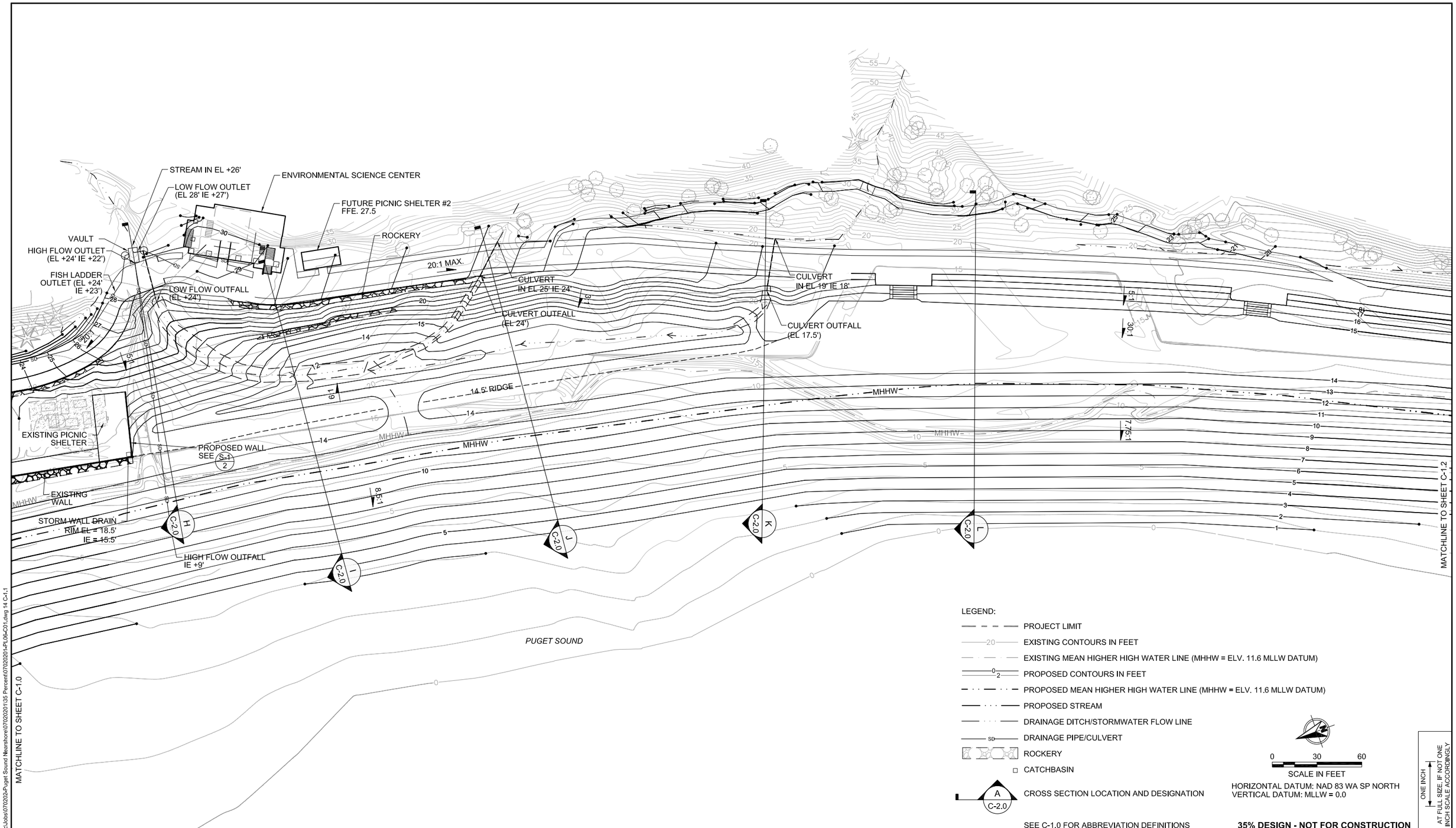
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

GRADING & DRAINAGE PLAN (1 OF 3)

C-1.0

SHEET NO. 13 OF 33

Apr 21, 2010 3:00pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\070202\01\35 Percent\070202\01-PL06-C01.dwg 13 C-1.0



Apr 21, 2010 2:57pm bberringham:K:\Jobs\070202-Puget Sound Nearshore\070202\01135 Percent\070202\01-PL06-C01.dwg 14 C-1.1

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

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DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

GRADING & DRAINAGE PLAN (2 OF 3)

C-1.1

SHEET NO. 14 OF 33

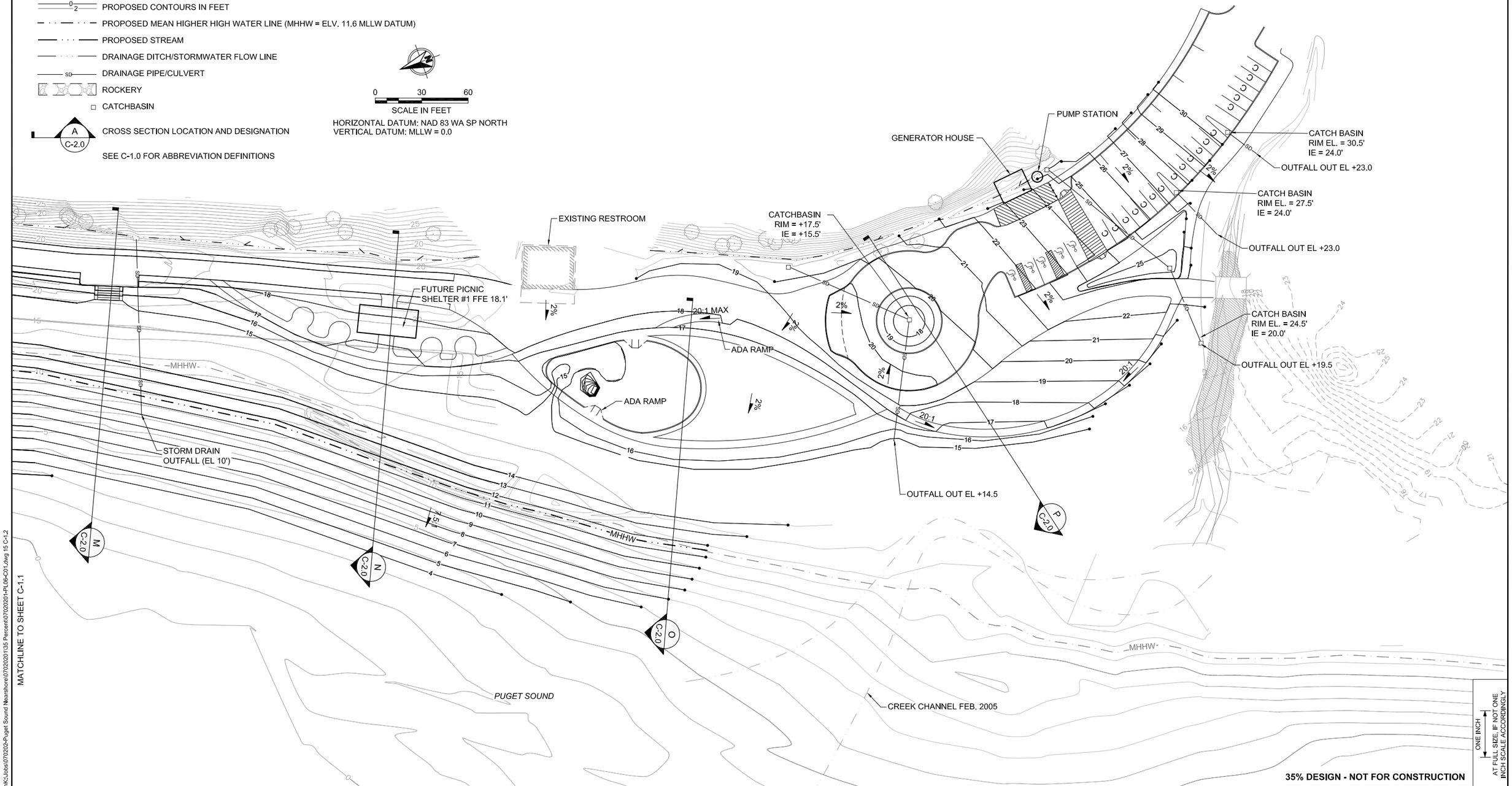
LEGEND:

- PROJECT LIMIT
- EXISTING CONTOURS IN FEET
- EXISTING MEAN HIGHER HIGH WATER LINE (MHHW = ELV. 11.6 MLLW DATUM)
- PROPOSED CONTOURS IN FEET
- PROPOSED MEAN HIGHER HIGH WATER LINE (MHHW = ELV. 11.6 MLLW DATUM)
- PROPOSED STREAM
- DRAINAGE DITCH/STORMWATER FLOW LINE
- DRAINAGE PIPE/CULVERT
- ROCKERY
- CATCHBASIN
- CROSS SECTION LOCATION AND DESIGNATION

SEE C-1.0 FOR ABBREVIATION DEFINITIONS

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



MATCHLINE TO SHEET C-1.1

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

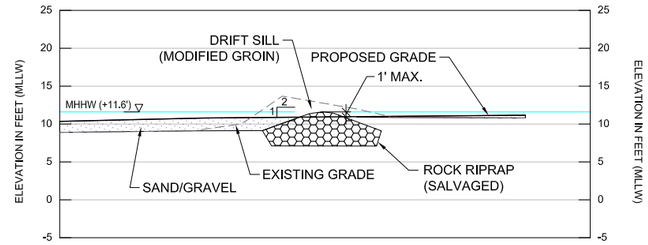
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

GRADING & DRAINAGE PLAN (3 OF 3)

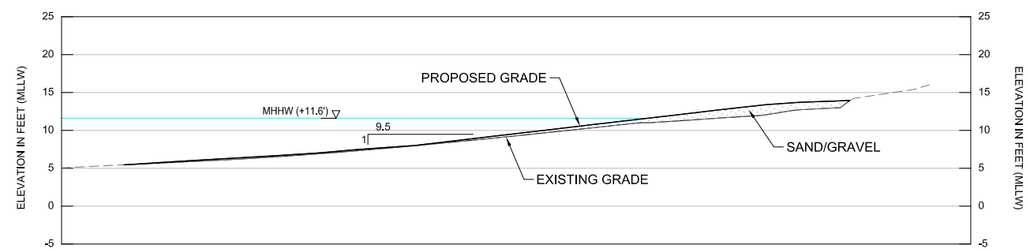
C-1.2

SHEET NO. 15 OF 33

Apr 21, 2010 3:00pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL06-C01.dwg 15 C-1.2



A C-1.0 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



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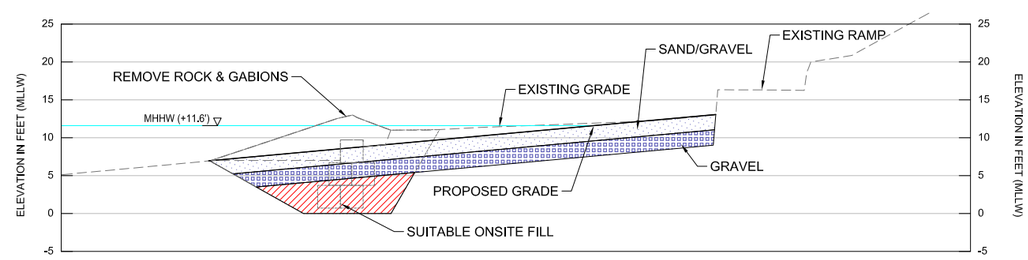

C C-1.0 SECTION
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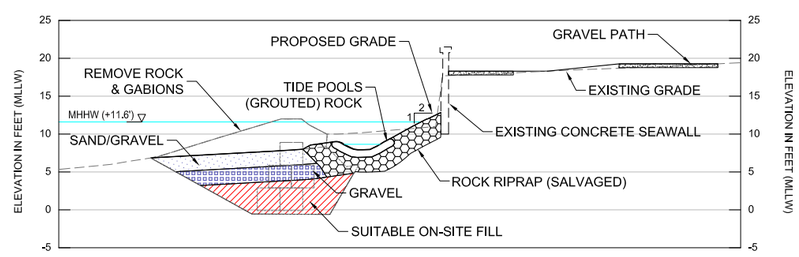
VERT. SCALE: 1" = 10'



D C-1.0 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'

0 10 20
SCALE IN FEET

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

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DRAWN BY: B. BERMINGHAM/CDAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

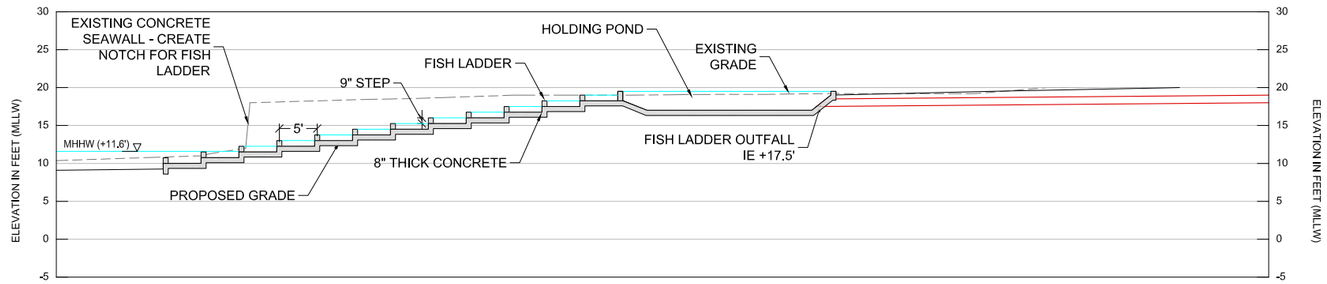
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

GRADING CROSS SECTIONS

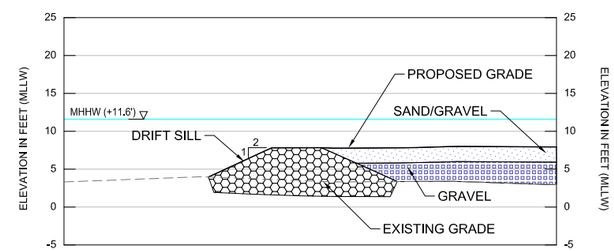
C-2.0

SHEET NO. 16 OF 33

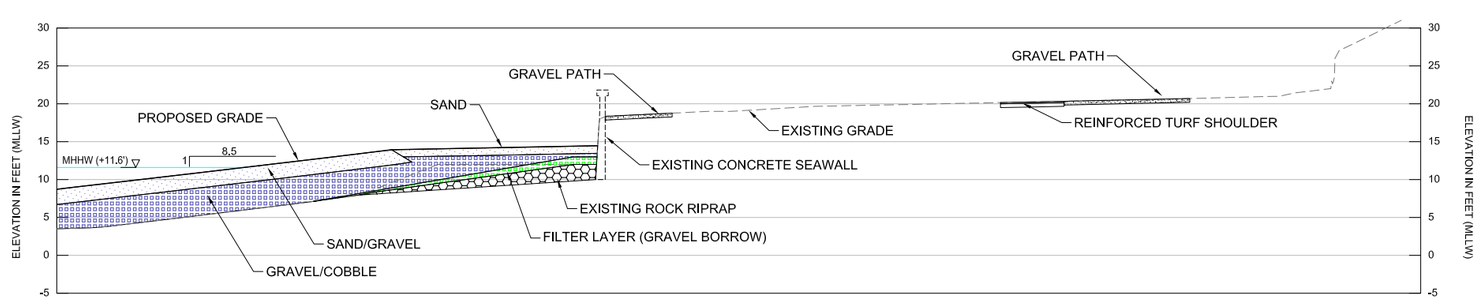
Apr 20, 2010 2:20pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL07-C02.dwg 16 C-2.0



E / C-1.0 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



F / C-1.0 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



G / C-1.0 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'

0 10 20
SCALE IN FEET

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS				
REV	DATE	BY	APP'D	DESCRIPTION

DESIGNED BY: B. BERMINGHAM/P. HUMMEL
DRAWN BY: B. BERMINGHAM/C/ DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

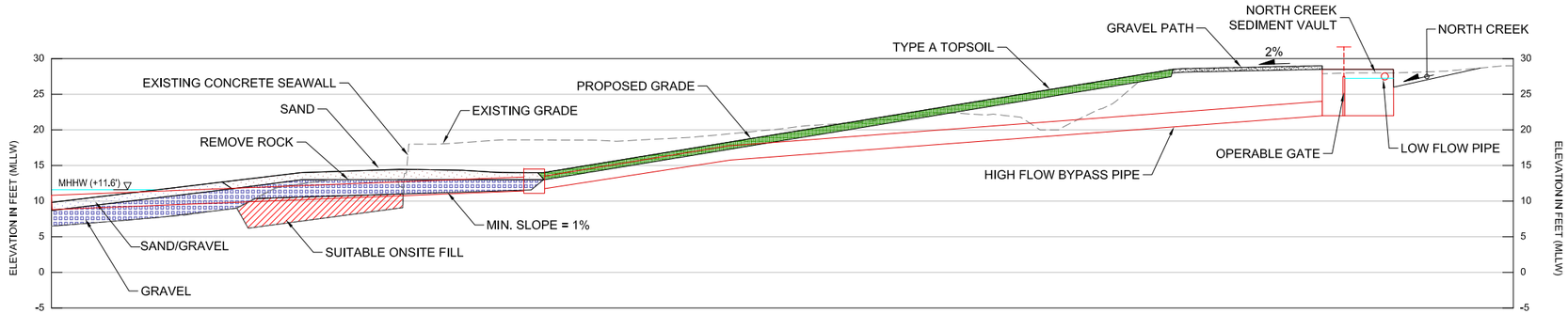
SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

GRADING CROSS SECTIONS

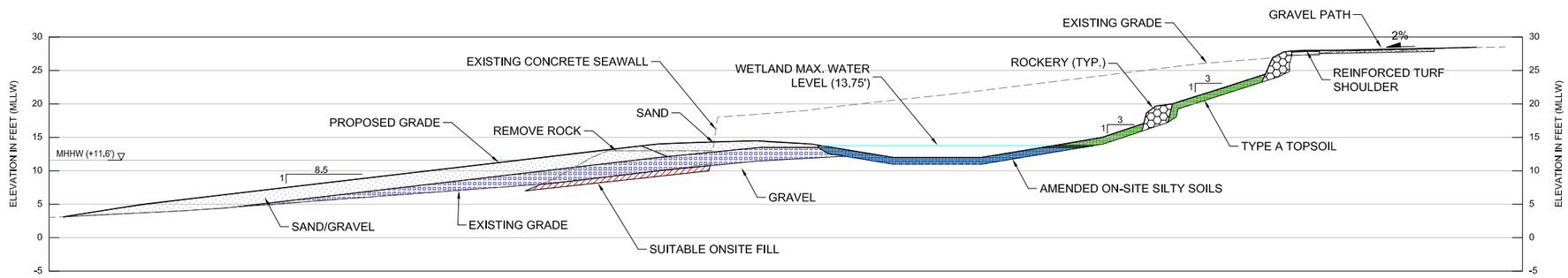
C-2.1

SHEET NO. 17 OF 33

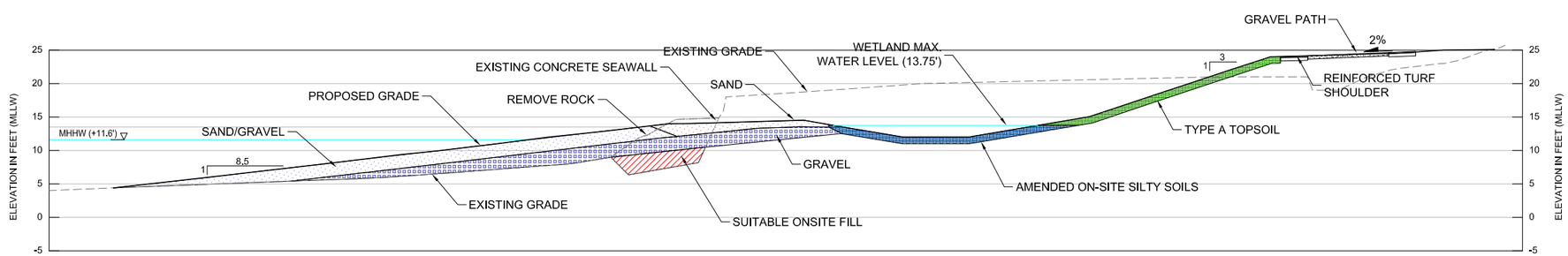
Apr 20, 2010 2:21pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202\01\35 Percent\070202\01-PL\07-C02.dwg 17 C-2.1



H C-1.1 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



I C-1.1 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



J C-1.1 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'

0 10 20
SCALE IN FEET

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

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DATE: APRIL 2010

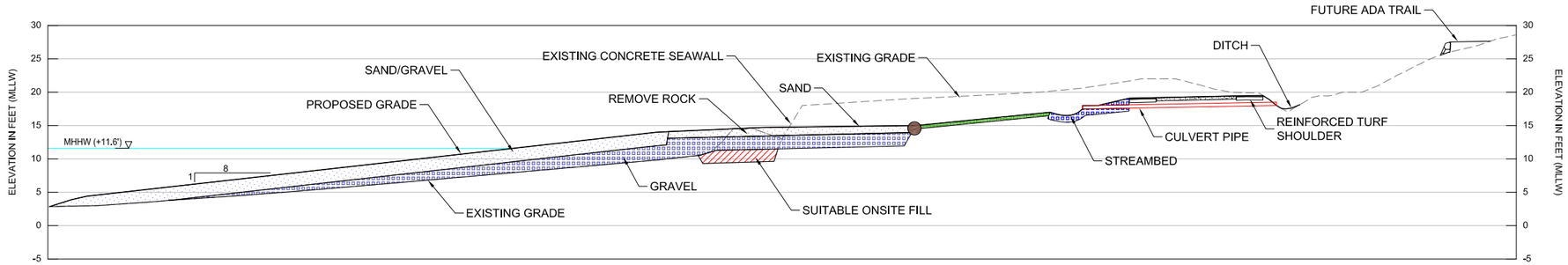
SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

GRADING CROSS SECTIONS

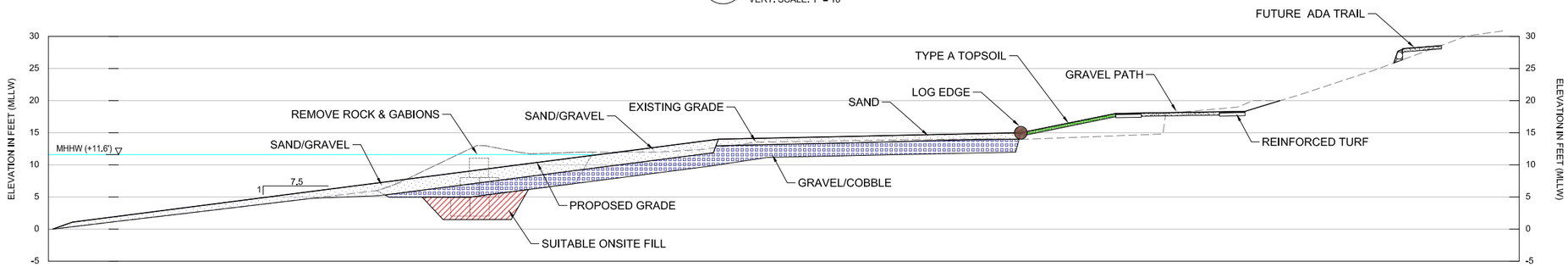
C-2.2

SHEET NO. 18 OF 33

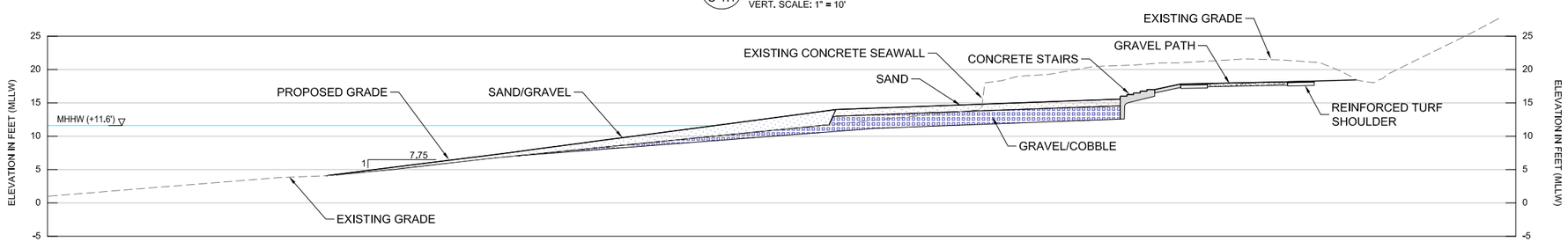
Apr 20, 2010 2:21pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL07-C02.dwg 18 C-2.2



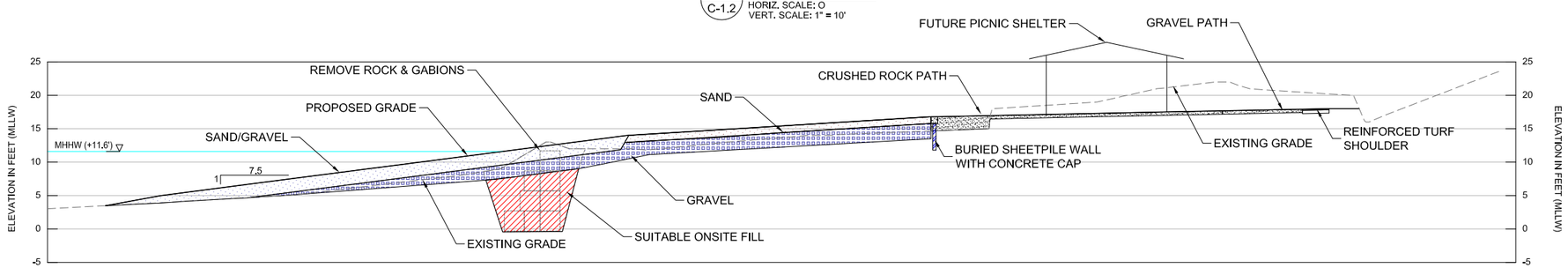
K C-1.1 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



L C-1.1 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'



M C-1.2 SECTION
HORIZ. SCALE: O
VERT. SCALE: 1" = 10'



N C-1.2 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'

0 10 20
SCALE IN FEET

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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ANCHOR QEA

US Army Corps of Engineers

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SCALE: AS SHOWN
DATE: APRIL 2010

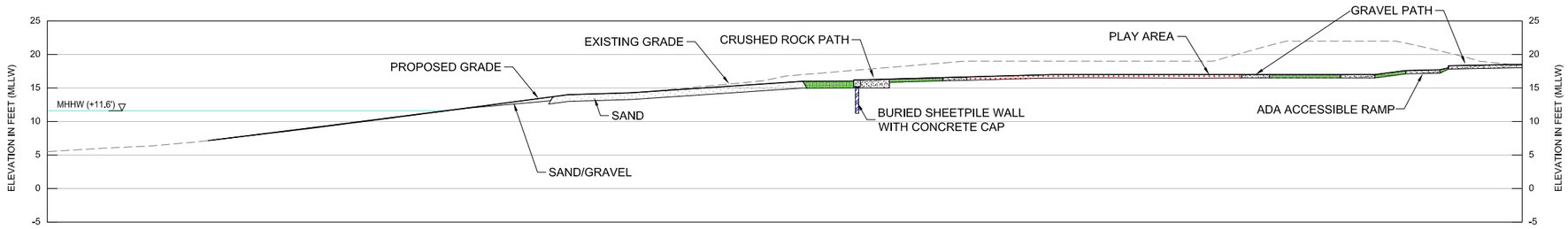
SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

GRADING CROSS SECTIONS

C-2.3

SHEET NO. 19 OF 33

Apr 20, 2010 2:22pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-Pl\07-C02.dwg 19 C-2.3



0 / C-1.2 SECTION
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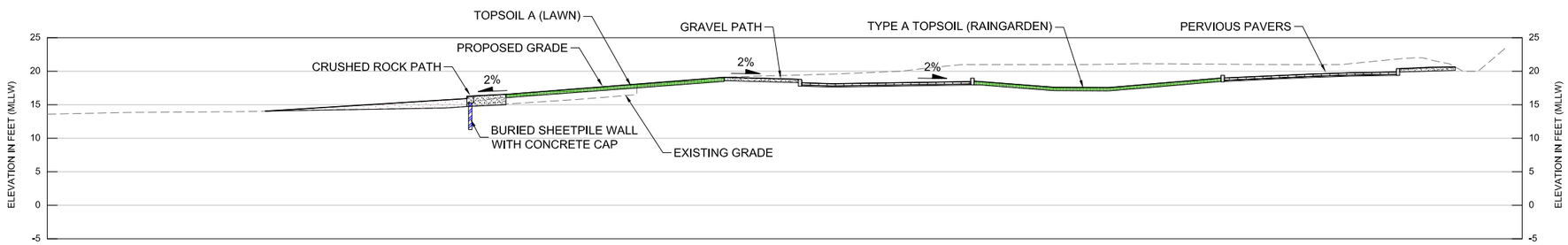
VERT. SCALE: 1" = 10'



P / C-1.2 SECTION
HORIZ. SCALE: 1" = 10
VERT. SCALE: 1" = 10'

0 10 20
SCALE IN FEET

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

REVISIONS

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

GRADING CROSS SECTIONS

C-2.4

SHEET NO. 20 OF 33

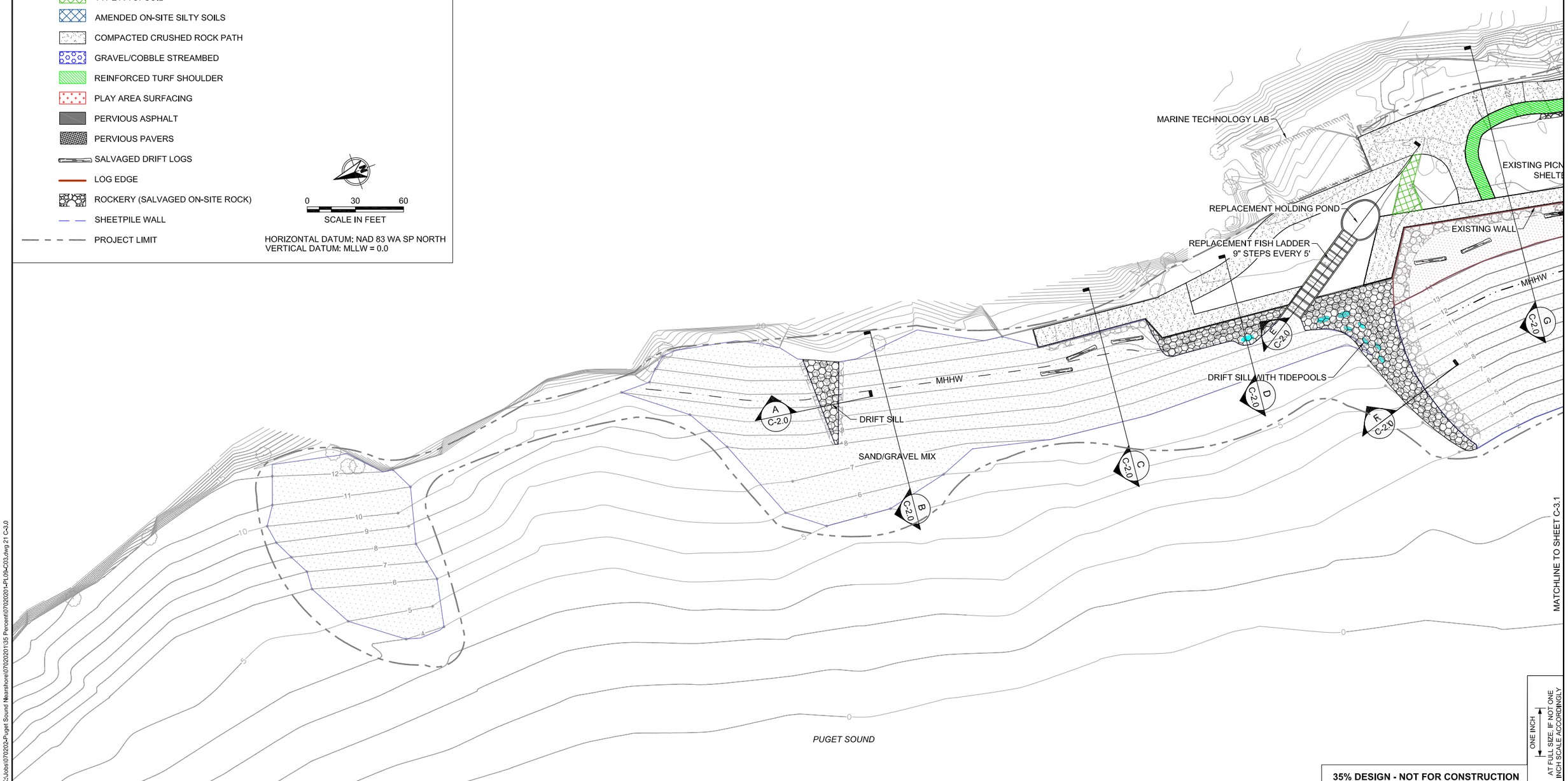
Apr 20, 2010 2:22pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202\01\35 Percent\070202\01-PL07-C02.dwg 20 C-2.4

LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- TYPE A TOPSOIL
- AMENDED ON-SITE SILTY SOILS
- COMPACTED CRUSHED ROCK PATH
- GRAVEL/COBBLE STREAMBED
- REINFORCED TURF SHOULDER
- PLAY AREA SURFACING
- PERVIOUS ASPHALT
- PERVIOUS PAVERS
- SALVAGED DRIFT LOGS
- LOG EDGE
- ROCKERY (SALVAGED ON-SITE ROCK)
- SHEETPILE WALL
- PROJECT LIMIT

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



ONE INCH
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ANCHOR QEA

US Army Corps of Engineers

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APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

CONSTRUCTION LAYOUT & MATERIALS PLAN (1 OF 3)

C-3.0

SHEET NO. 21 OF 33

Apr 20, 2010 2:23pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202011\35 Percent\070202011-PL09-C03.dwg 21 C-3.0

ENVIRONMENTAL SCIENCE BUILDING

FUTURE PICNIC SHELTER #2

GRAVEL PATH WITH REINFORCED TURF SHOULDERS

FUTURE GRAVEL TRAIL

GRAVEL PATH WITH REINFORCED TURF SHOULDERS

VAULT

ROCKERY WALL

LARGE WOODY DEBRIS - NOTCHED FOR STREAM GRADE CONTROL

BOULDERS

IMPERMEABLE STREAMBED LINER

GRADE BREAK

MHHW

EXISTING PICNIC SHELTER

RETAINING WALL SEE 2/S-1

PUGET SOUND

H C-2.0

I C-2.0

J C-2.0

K C-2.0

L C-2.0

MATCHLINE TO SHEET C-3.0

MATCHLINE TO SHEET C-3.2

LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- TYPE A TOPSOIL
- AMENDED ON-SITE SILTY SOILS
- COMPACTED CRUSHED ROCK PATH
- GRAVEL/COBBLE STREAMBED
- REINFORCED TURF SHOULDER
- PLAY AREA SURFACING
- PERVIOUS ASPHALT
- PERVIOUS PAVERS
- LOG EDGE
- SALVAGED DRIFT LOGS
- LARGE WOODY DEBRIS
- ROCKERY (SALVAGED ON-SITE ROCK)
- COIR FABRIC
- COIR LOG
- JUTE FABRIC
- SHEETPILE WALL
- PROJECT LIMIT

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

ANCHOR QEA

US Army Corps of Engineers

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

CONSTRUCTION LAYOUT & MATERIALS PLAN (2 OF 3)

C-3.1

SHEET NO. 22 OF 33

Apr 20, 2010 2:25pm bberminghamK:\Jobs\070202-Puget Sound Nearshore\070202011\35 Percent\070202011-PL09-C03.dwg 22 C-3.1

LEGEND:

- SHELTERS
- SAND/GRAVEL MIX
- SAND OVER EXISTING/PROPOSED BEACH
- TYPE A TOPSOIL
- AMENDED ON-SITE SILTY SOILS
- COMPACTED CRUSHED ROCK PATH
- GRAVEL/COBBLE STREAMBED
- SHEETPILE WALL
- REINFORCED TURF SHOULDER
- PLAY AREA SURFACING
- PERVIOUS ASPHALT
- PERVIOUS PAVERS
- SALVAGED DRIFT LOGS
- LOG EDGE
- ROCKERY (SALVAGED ON-SITE ROCK)
- PROJECT LIMIT

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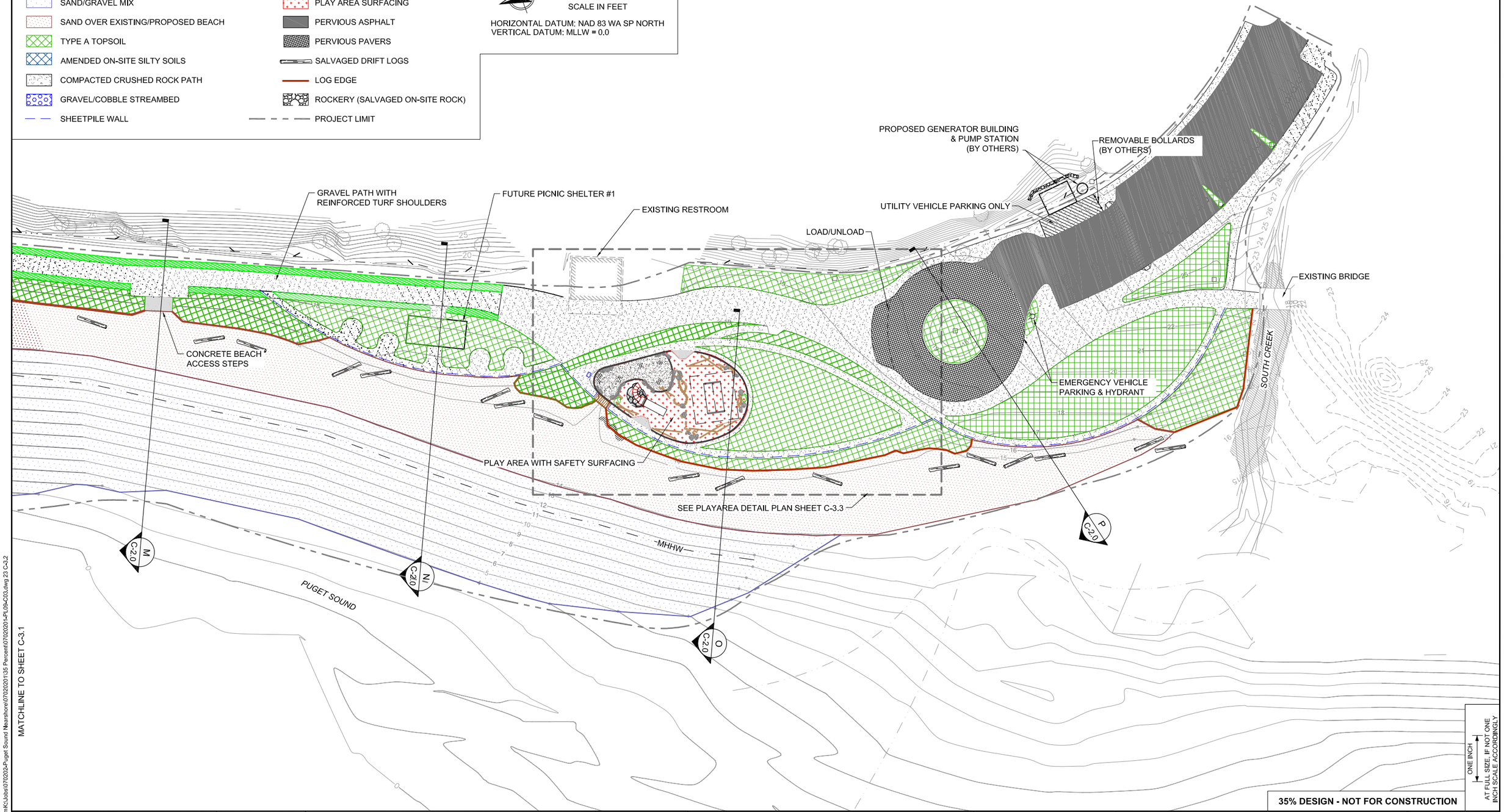
VERTICAL DATUM: MLLW = 0.0



MATCHLINE TO SHEET C-3.1

35% DESIGN - NOT FOR CONSTRUCTION

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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US Army Corps of Engineers

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DRAWN BY: B. BERMINGHAM/C. DAVIDSON
CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

CONSTRUCTION LAYOUT & MATERIALS PLAN (3 OF 3)

C-3.2

SHEET NO. 23 OF 33

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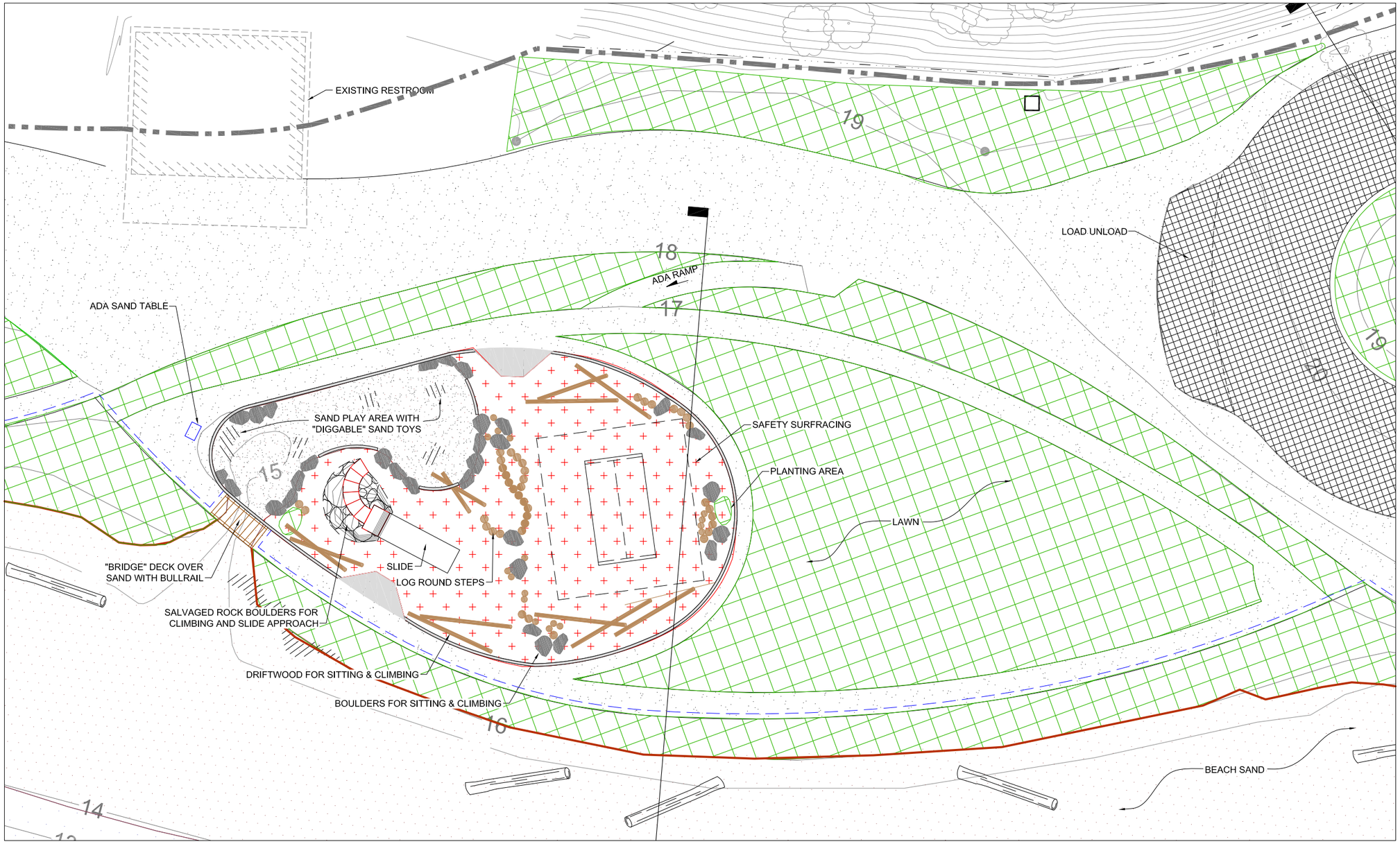

0 10 20

SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

ONE INCH

AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLAY AREA DETAIL PLAN

C-3.3

SHEET NO. 24 OF 33

Apr 20, 2010 2:27pm bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202\01135 Percent\070202\01-PL09-C03.dwg 24 C-3.3

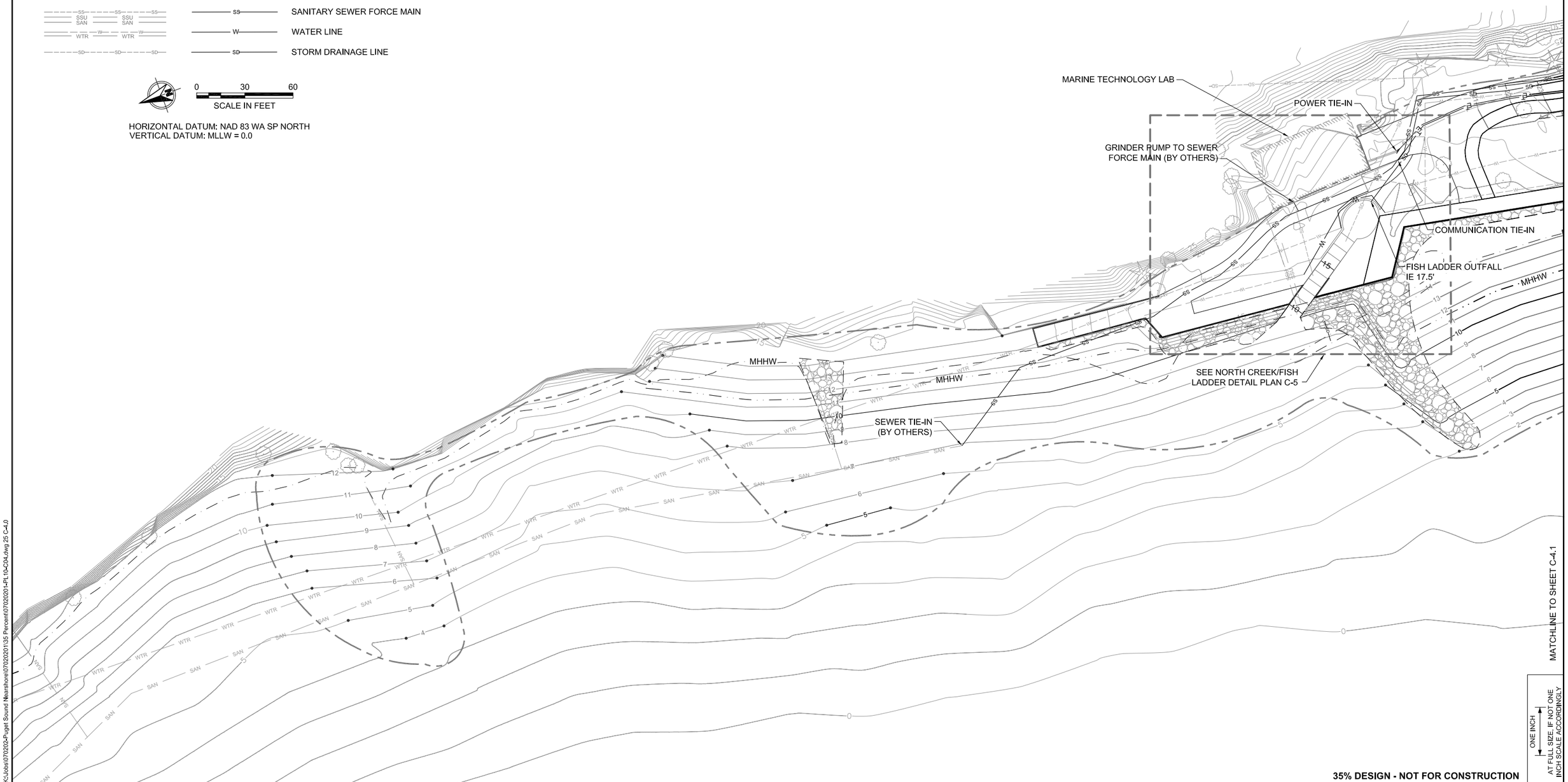
LEGEND:

PROJECT LIMIT

EXISTING	PROPOSED	
COM	T	COMMUNICATION LINE
P	E	POWER LINE
SS, SSU SAN	SS	SANITARY SEWER FORCE MAIN
W, WTR	W	WATER LINE
SD	SD	STORM DRAINAGE LINE

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

UTILITIES PLAN (1 OF 3)

C-4.0

SHEET NO. 25 OF 33

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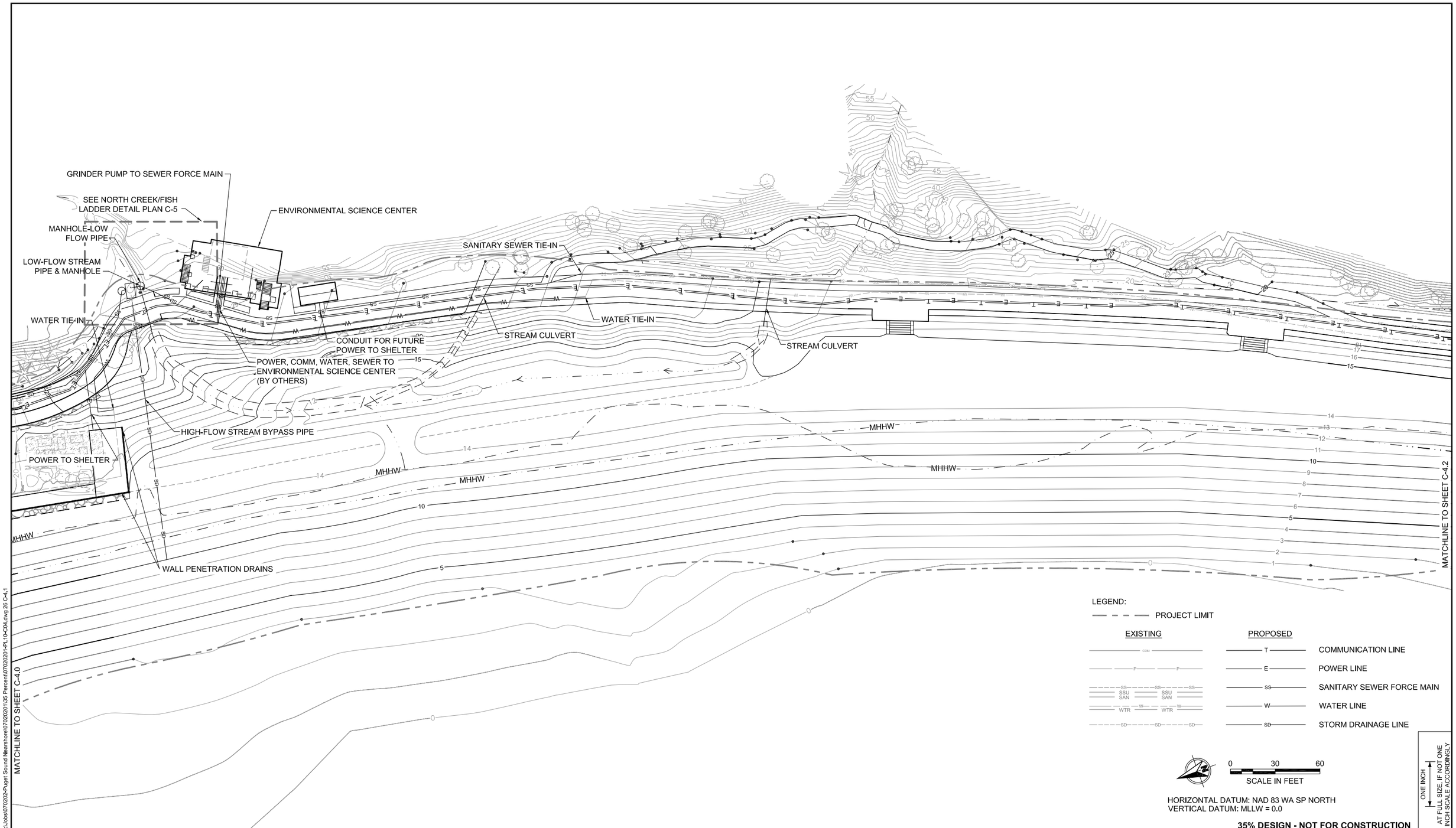

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

UTILITIES PLAN (2 OF 3)

C-4.1

SHEET NO. 26 OF 33

Apr 20, 2010 2:28pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\07020201135 Percent\07020201-PL10-C04.dwg 26 C-4.1

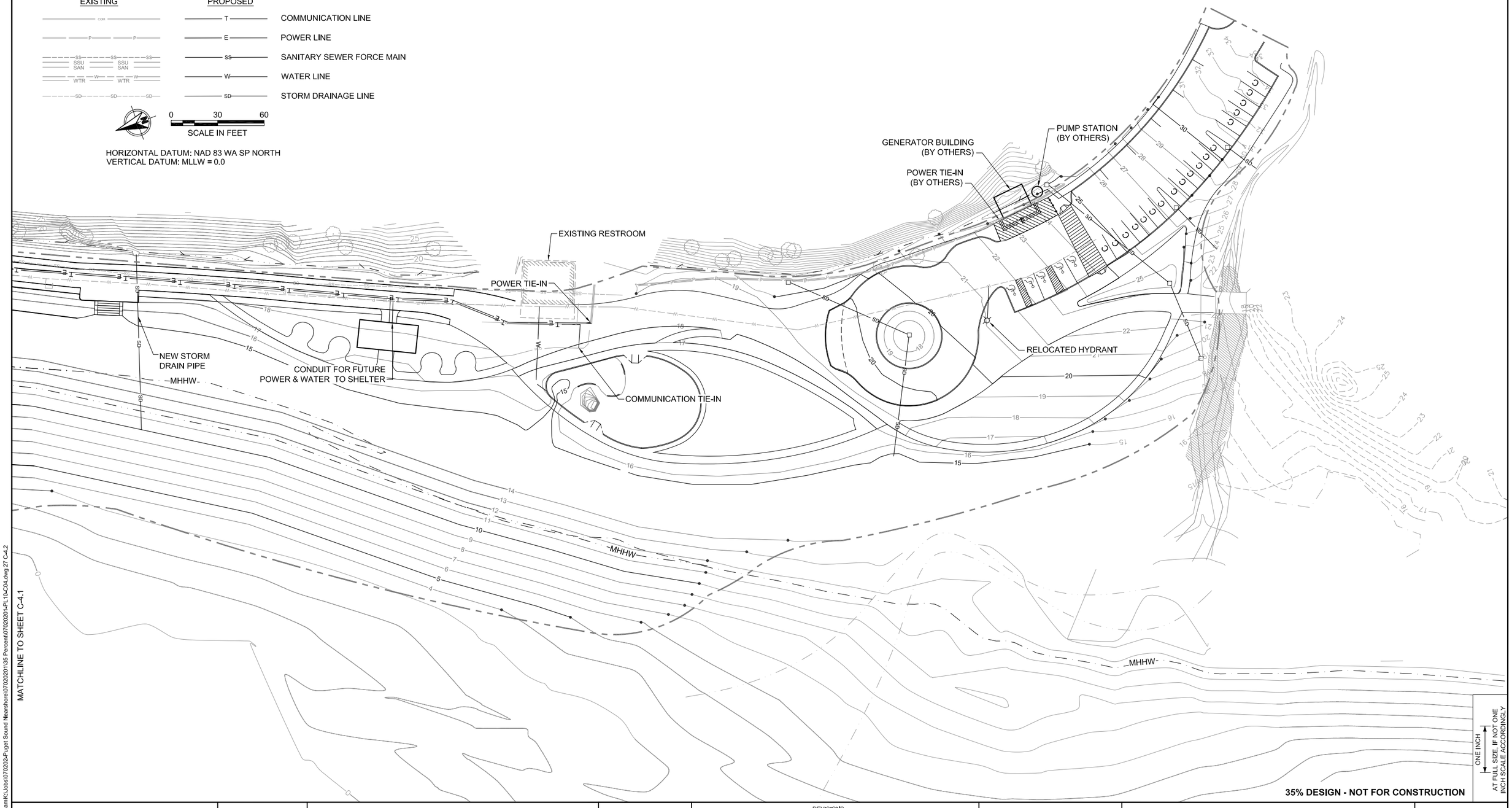
LEGEND:

PROJECT LIMIT

EXISTING	PROPOSED	
COM	T	COMMUNICATION LINE
P	E	POWER LINE
SS / SSU SAN	SS	SANITARY SEWER FORCE MAIN
W / WTR	W	WATER LINE
SD	SD	STORM DRAINAGE LINE

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

UTILITIES PLAN (3 OF 3)

C-4.2

SHEET NO. 27 OF 33

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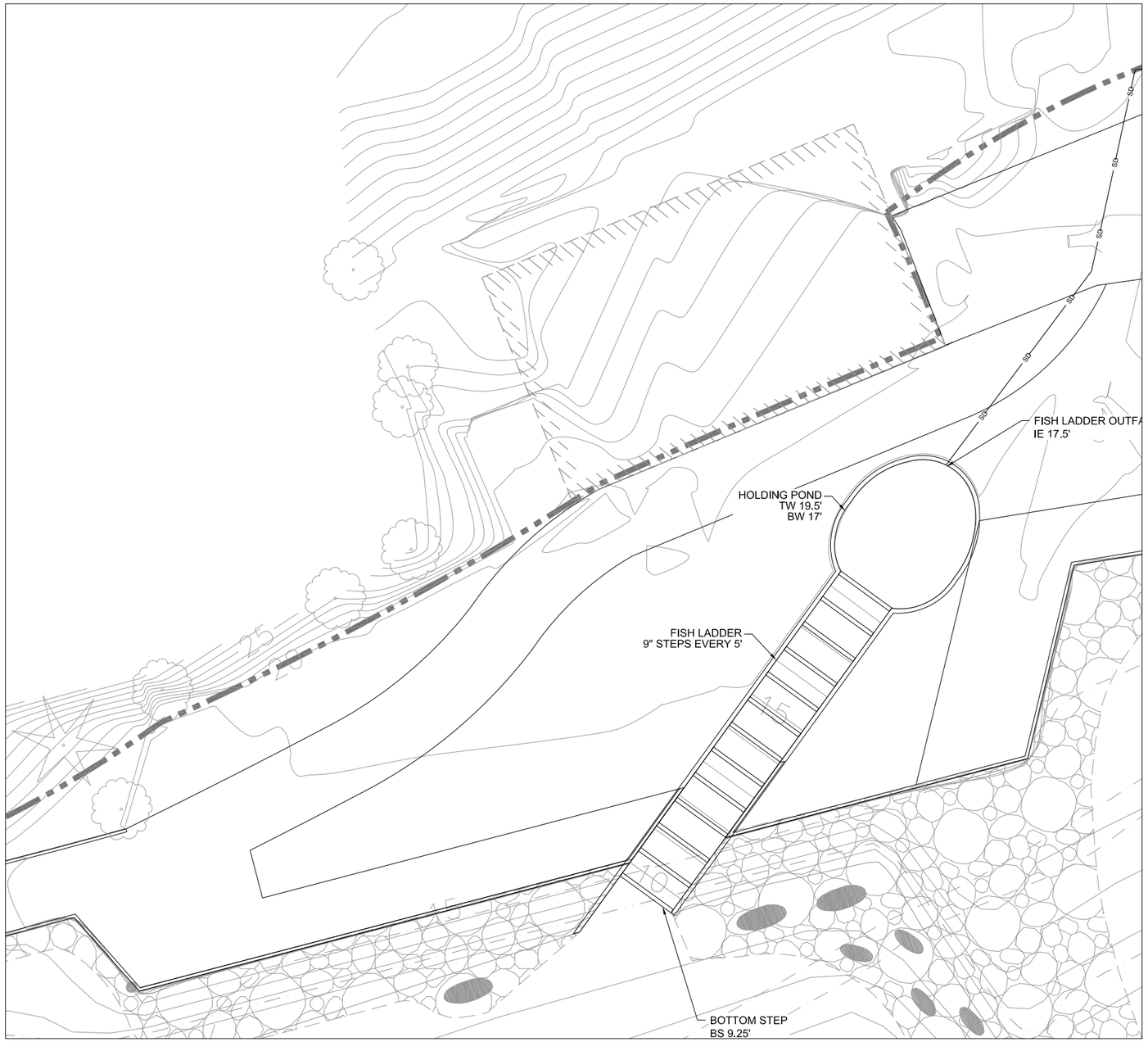
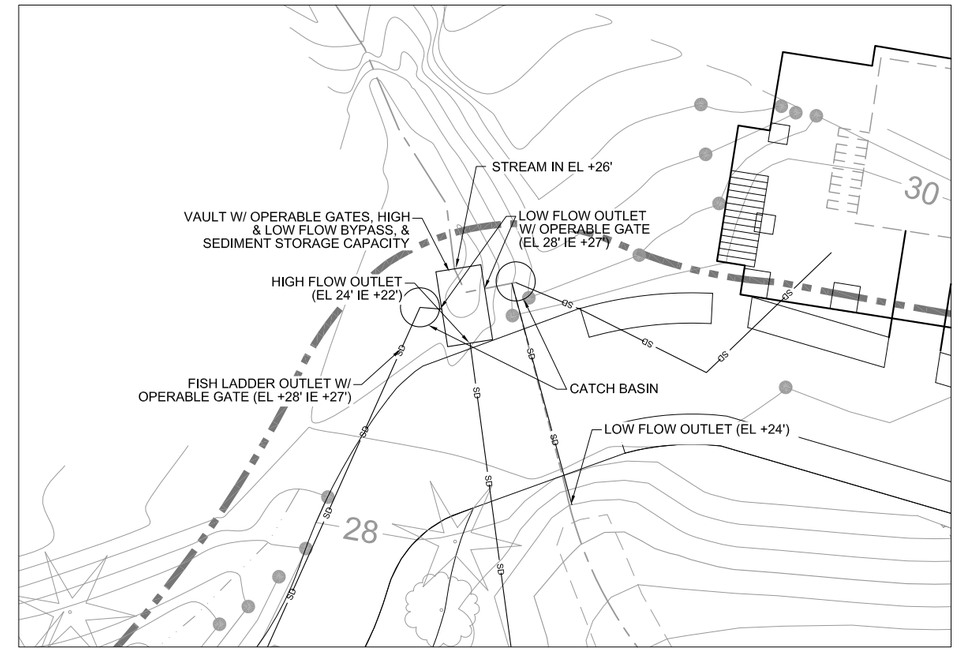


FISH LADDER AND HOLDING POND DETAIL PLAN



NORTH CREEK DETAIL PLAN

LEGEND:

— — — — PROJECT LIMIT

0 10 20

SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

ONE INCH
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APPROVED BY:
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DATE: APRIL 2010

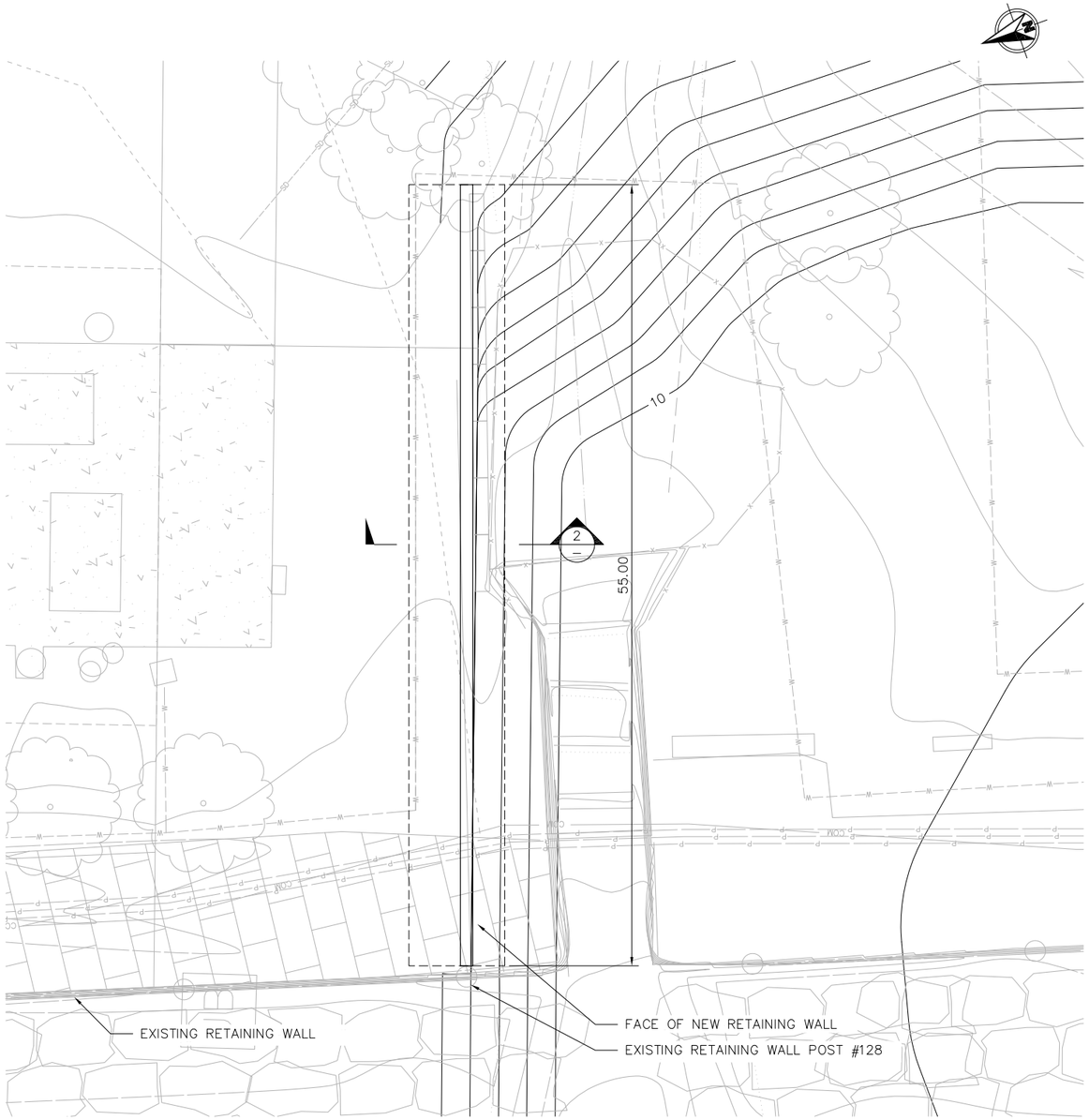
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

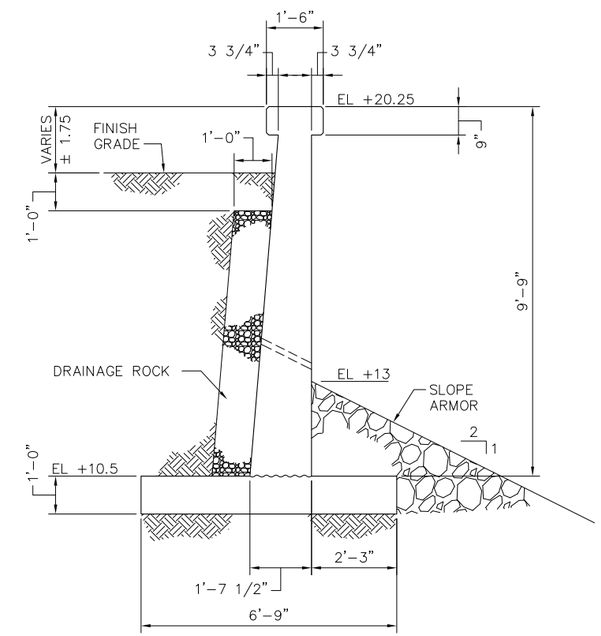
NORTH CREEK/FISH LADDER DETAIL PLAN

C-5

SHEET NO. 28 OF 33

Apr 21, 2010 11:35am bbermingham:K:\Jobs\070202-Puget Sound Nearshore\070202201135 Percent\070202201-PL11-C05.dwg 28 C-5





2 – SECTION – RETAINING WALL

SCALE: 1"=4' 4 0 4 8 scale feet

1 – PLAN – NEW RETAINING WALL

SCALE: 1"=10' 10 0 10 20 scale feet

BergerABAM
33301 9th Avenue South, Suite 300
Federal Way, Washington 98003-2600
(206) 431-2300 Fax: (206) 431-2250

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II SHORELINE ECOSYSTEM RESTORATION

RETAINING WALL PLAN & SECTION

S-1

SHEET NO. 29 OF 33

Apr 20, 2010 2:41pm bberminghamK:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL12-S01.dwg 29 S-1

LEGEND:

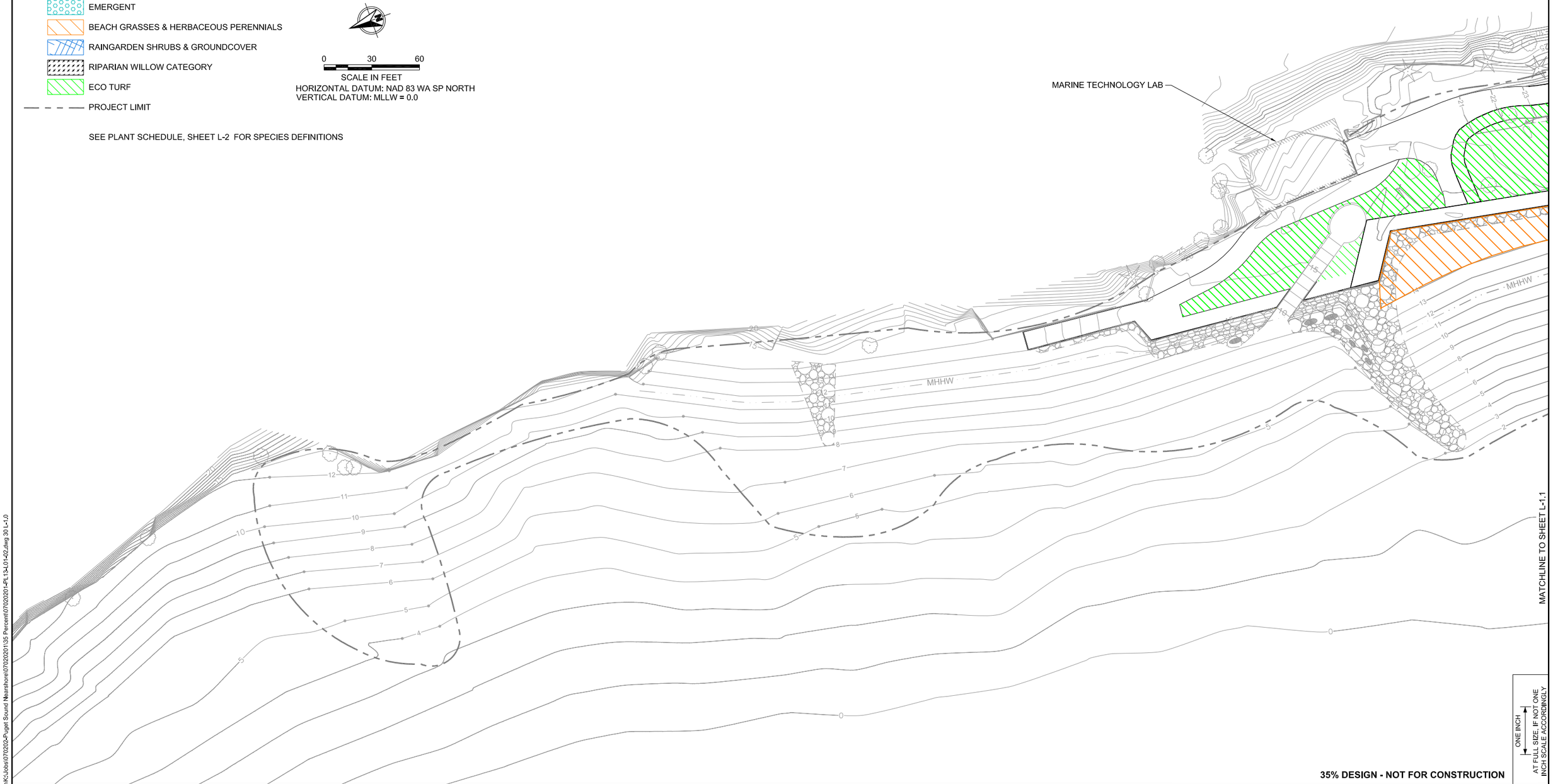
- NATIVE TREES MEDIUM TO TALL
- NATIVE SHRUBS - MEDIUM TO TALL
- NATIVE LOW SHRUBS & GROUNDCOVER
- EMERGENT
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF
- PROJECT LIMIT

SEE PLANT SCHEDULE, SHEET L-2 FOR SPECIES DEFINITIONS

0 30 60

SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



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US Army Corps of Engineers

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

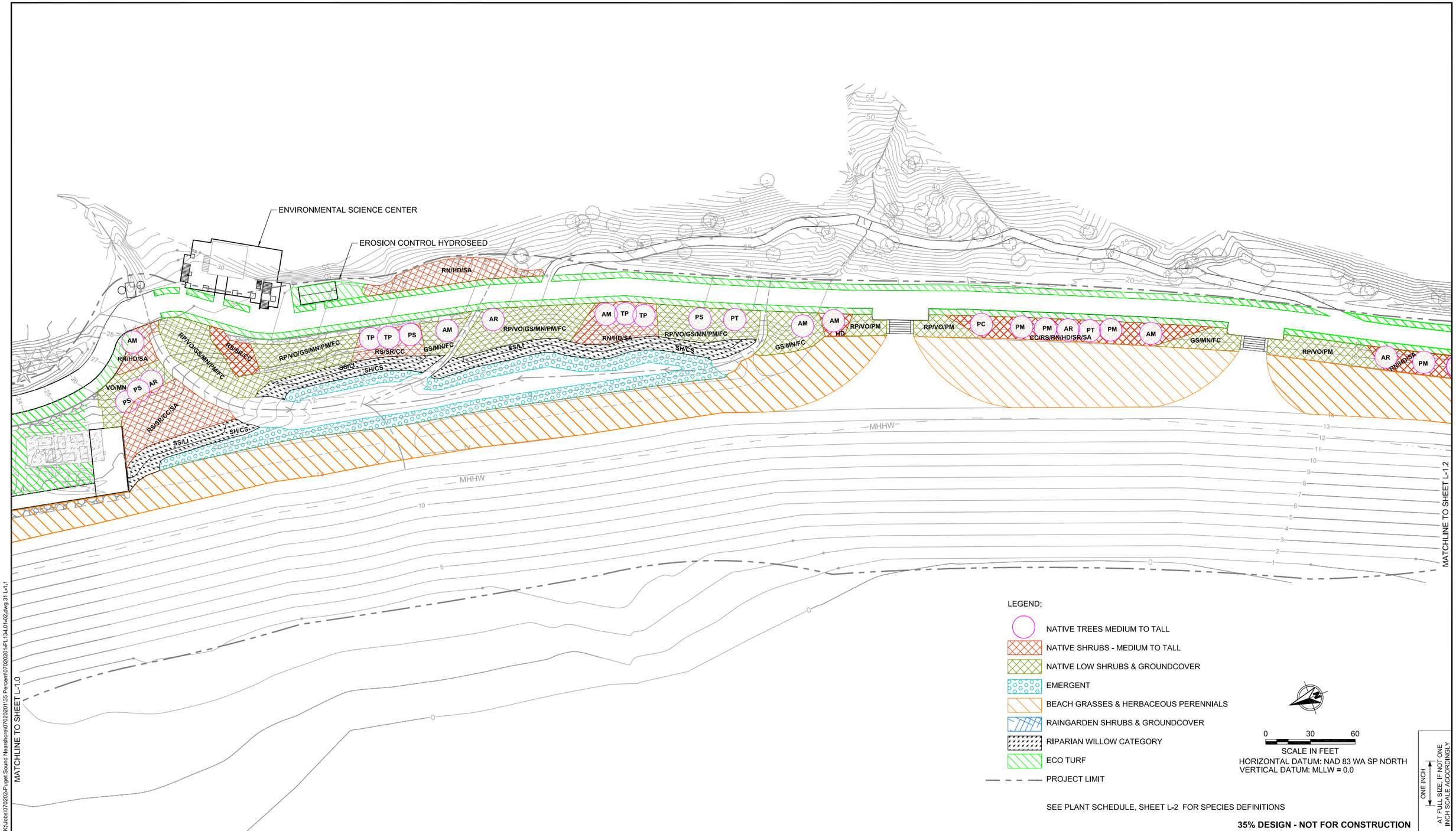
SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLANTING PLAN (1 OF 3)

L-1.0

SHEET NO. 30 OF 33

Apr 21, 2010 3:14pm bbermingham K:\Jobs\070202-Puget Sound Nearshore\070202\0135 Percent\070202\01-PL13-L01-L02.dwg 30 L-1.0



LEGEND:

- NATIVE TREES MEDIUM TO TALL
- NATIVE SHRUBS - MEDIUM TO TALL
- NATIVE LOW SHRUBS & GROUNDCOVER
- EMERGENT
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF
- PROJECT LIMIT

0 30 60
SCALE IN FEET
HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0

SEE PLANT SCHEDULE, SHEET L-2 FOR SPECIES DEFINITIONS

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APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLANTING PLAN (2 OF 3)

L-1.1

SHEET NO. 31 OF 33

Apr 21, 2010 3:15pm bbirmingham K:\Jobs\070202-Puget Sound Nearshore\07020201\35 Percent\07020201-PL13-L01-x02.dwg 31 L-1.1

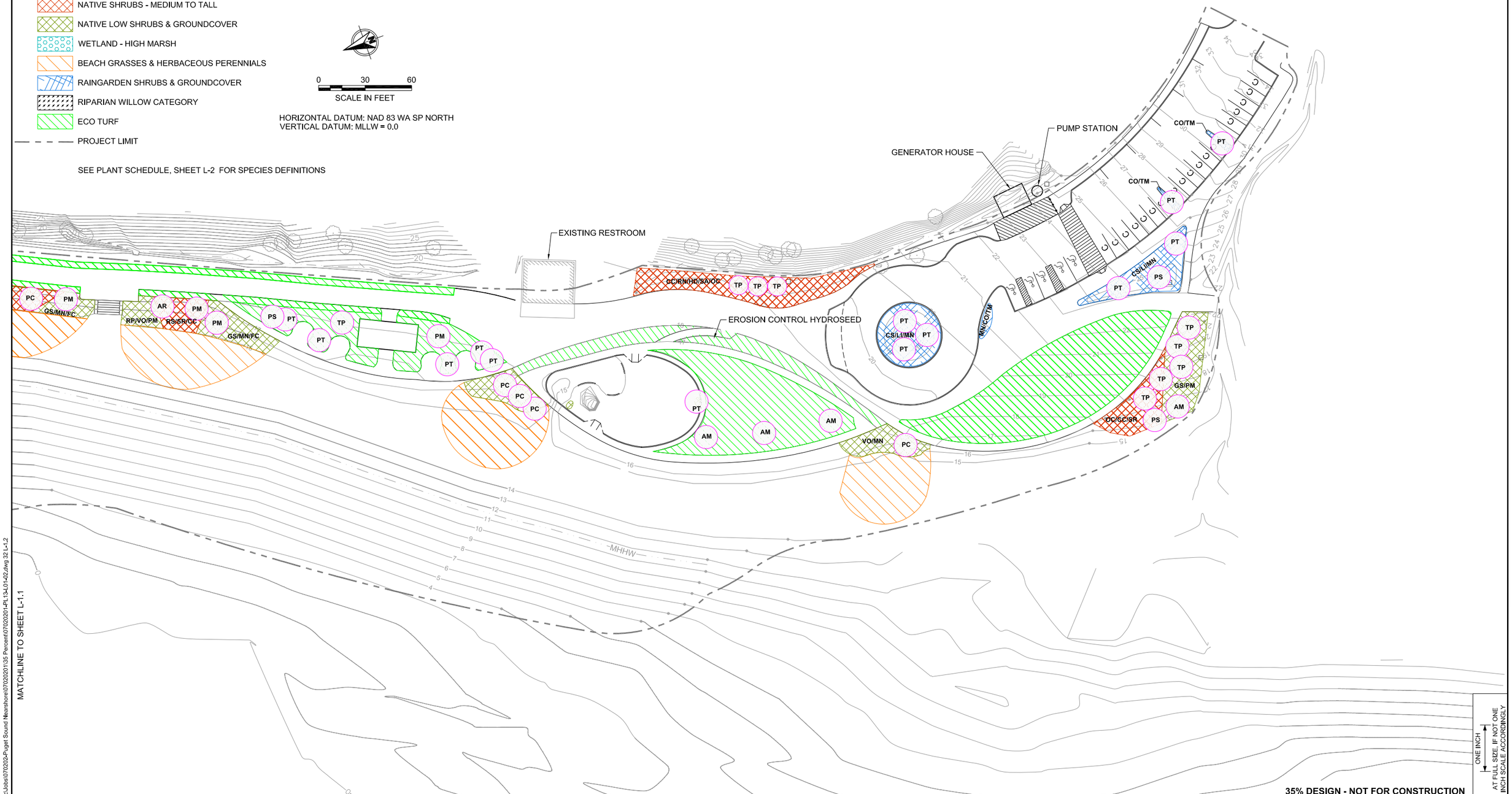
LEGEND:

- NATIVE TREES MEDIUM TO TALL
- NATIVE SHRUBS - MEDIUM TO TALL
- NATIVE LOW SHRUBS & GROUNDCOVER
- WETLAND - HIGH MARSH
- BEACH GRASSES & HERBACEOUS PERENNIALS
- RAINGARDEN SHRUBS & GROUNDCOVER
- RIPARIAN WILLOW CATEGORY
- ECO TURF
- PROJECT LIMIT

SEE PLANT SCHEDULE, SHEET L-2 FOR SPECIES DEFINITIONS

0 30 60
SCALE IN FEET

HORIZONTAL DATUM: NAD 83 WA SP NORTH
VERTICAL DATUM: MLLW = 0.0



ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

35% DESIGN - NOT FOR CONSTRUCTION

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US Army Corps of Engineers

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLANTING PLAN (3 OF 3)

L-1.2

SHEET NO. 32 OF 33

Apr 21, 2010 3:15pm bbermingham:K:\Jobs\0702024-Puget Sound Nearshore\07020201\35 Percent\07020201-PL13-01-02.dwg 32 L-1.2

PLANT SHCEDULE

SYMBOL	COMMON NAME	SPECIES NAME	SIZE	SPACING
NATIVE TREES MEDIUM TO TALL				
TP	Western Red Cedar	Thuja plicata	5 Gal. & 6-8'	As Shown
PS	Sitka Spruce	Picea sitchensis	5 Gal.	As Shown
PM	Douglas Fir	Pseudotsuga menziesii	5 Gal. & 6-8'	As Shown
PC	Shore Pine	Pinus contorta	5 Gal.	As Shown
AR	Red Alder	Alnus rubra	5 Gal.	As Shown
AM	Big Leaf Maple	Acer macrophyllum	5 Gal. & 2" cal.	As Shown
PT	Quaking Aspen	Populus tremuloides	5 Gal. & 6-8'	As Shown
NATIVE SHRUBS MEDIUM TO TALL				
CC	Beaked Hazlenut	Corylus cornuta	2 Gal.	5' O.C.
RS	Salmonberry	Rubus spectabilis	2 Gal.	5' O.C.
RN	Nootka Rose	Rosa nutkana	2 Gal.	5' O.C.
HD	Oceanspray	Holodiscus discolor	2 Gal.	5' O.C.
SR	Elderberry	Sambucus racemosa	2 Gal.	5' O.C.
SA	Snowberry	Symphoricarpus albus	2 Gal.	5' O.C.
OC	Indian Plum	Oemleria cerasiformis	2 Gal.	5' O.C.
NATIVE LOW SHRUBS AND GROUNDCOVERS				
RP	Thimbleberry	Rubus parviflorus	1 Gal.	3' O.C.
VO	Evergreen huckleberry	Vaccinium ovatum	1 Gal.	3' O.C.
GS	Salal	Gautheria shallon	1 Gal.	3' O.C.
MN	Low Oregon Grape	Mahonia nervosa	1 Gal.	3' O.C.
PM	Swordfern	Polystichum munitum	1 Gal.	3' O.C.
FC	Coastal strawberry	Fragaria chiloensis	1 Gal.	3' O.C.

PLANT SHCEDULE

SYMBOL	COMMON NAME	SPECIES NAME	SIZE	SPACING
EMERGENT WETLAND				
	Small fruited bulrush	Scirpus microcarpus	10 cu-in	2' O.C.
	Hardstem bulrush	Schoenoplectus acutus	10 cu-in	2' O.C.
	American threesquare	Scirpus americanus	10 cu-in	2' O.C.
	Tufted hairgrass	Deschampsia cespitosa	10 cu-in	2' O.C.
	Pacific silverweed	Potentilla anserina ssp. Pacifica	10 cu-in	2' O.C.
BEACH GRASSES & HERBACEOUS PERENNIALS				
	American beach grass	Elymus mollis	10 cu-in	2' O.C.
	Puget Sound gumweed	Grindelia integrifolia	10 cu-in	2' O.C.
RAINGARDEN SHRUBS AND GROUNDCOVERS				
CS	Red ossier dogwood	Cornus sericea	5 Gal.	5' O.C.
LI	Black Twinberry	Lonicera involucrata	5 Gal.	5' O.C.
MN	Low Oregon Grape	Mahonia nervosa	1 Gal.	3' O.C.
CO	Slough sedge	Carex obnupta	10 cu-in	2' O.C.
TM	Piggy-back plant	Tolmela menziesII	10 cu-in	2' O.C.
WILLOWS				
SH	Hooker Willow	Salix hookeriana	4' Live Stake	2' O.C.
SS	Scouler Willow	Salix scouleriana	4' Live Stake	2' O.C.
CS	Red Ossier Dogwood	Cornus sericea	4' Live Stake	2' O.C.
LI	Black Twinberry	Lonicera involucrata	5 Gal.	5' O.C.
TURF GRASS PRODUCT NAME - HYDROSEED ECOLOGY LAWN				
	ECO TURF	MIX	RATE	RATE
		Elf Perennial Rye	80%	2 lbs per 1,000 s.f.
		English Daisy, Alyssum, Yarrow, Baby Blue Eyes, and Strawberry Clover	20%	

MATCHLINE TO SHEET C-4.1

ONE INCH
AT FULL SIZE, IF NOT ONE INCH SCALE ACCORDINGLY

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US Army Corps of Engineers

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CHECKED BY: P. HUMMEL
APPROVED BY:
SCALE: AS SHOWN
DATE: APRIL 2010

SEAHURST PHASE II
SHORELINE ECOSYSTEM RESTORATION

PLANTING SCHEDULE

L-2

SHEET NO. 33 OF 33

Apr 21, 2010 3:15pm bbermingham K:\Jobs\070202\4-Puget Sound Nearshore\070202\01135 Percent\070202\01-PL13-L01-02.dwg 33 L-2

APPENDIX F
SEAHURST PHASE I SHORELINE ECOSYSTEM RESTORATION MONITORING REPORTS

FINAL

PRE-CONSTRUCTION EELGRASS SURVEY

SEAHURST PARK NEARSHORE RESTORATION PROJECT

Prepared for

Seattle District

U.S. Army Corps of Engineers

4735 E. Marginal Way South

Seattle, Washington 98124

Prepared by

Anchor Environmental, L.L.C.

1423 Third Avenue, Suite 300

Seattle, Washington 98101

March 2005

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2 METHODS 3

3 RESULTS 6

4 DISCUSSION 13

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Table 2 Summary of Eelgrass Bed Characteristics

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Table 4 List of Macrofauna Observed

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Figure 2 Eelgrass Survey Area and Transects

Figure 3 Eelgrass Bed Delineation

1 INTRODUCTION

The U.S. Army Corps of Engineers, Seattle District, is constructing a nearshore restoration project along the shoreline of Seahurst Park in Burien, Washington (Figure 1). The project will entail the removal of approximately 3,110 cubic yards of gabion and toe stone and 5,085 cubic yards of path fill material in the form of the existing gabion and fill structure located between elevations +18 and +9 feet mean lower low water (MLLW) datum. The project area extends along approximately 1,200 feet of shoreline at the south end of the park.

Construction on the project began in December 2004. In order to characterize baseline habitat conditions at the site, a pre-construction eelgrass survey was conducted in October 2004. The survey design was developed with input from the Washington Department of Fish and Wildlife (WDFW), as part of that agency's preparation of an advisory Hydraulic Project Approval. As described in the environmental monitoring plan contained in the final environmental assessment (USACE 2003), the pre-construction eelgrass survey has three goals:

1. Document the full distribution (i.e., to waterward extent) of eelgrass within the project area.
2. Document turion (shoot) density of eelgrass.
3. Obtain data on macrophytes.

The pre-construction survey will also serve to establish the survey transect locations and methodologies to be implemented, as possible, in a Year-1 post-construction survey to be conducted in the late summer of 2005. This report describes the methods and results of the pre-construction survey.

Note: Base map prepared from Terrain Navigator Pro
USGS 7.5 x 15 minute quadrangle map of Burien, WA.

Mar 16, 2005 10:52am cdavidson K:\Jobs\020202-Seattle Corps\02020201\0202020119.dwg FIG 1

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 1
Vicinity Map
Pre-Construction Eelgrass Survey
Seahurst Park Nearshore Restoration Project

2 METHODS

The pre-construction eelgrass survey was conducted on October 18 to 21, 2004. The survey was completed by SCUBA divers recording observations along a series of transects in accordance with the WDFW *Intermediate Eelgrass/Macroalgae Habitat Survey Guidelines* (WDFW 1996). Transects were aligned perpendicular to the orientation of the gabion seawall at the south end of the park (see Figure 2). Transects extended from near the base of the gabion seawall to approximately 40 feet beyond the offshore end of the eelgrass bed. Transects were spaced at 40-foot intervals along the shoreline starting at the southern boundary of the park and moving northward. Thirty-two transects were conducted within the park. In addition, four transects were surveyed in a reference area located adjacent to the southern boundary of the park. The four reference transects were located between 120 feet and 240 feet south of the park boundary.

Observations were recorded every 40 feet along each transect to record at a single point the water depth, time, surface substrate type, eelgrass density, percentage and species of macroalgae cover, and presence of macrofauna. Due to the extensive eelgrass beds present in the project area and the high shoot densities, eelgrass shoot density was counted at one observation point along each transect. At this observation point, shoot density was counted in three 0.25 square meter (m^2) quadrats positioned at the 2, 6, and 10 o'clock positions. At all other observation points along the transects, eelgrass density was characterized as "dense" if there were more than 30 shoots per 0.25 m^2 quadrat. Additional observations were noted at the margins of eelgrass beds and where eelgrass density changed from patchy to a bed.

Photo Source: USGS 2002

T-1 Eelgrass Survey Transect

Project Area

Reference Area

0 300

Scale in Feet

Mar 16, 2005 10:57am cdavidson K:\Jobs\020202-Seattle Corps\02020201\020202012O.dwg FIG 2

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 2

Eelgrass Survey Area and Transects

Pre-Construction Eelgrass Survey

Seahurst Park Nearshore Restoration Project

Native eelgrass (*Zostera marina*) and a non-native species of eelgrass (*Z. japonica*) were considered likely to occur in the survey area. The two species of eelgrass can be somewhat reliably distinguished based on blade width, as the non-native eelgrass species has very thin blades (approximately 1/8 inch width) whereas native eelgrass blades can be equally thin or quite a bit wider (up to approximately 1/2 inch width). Due to the overlap in blade width between the species, divers will implement another commonly used and reliable method for distinguishing the species. Divers will gently pull and break apart the blades of the eelgrass plant. If the green portion of the blade can be broken apart, but a series of "fibers" keep the blade pieces connected, then it will be considered native eelgrass. Alternatively, if the blade breaks cleanly apart, then it will be considered the non-native eelgrass species. This method is effective due to the physical differences between the species. The native eelgrass has lacunae that extend lengthwise through the blade and transport water and nutrients. The lacunae are the "fibers" that keep the native eelgrass blade connected after the green portion is separated. The non-native eelgrass species does not have lacunae and, therefore, the blade breaks cleanly.

At the inshore and offshore margins of each transect, differential Global Positioning System (DGPS) location information was collected using a Trimble Pathfinder. Additional DGPS data were collected at locations along the transects. DGPS location information at positions other than the inshore ends of the transects were collected by moving the boat on top of the divers' bubbles and record a DGPS position. Currents in the water column often moved divers' air bubbles away from being directly above them; therefore, prior to having the boat come over to record a DGPS position, divers moved to locations that resulted in their bubbles reaching the surface at the target location. In this way, divers were slightly upcurrent from the target position, but the boat operator could move to their bubble and collect position information from the desired location. Depth observations were measured using a dive computer and adjusted to MLLW based on predicted tides for Seattle using the Tides and Currents Program.

3 RESULTS

Thirty-two project area transects and four reference area transects were surveyed (Figure 2). Table 1 provides the approximate inshore and offshore endpoints of each transect. Some approximation was necessary in order to account for occasionally spotty satellite coverage, difficulties getting a position fix directly over the divers due to currents in the water column that caused the air bubbles to drift away from being directly over divers, and some deviations from the targeted route.

Table 1
Transect Endpoint Locations

Transect Number	Distance from Starting Point Established at South Boundary of Park	Inshore End		Offshore End	
		Latitude	Longitude	Latitude	Longitude
1	0	49.13943	122.76143	49.13971	122.76320
2	40 ft north	49.13952	122.76132	49.13983	122.76317
3	80 ft north	49.13964	122.76133	49.13992	122.76302
4	120 ft north	49.13973	122.76119	49.14001	122.76304
5	160 ft north	49.13985	122.76119	49.14011	122.76299
6	200 ft north	49.13994	122.76114	49.14030	122.76281
7	240 ft north	49.14005	122.76107	49.14041	122.76282
8	280 ft north	49.14015	122.76101	49.14049	122.76268
9	320 ft north	49.14031	122.76101	49.14056	122.76237
10	360 ft north	49.14038	122.76084	49.14068	122.76223
11	400 ft north	49.14047	122.76079	49.14082	122.76223
12	440 ft north	49.14054	122.76070	49.14088	122.76226
13	480 ft north	49.14064	122.76064	49.14102	122.76236
14	520 ft north	49.14071	122.76058	49.14110	122.76216
15	560 ft north	49.14082	122.76042	49.14123	122.76209
16	600 ft north	49.14089	122.76039	49.14132	122.76206
17	640 ft north	49.14097	122.76033	49.14134	122.76159
18	680 ft north	49.14106	122.76024	49.14145	122.76152
19	720 ft north	49.14111	122.75999	49.14157	122.76149
20	760 ft north	49.14124	122.76004	49.14167	122.76144
21	800 ft north	49.14133	122.75984	49.14180	122.76147
22	840 ft north	49.14145	122.75993	49.14184	122.76131
23	880 ft north	49.14151	122.75974	49.14195	122.76125
24	920 ft north	49.14164	122.75983	49.14205	122.76119
25	960 ft north	49.14167	122.75964	49.14216	122.76113
26	1000 ft north	49.14186	122.75970	49.14225	122.76111
27	1040 ft north	49.14187	122.75944	49.14241	122.76128
28	1080 ft north	49.14205	122.75950	49.14262	122.76135

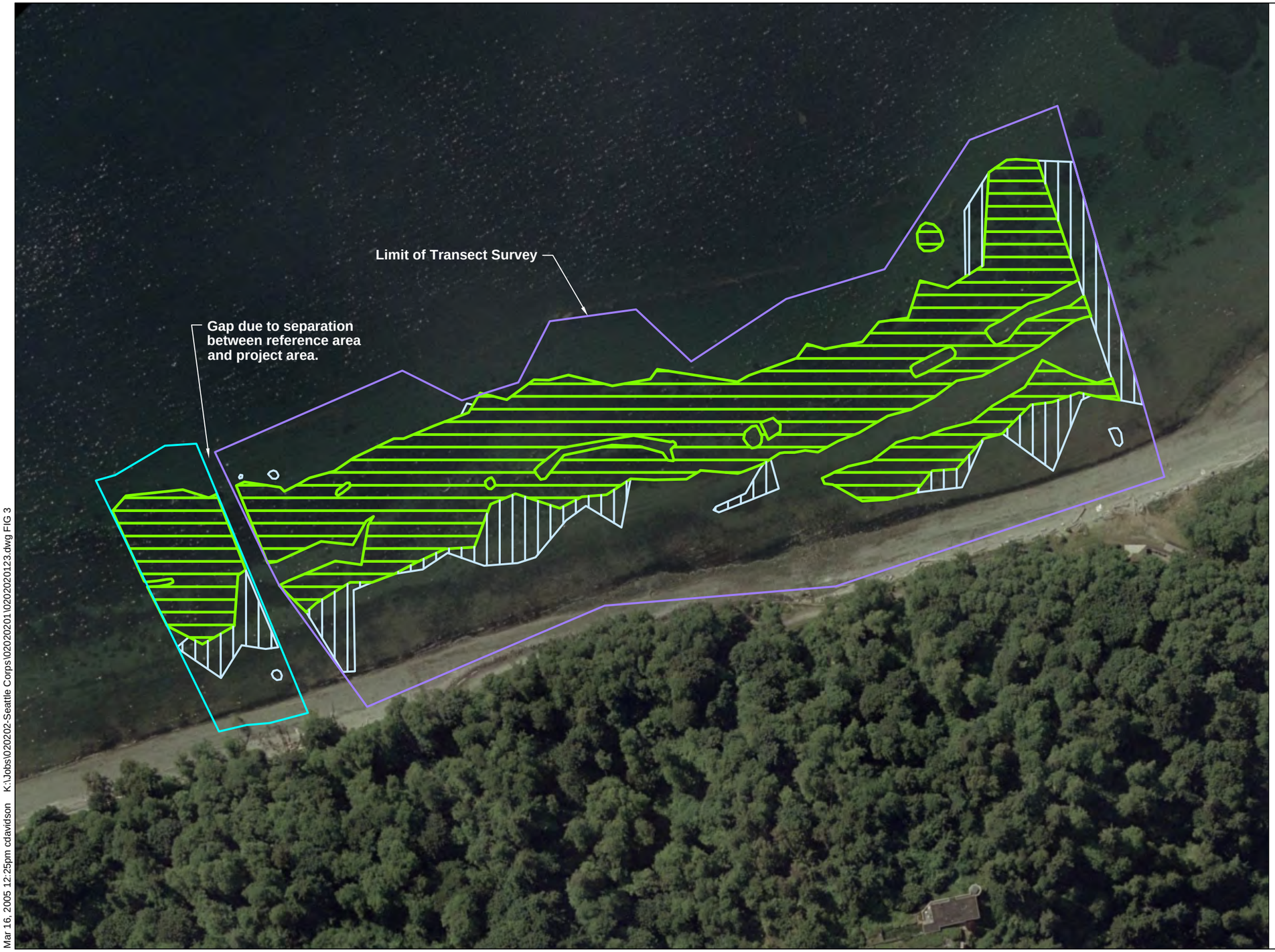
Table 1
Transect Endpoint Locations

Transect Number	Distance from Starting Point Established at South Boundary of Park	Inshore End		Offshore End	
		Latitude	Longitude	Latitude	Longitude
29	1120 ft north	49.14212	122.75950	49.14279	122.76139
30	1160 ft north	49.14220	122.75927	49.14287	122.76133
31	1200 ft north	49.14228	122.75920	49.14295	122.76126
32	1240 ft north	49.14241	122.75925	49.14308	122.76118
Ref-1	120 ft south	49.13917	122.76179	49.13961	122.76336
Ref-2	160 ft south	49.13908	122.76179	49.13955	122.76348
Ref-3	200 ft south	49.13900	122.76188	49.13932	122.76355
Ref-4	240 ft south	49.13892	122.76200	49.13926	122.76361

Note: All locations provided in NAD83 decimal degrees.

Native eelgrass was found along each transect surveyed in the project area and reference area (Figure 3). For much of the shoreline, the farthest inshore eelgrass was very thin bladed and consistent with the morphology of the non-native species of eelgrass. However, the confirmatory test to distinguish between native versus non-native eelgrass by pulling blades apart provided results that were indicative of native eelgrass (i.e., after gently pulling apart blades, fibers remained that kept the blade pieces connected) except at one location. In this way, the visual observations and the confirmatory test provided differing results for eelgrass species. It was concluded that the non-native eelgrass likely occurs along much of the inshore portion of the project area and reference area shoreline. The eelgrass delineation presented in Figure 3 shows the border of all eelgrass (native and non-native) in the survey area.

The eelgrass beds were not areas of uniform eelgrass growth. The eelgrass beds along much of the project area occurred in bands, such that as divers moved offshore along the transect, they would encounter large gaps where no eelgrass was found (see Figure 3). These gaps were typically 10- to 50-foot-wide sections of a transect where little or no eelgrass was growing and where divers did not see eelgrass growing to the north or south. In addition, smaller holes of various sizes ranging from approximately 25 to 100 square feet were found in the eelgrass beds.



Project Area

Reference Area

Eelgrass Continuous Bed

Eelgrass Patchy

Photo Source: USGS 2002

0 150
Scale in Feet

Mar 16, 2005 12:25pm cdavidson K:\Jobs\020202-Seattle Corps\02020201\02020020123.dwg FIG 3

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3
Eelgrass Bed Delineation
Pre-Construction Eelgrass Survey
Seahurst Park Nearshore Restoration Project

Characteristics of the eelgrass bed (not including patchy areas) are summarized in Table 2. A general observation noted was that eelgrass distributions were patchy in the lower intertidal and shallow subtidal areas where the substrate was a mix of cobble, gravel, sand, and, in some areas, scattered riprap. Offshore from there, the substrate became almost entirely sand and the eelgrass grew in thick beds. In the north end of the project area, between Transects 22 and 32, the existing gabions do not extend into the intertidal zone. In this area, an eelgrass bed was documented closer to shore than elsewhere in the project area where the gabions extend into the intertidal zone. The average inshore elevation of the eelgrass beds was more than 1.5 feet higher in the north end compared to the rest of the project area (-0.9 foot MLLW in Transects 1 through 21 and +0.7 foot MLLW in Transects 22 through 32). The average inshore elevation of eelgrass in the south reference area was -1.4 feet MLLW.

Table 2
Summary of Eelgrass Bed Characteristics

Transect	Distance (ft) Between Inshore and Offshore Margin of Eelgrass Bed	Shoot Density (No. of Shoots/ 0.25 m^2)	Depth (ft MLLW)	
			Inshore Margin of Bed	Offshore Margin of Bed
1	208	60	+1.3	-6.0
2	176	91	-1.3	-6.9
3	180	73	-0.8	-6.8
4	175	73	-0.8	-6.8
5	180	104	+0.4	-7.4
6	184	54	-0.3	-7.1
7	198	94	-0.5	-7.2
8	139	32[a]	-2.2	-7.5
9	151	57	-1.1	-9.6
10	190	50	-0.2	-6.6
11	187	66	-1.4	-8.6
12	192	78	-1.4	-5.7
13	180	72	-1.6	-8.2
14	152	131	+0.1	-5.0
15	157	102	-2.2	-7.3
16	167	85	---	---
17	166	40	-0.4	-6.8
18	149	121	-1.8	-5.9
19	125	87	-2.1	-7.4
20	201	152	-1.2	-6.4
21	248	57	-0.3	-6.4
22	246	130	+1.4	-6.5

Table 2
Summary of Eelgrass Bed Characteristics

Transect	Distance (ft) Between Inshore and Offshore Margin of Eelgrass Bed	Shoot Density (No. of Shoots/ 0.25 m^2)	Depth (ft MLLW)	
			Inshore Margin of Bed	Offshore Margin of Bed
23	244	dense	+1.8	-4.9
24	235	dense	+1.2	-7.0
25	235	156[b]	+1.4	-5.8
26	250	76[b]	+0.4	-7.2
27	326	78	-0.5	-7.9
28	217	106	-0.8	-6.4
29	351	112	-0.7	-7.6
30	359	123	+0.4	-6.6
31	375	dense	+2.4	-6.8
32	370	123	---	---
Ref-1	120	dense	---	---
Ref-2	214	208	-2.0	-9.5
Ref-3	200	152	-1.1	-9.6
Ref-4	188	dense	-1.2	---
Avg. for Project Area	**216**	**89[c]**	**-0.4**	**-6.9**
Avg. for Reference Area	**180**	**180**	**-1.4**	**-9.6**

Notes: a) Shoot count taken next to hole in bed.
b) Shoot count based on only one 0.25 m^2 count, rather than three.
c) Average shoot count excludes Transect 8 where the count was conducted next to a hole in the eelgrass.

The distance between the inshore and offshore margins of the eelgrass bed was greatest in the north end of the project area, particularly for Transects 29 through 32, where a large sandy delta has formed near a creek mouth. The distance information does not subtract hole or gap distances from the calculation of total width of the eelgrass bed. In the project area transects, the distance between the inshore and offshore margins ranged from 125 to 375 feet with an average of 216 feet. Along Transect 32, the northernmost transect, eelgrass was found over a 370 foot distance; however, it was patchy throughout and no eelgrass bed portion was delineated. In the reference area transects, the distance between the inshore and offshore margins of the eelgrass bed ranged from 120 to 214 feet with an average of 180 feet. Eelgrass bed shoot densities in the project area[1] ranged from 50 to 152 shoots/m^2 with an average of 89 shoots/m^2. Eelgrass bed shoot densities in the reference area ranged from 152 to 208 shoots/m^2 with an average of 180 shoots/m^2.

[1] This range excludes Transect 8 where the count was conducted next to a hole in the eelgrass.

Substrate in the project area and reference area was typically a mix of gravel (0.5 inch to 1.5 inch diameter) and cobble (1.5 inch to 5.0 inch diameter) in the middle and lower intertidal areas. Generally, in the elevations between +2.5 feet MLLW and 0 feet MLLW, sand became the dominant substrate with some cobble and scattered riprap present. Along much of the shoreline, patchy eelgrass grew from the sand portions in this area. Below this elevation range, substrates transitioned into a sand and silt that continued throughout the subtidal areas of the survey.

A diverse community of macroflora and macrofauna was documented in the project and reference area. Tables 3 and 4 provide a list of macroflora and macrofauna documented, respectively.

Table 3
List of Macroflora Observed

Common Name	Scientific Name
Sea lettuce	*Ulva fenestrata*
Sea hair	*Enteromorpha linza*
Red ribbon	*Palmaria* sp.
Succulent seaweed	*Sarcodiotheca gaudichaudii*
Red spaghetti	*Gracilaria/Gracilariopsis*
Sugar kelp	*Laminaria saccharina*
Eelgrass (native)	*Zostera marina*
Eelgrass (non-native)	*Zostera japonica*
Fine red algae	Unspecified
Diatoms	Unspecified

Table 4
List of Macrofauna Observed

Common Name	Scientific Name
Annelids	
Northern feather duster worms	*Eudistylia vancouveri*
Echinoderms	
Ochre star	*Pisaster ochraceus*
Short-spined star	*Pisaster brevispinus*
Sunflower star	*Pycnopodia helianthoides*
Mottled sea star	*Evasterias troschelii*
Mollusks	
Acorn barnacles	*Balanus glandula*
Pacific blue mussels	*Mytilus trossulus*
Dogwinkle	*Nucella* sp.
Moon snail	*Polinices lewisii*
Chiton	Unspecified
Limpet	Unspecified
Hooded nudibranch	*Melibe leonina*
Cockle	*Clinocardium nuttali*
Rough piddock	*Zirfaea pilsbryii*
Horse clam	*Tresus* sp.
Arthropods	
Dungeness crab	*Cancer magister*
Red rock crab	*Cancer productus*
Graceful crab	*Cancer gracilis*
Kelp crab	*Pugettia producta*
Hermit crab	*Pagurus* sp.
Helmet crab	*Telmessus cheiragonus*
Sitka shrimp	*Heptacarpus sitchensis*
Isopod	Unspecified
Amphipod	Unspecified
Cnidarians	
Plumose anenome	*Metridium senile*
Moon jelly	*Cyanea capillata*
Orange sea pen	*Ptilosarcus gurneyi*
Fish	
Sculpin	Unspecified
Tubesnout	*Aulorhynchus flavidus*
Starry flounder	*Platichthys stellatus*
Flatfish	Unspecified
Shiner perch	*Cymatogaster aggregata*

4 DISCUSSION

This eelgrass survey successfully documented pre-construction eelgrass conditions in the project area and reference area. The survey was conducted after the June 1 through October 1 timeframe established for conducting WDFW Intermediate surveys. The timing of the survey was necessary due to last minute approvals of the construction project. The survey was conducted prior to any significant storm events that may have affected the eelgrass bed or macroalgae characteristics.

Eelgrass distributions were not uniform throughout the delineated eelgrass bed. In many areas, the eelgrass grew in bands, such that there was a gap in eelgrass or decrease in shoot density along a short portion (10 to 50 feet) of each transect (see Figure 3). In the north end of the project area (as one moves offshore), there were three bands of eelgrass with two noticeable gaps in between. In the south end (as one moves offshore), there were two bands of eelgrass with one noticeable gap in between. These gaps presumably are the result of the nearshore energy regime at the park, particularly wave action. There was no noticeable change in substrate or elevation to explain the occurrence or location of the gaps. The bands of eelgrass do not represent a native band and a non-native band within the bed. Despite the difficulty distinguishing the eelgrass species in the field, it was clear that the inner most band was comprised of native and non-native eelgrass. The removal of scattered riprap from the intertidal zone as part of the habitat restoration project is expected to allow for some landward expansion of eelgrass due to the increased availability of the sandy substrate necessary for eelgrass growth.

In several locations within the eelgrass bed, holes were noted. These holes did not appear to be due to any unnatural event. One potential explanation of the holes is that they may have been created when mats of kelp or macroalgae (e.g., sugar kelp, *Laminaria saccharina*, or sea lettuce, *Ulva fenestrata*) are carried into the area by currents and tides and deposited onto the eelgrass bed. These mats can smother small portions of eelgrass in a pattern similar to that observed in the survey.

One objective of a post-construction survey that is planned soon after construction is completed is to identify areas of disturbance caused by construction activities. While

such a survey will be effective in identifying any such disturbances, it is important to note that gaps or holes in the eelgrass bed do not necessarily mean that they are construction-related. Construction-related disturbance will also be identified based the presence of unnatural depressions

The WDFW transect-based protocols were successful in characterizing the eelgrass bed, as well as identifying the macroflora and macrofauna communities. The delineation of the inshore margin of the eelgrass bed is based on the inshore observations made at each transect, which were spaced at 40-foot intervals. The delineation of the inshore margin of the eelgrass bed and patches could be enhanced by adding a survey effort to track the inshore margin of the eelgrass bed and by recording DGPS location information. It is recommended that this delineation survey effort is conducted in the post-construction monitoring efforts.

5 REFERENCES

U.S. Army Corps of Engineers (USACE). 2003. Final Environmental Assessment for Nearshore Restoration at Seahurst Park, Burien, Washington. Prepared by the U.S. Army Corps of Engineers, Seattle District. August 31, 2003.

Washington Department of Fish and Wildlife (WDFW). 1996. Intermediate Eelgrass/Macroalgae Habitat Survey Guidelines. Prepared by the Washington Department of Fish and Wildlife. January 12, 1996.

YEAR-1 POST-CONSTRUCTION EELGRASS SURVEY
SEAHURST PARK NEARSHORE RESTORATION PROJECT

Prepared for

Seattle District, U.S. Army Corps of Engineers

4735 E. Marginal Way South

Seattle, Washington 98124

Prepared by

Anchor Environmental, L.L.C.

1423 Third Avenue, Suite 300

Seattle, Washington 98101

December 2005

ANCHOR ENVIRONMENTAL, L.L.C.

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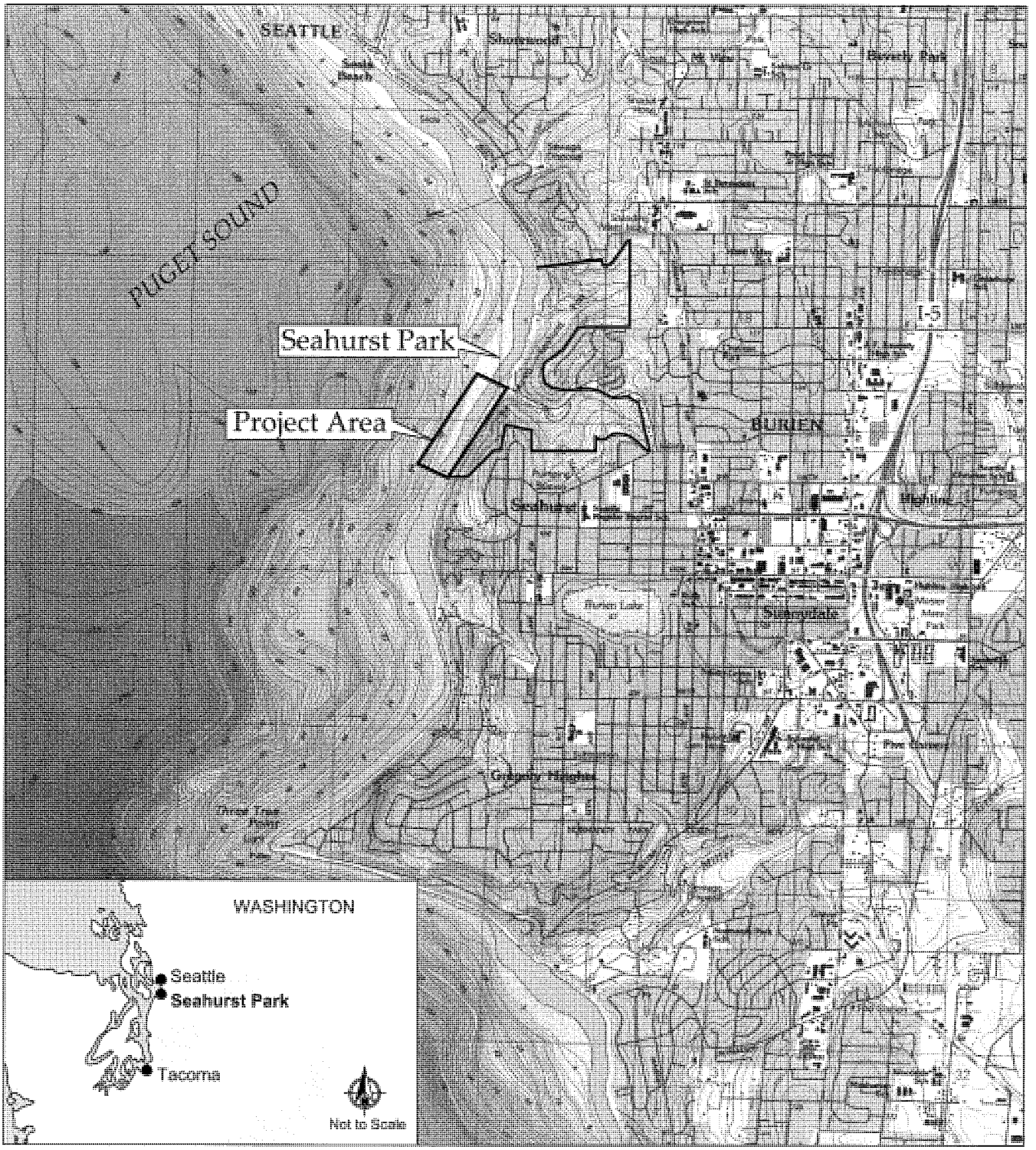
Photo 6 Transition from mid-intertidal beach mix of gravel and cobble to a lower intertidal flat of sand with cobble and gravel in the southern half of the project area.

Photo 7 Transition from mid-intertidal beach mix of gravel and cobble to a lower intertidal flat of sand and gravel in the northern half of the project area.

1 INTRODUCTION

In February 2005, the U.S. Army Corps of Engineers, Seattle District, completed construction on a nearshore restoration project along the shoreline of Seahurst Park in Burien, Washington (Figure 1). The nearshore restoration area extended along approximately 1,200 feet of shoreline at the south end of the park. The project entailed the removal of approximately 3,800 cubic yards (CY) of gabion and toe stone and 2,900 CY of path fill material between elevations +18 and +2 feet mean lower low water (MLLW; Photo 1). Placement of imported materials included approximately 4,200 CY of gravel and cobble and 5,200 CY of a sand-gravel mix between elevations +15 and +2 feet MLLW (Photo 2). Materials were imported and exported using barges.

This report presents the methods and results of an eelgrass survey conducted during Year-1 post-construction (August 2005) to document eelgrass distributions in the park and determine whether the construction activities appeared to have any direct effects on eelgrass. A pre-construction eelgrass survey conducted in October 2004 (Anchor Environmental 2005) provides baseline eelgrass distribution for comparison to post-construction survey data. The Year-1 survey focused on the distribution of eelgrass, whereas the pre-construction survey investigated eelgrass and macroalgae distribution and density. The survey design was developed with input from the Washington Department of Fish and Wildlife (WDFW), as part of that agency's preparation of an advisory Hydraulic Project Approval.



Note: Base map prepared from Terrain Navigator Pro
USGS 7.5 x 15 minute quadrangle map of Burien, WA.

0 3000
Scale in Feet

Oct 19, 2005 8:49am cdavidson K:\Jobs\020202-Seattle Corps\02020201\02020201 19.dwg YR 1 FIG 1

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Figure 1
Vicinity Map
Year-1 Post-Construction Eelgrass Survey
Seahurst Park Nearshore Restoration Project

Photo 1. Failing gabions and toe rock in intertidal zone prior to beach restoration.

Photo 2. Restored beach configuration with natural beach slopes, natural substrate sizes, and drift logs.

2 METHODS

The Year-1 post-construction eelgrass survey was conducted using a combination of a diver-based transect survey and an edge delineation effort. The dive survey was conducted August 24 through August 26, 2005. The edge delineation was conducted by walking the intertidal zone during low tide (-2.6 feet MLLW) on August 18, 2005, and by diving along the offshore edge on August 25, 2005.

2.1 Transect Survey

The transect survey was conducted by two qualified divers using self-contained underwater breathing apparatus (SCUBA) gear. The divers were supported by a boat operator; lines of communication between the three-person crew were maintained using wireless communications. Divers recorded observations along a series of transects in accordance with the WDFW *Intermediate Eelgrass/Macroalgae Habitat Survey Guidelines* (WDFW 1996). Transects were aligned perpendicular to the orientation of the shoreline at the south end of the park (Figure 2). These transects had the same alignment as was used in the pre-construction eelgrass survey (Anchor Environmental 2005). Transects extended from the upper intertidal zone to approximately 40 feet beyond the offshore end of the eelgrass bed. Transects were spaced at 40-foot intervals along the shoreline starting at the southern boundary of the park and moving northward.

The 25 transects were surveyed within a project area that was characterized by 32 transects in the pre-construction survey. The 25 transects supplemented by the eelgrass bed edge delineation (described in Section 2.2) provided more detailed information on eelgrass distributions. Since shoot densities were not part of the Year 1 survey, the adjustment to fewer transects was justified.

Four additional transects were surveyed in a reference area located adjacent to the southern boundary of the park (Figure 2). The four reference transects were located between 120 feet and 240 feet south of the park boundary.

At observation points spaced 20 feet apart along each transect, the divers recorded surface substrate size, eelgrass presence, macroalgae species, and macrofauna. Water depth and time were recorded intermittently along each transect. Additional observations were noted

at the margins of eelgrass beds and where eelgrass distributions may have been impacted by construction-related activities.

Native eelgrass (*Zostera marina*) and a non-native species of eelgrass (*Z. japonica*) were considered likely to occur in the survey area. Eelgrass blade width was one reliable feature used to distinguish between the species. *Z. japonica* has very thin blades of approximately 1/8 inch width, whereas *Z. marina* blade widths range from 1/8 to 1/2 inch, with most blades greater than 1/4 inch wide. Since the species overlap in blade width, the divers utilized another commonly used and reliable method for distinguishing the species, gently pulling the blades of the eelgrass plant apart. If a series of "fibers" (lacunae) keep the blade pieces connected when the blade was broken apart, then the eelgrass was determined to be *Z. marina*. Alternatively, if the blade broke cleanly apart, then it was considered *Z. japonica*. This method was effective due to the physical differences between the species. *Z. marina* has lacunae that extend lengthwise through the blade and transport water and nutrients. The lacunae are the fibers that keep the *Z. marina* blade connected after the green portion is separated. *Z. japonica* does not have lacunae and, therefore, the blade breaks cleanly. Eelgrass samples were provided to Dr. Sandy Wyllie-Echeverria, a seagrass expert, for species identification confirmation. Dr. Wyllie-Echeverria's results confirmed that the technique described above was an accurate way to distinguish between the species.

Location information was collected along each transect using a Trimble Pathfinder Differential Global Positioning System (DGPS). DGPS location information for the inshore margins of transects was collected from land. All other DGPS location information was collected by moving the boat on top of the divers' bubbles and recording a DGPS position. Currents in the water column often moved divers' air bubbles away from being directly above them; therefore, prior to having the boat come over to record a DGPS position, divers moved to locations that resulted in their bubbles reaching the surface at the target location. Depth observations were measured using a dive computer and adjusted to MLLW based on predicted tides for Seattle using the Tides and Currents Program by Nobeltec, Inc.

Photo Source: USGS 2002

T-1 Eelgrass Survey Transect

Project Area

Reference Area

0 300

Scale in Feet

Oct 13, 2005 11:34am cdavidson K:\Jobs\020202-Seattle Corps\02020201\02020020129.dwg FIG 2

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Figure 2

Eelgrass Survey Area and Transects

Year-1 Post-Construction Eelgrass Survey

Seahurst Park Nearshore Restoration Project

2.2 Eelgrass Edge Delineation

The edges of eelgrass distribution in the intertidal zone were delineated by collecting DGPS line data along the margins of beds or patches during a -2.6 feet MLLW low tide. The intertidal edge delineation also allowed for a more thorough evaluation of the inshore portion of the project area where construction related impacts were more likely, due to possible barge grounding.

The delineation of the offshore margin of the main eelgrass bed was conducted by having a diver swim along the offshore margin, while a boat followed the diver bubbles and collected DGPS line data.

2.3 Investigation of Potential Construction-Related Impacts to Eelgrass

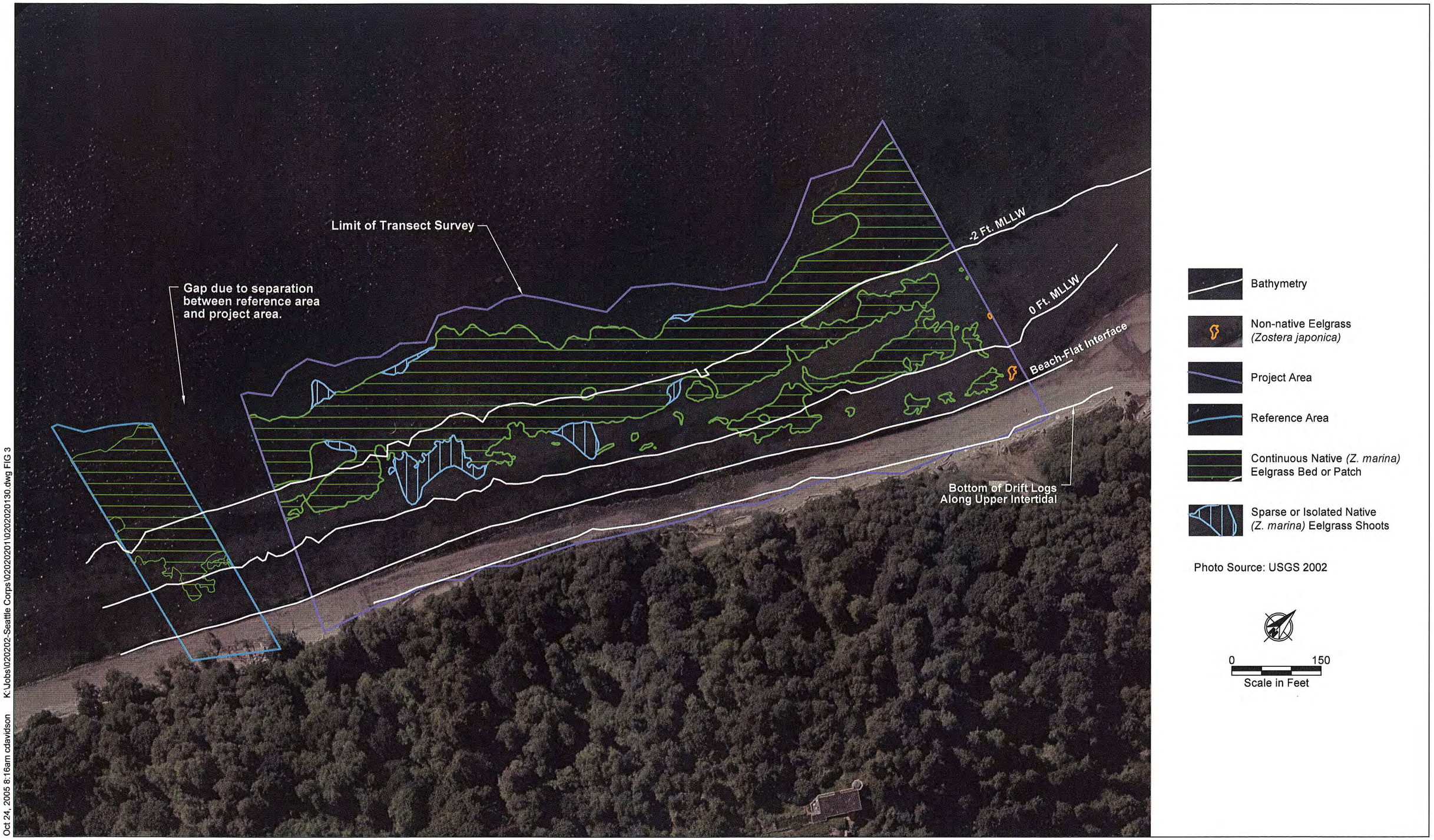
Investigation of potential construction-related impacts to eelgrass was conducted by examining whether there were any unusual holes in the eelgrass beds or signs of burial or scour. This information was collected during the transect dives, as well as during the land-based effort to delineate the inshore edge of eelgrass.

3 RESULTS

3.1 Eelgrass Distribution

Z. marina was found along each transect surveyed in the project area and reference area (Figure 3). The combination of the transect survey and the edge delineation efforts allowed for a markedly improved characterization of eelgrass distributions than would have been possible if only a transect survey was used (as in the pre-construction survey [Anchor Environmental 2005]). Eelgrass distributions in the Year-1 survey were nearly identical to the pre-construction survey (Figure 4). The minor differences noted between the surveys appeared to be the result of the enhanced resolution provided by the edge delineation.

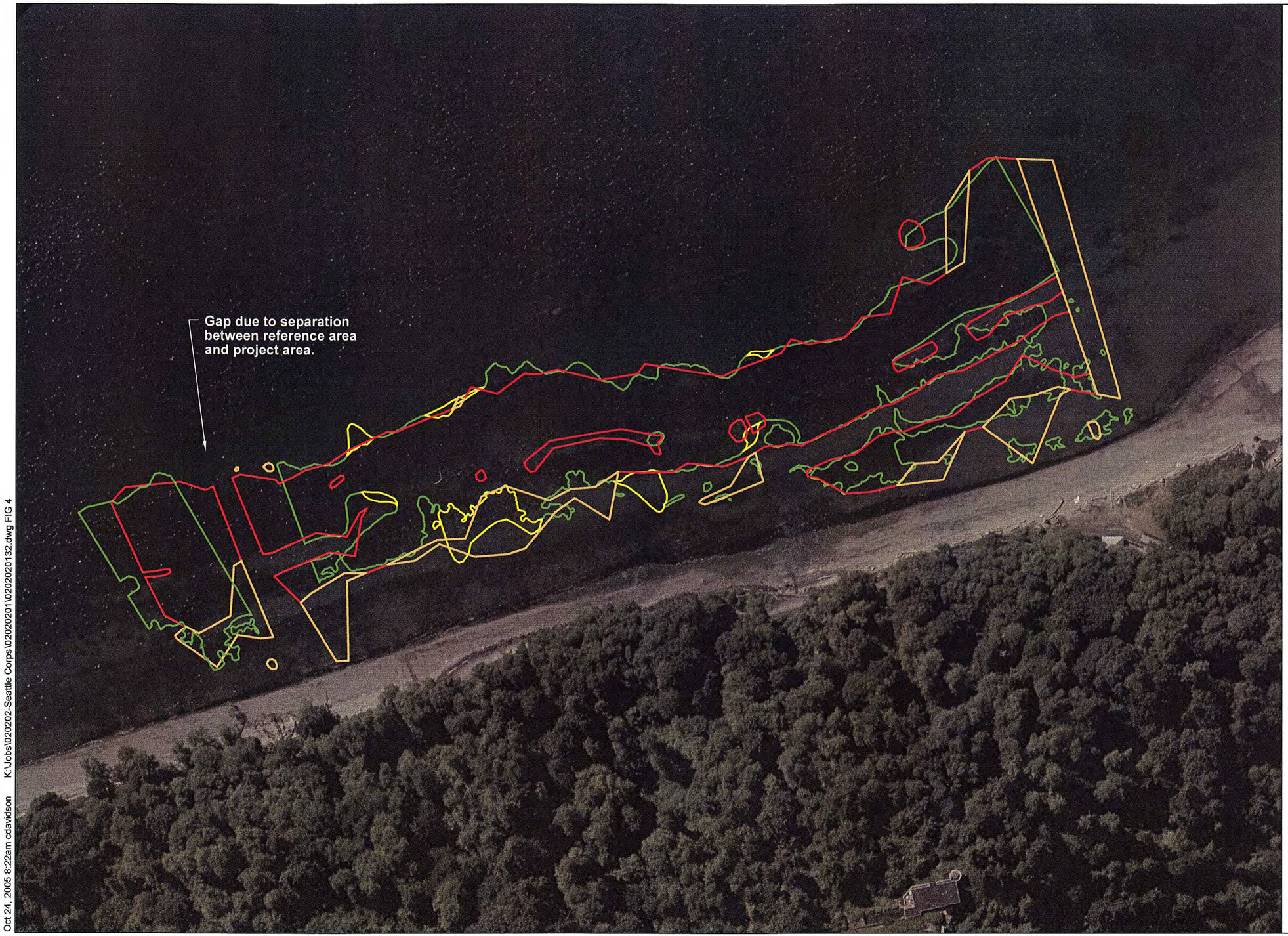
For much of the shoreline, the farthest inshore eelgrass was very thin-bladed and consistent with the morphology of *Z. japonica* (Photos 3 and 4); however, the confirmatory test to distinguish between *Z. marina* and *Z. japonica* by pulling blades apart provided results that were indicative of *Z. marina* (i.e., after gently pulling apart blades, fibers remained that kept the blade pieces connected). Eelgrass samples sent to Dr. Sandy Wyllie-Echeverria confirmed these identifications. *Z. japonica* was found in only two small patches near the north end of the project area. More extensive *Z. japonica* distributions are known to occur further north along the shoreline of Seahurst Park.



Oct 24, 2005 8:16am cdavidson K:\Jobs\020202-Seattle Corps\02020201\0202020130.dwg FIG 3

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 3
Eelgrass Bed Delineation
Year-1 Post-Construction Eelgrass Survey
Seahurst Park Nearshore Restoration Project



Pre-Construction (2004)

Eelgrass Bed

Eelgrass Patchy

Year-1 Post-Construction (2005)

Eelgrass Bed

Isolated Sparse Eelgrass

Photo Source: USGS 2002

0 150

Scale in Feet

Oct 24, 2005 8:22am cdavidson K:\Jobs\020202-Seattle Corps\02020201\02020020132.dwg FIG 4

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 4

Eelgrass Bed Delineation

Comparison of Eelgrass Distributions in the Pre-Construction and Year-1 Post-Construction Surveys

Seahurst Park Nearshore Restoration Project

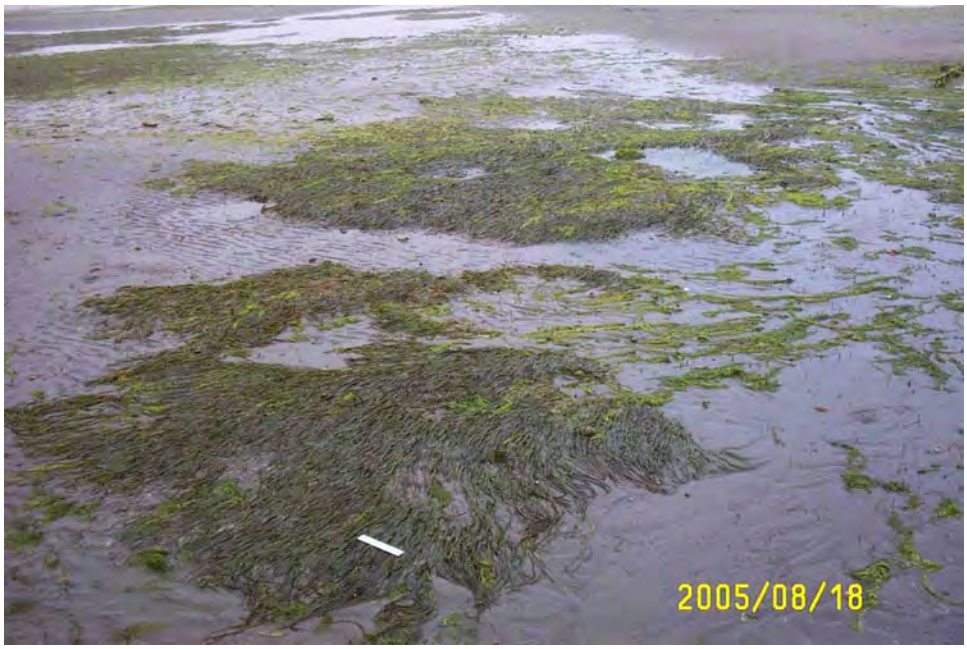


Photo 3. *Z. marina* patches in intertidal zone.
(Note white 6-inch ruler in foreground.)

Photo 4. Close-up view of thin bladed *Z. marina* in intertidal zone.
(Note white 6-inch ruler in foreground.)

In the southern half of the project area, where rock gabions extended into the intertidal zone prior to the beach restoration activities, eelgrass was found exclusively as part of a large bed with an inshore margin near 0 feet MLLW (see Figure 3). In the northern half of the project area, large patches of eelgrass grew inshore of the large bed (Photo 5 and Figure 3) and extended up to +2 feet MLLW. In the reference area, the large eelgrass bed extended inshore

to approximately +1 feet MLLW, which is farther inshore than it occurred in the project area. In all areas surveyed, eelgrass generally occurred out to depths of -8 to -9 feet MLLW.

3.2 Observations of Potential Construction-Related Impacts to Eelgrass

No observations of possible construction-related impacts to eelgrass distributions were noted during the survey. The eelgrass bed and additional patches appeared healthy along their entire inshore margin with no signs of substrate scour, plant burial, or other indications to suggest any construction-related impacts.

Photo 5. Intertidal portion of the *Z. marina* bed in the northern half of the project area.

3.3 Macroflora and Macrofauna

A diverse community of macroflora and macrofauna was documented in the project and reference area. Tables 1 and 2 provide a list of macroflora and macrofauna documented, respectively.

Table 1
List of Macroflora Observed

Common Name	Scientific Name
Sea lettuce	*Ulva fenestrata*
Sea hair	*Enteromorpha linza*
Laver	*Porphyra* spp.
Succulent seaweed	*Sarcodiotheca gaudichaudii*
Sugar kelp	*Laminaria saccharina*
Acid kelp	*Desmarestia* spp.
Eelgrass (native)	*Zostera marina*
Eelgrass (non-native)	*Zostera japonica*
Fine red algae	Unspecified
Diatoms	Unspecified

Table 2
List of Macrofauna Observed

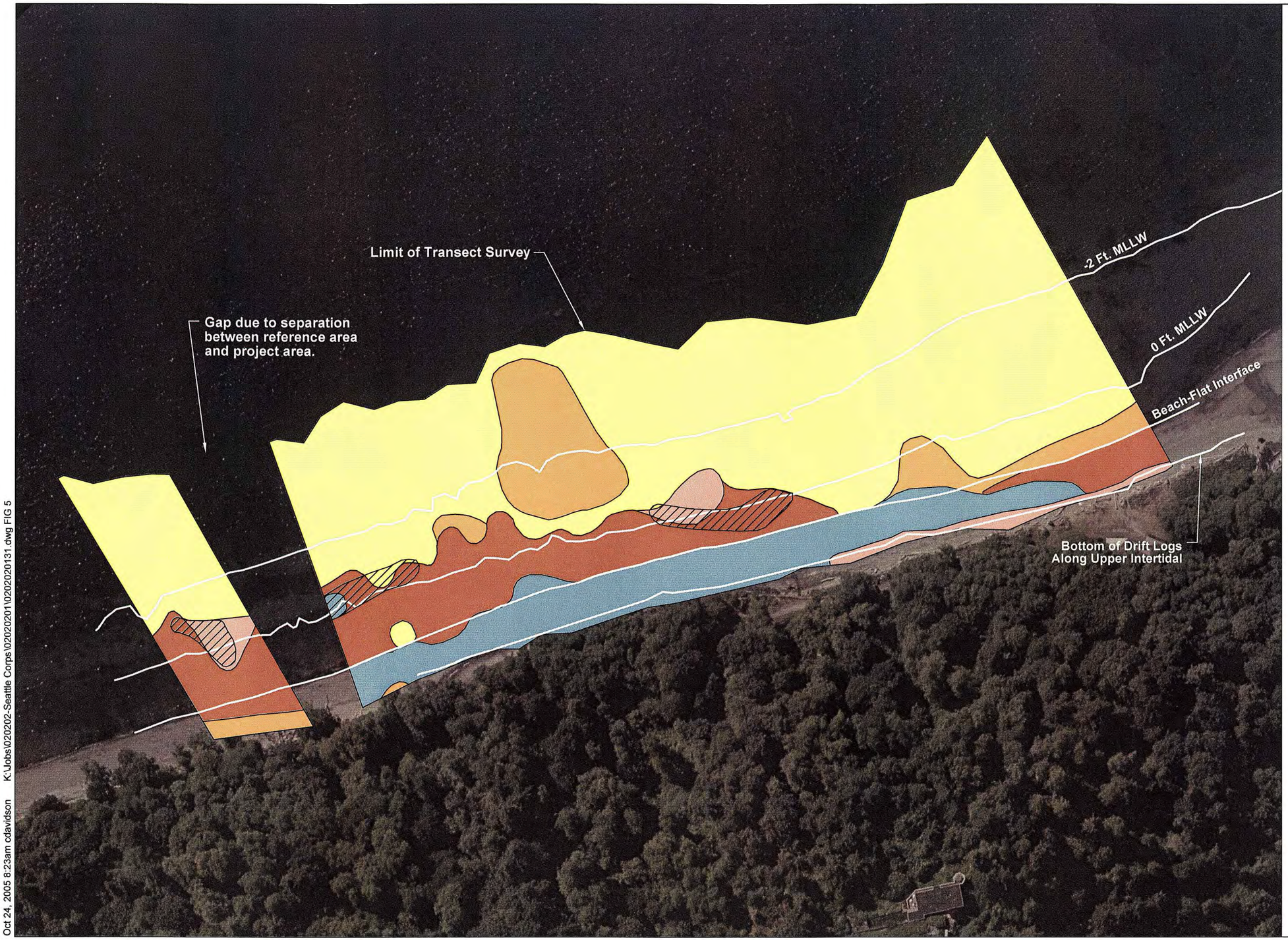
Common Name	Scientific Name
Annelids	
Northern feather duster worms	*Eudistylia vancouveri*
Echinoderms	
Ochre star	*Pisaster ochraceus*
Mottled sea star	*Evasterias troschelli*
California sea cucumber	*Parastichopus californicus*
Mollusks	
Acorn barnacles	*Balanus glandula*
Pacific blue mussels	*Mytilus trossulus*
Dogwinkle	*Nucella* sp.
White bubble shell	*Haminoea vesicula*
Moon snail	*Polinices lewisii*
Lined chiton	*Tonicella lineata*
Limpet	Unspecified
Cockle	*Clinocardium nuttali*
Rough piddock	*Zirfaea pilsbryii*
Horse clam	*Tresus* sp.
Geoduck	*Panope abrupta*
Arthropods	
Dungeness crab	*Cancer magister*
Red rock crab	*Cancer productus*
Graceful crab	*Cancer gracilis*
Decorator crab	*Oregonia gracilis*
Kelp crab	*Pugettia producta*
Hermit crab	*Pagurus* sp.
Helmet crab	*Telmessus cheiragonus*
Coonstripe shrimp	*Pandalus danae*
Eelgrass isopod	*Idotea resecata*
Cnidarians	
Aggregating anemone	*Anthopleura elegantissima*
Brooding anemone	*Epiactis lisbethae*
Moon jelly	*Cyanea capillata*
Fish	
Shiner perch	*Cymatogaster aggregata*
Sculpin	Unspecified
Great sculpin	*Myoxocephalus polyacanthocephalus*
Tubesnout	*Aulorhynchus flavidus*
Starry flounder	*Platichthys stellatus*
English sole	*Parophrys vetulus*
Speckled sanddab	*Citharichthys stigmaeus*

3.4 Substrate

Substrate in the project area and reference area consisted of sand, gravel (0.1 to 1 inch diameter), and cobble (1 to 4 inch diameter) material (Figure 5). A limited amount of scattered riprap (6 to 12 inch diameter angular rock) was noted in the low intertidal and subtidal zones of the southern half of the project area and reference area.

Throughout the project area, the gravel and cobble mix placed in the middle and upper intertidal zones during beach restoration appeared to have remained in place. Substrate composition in the upper and middle intertidal zones of the southern half of the project area consisted of a cobble and gravel mix (see Figure 5). In the intertidal areas below a gradient break occurring at approximately +3 to +4 feet MLLW where the beach flattens (referred to as the beach-flat interface on Figures 3 and 5), sand is the dominant substrate with gravel and cobble mixed in (Photo 6). At approximately 0 feet MLLW and extending to the offshore limit of the southern half of the project area, the substrate transitions to entirely sand, except in one area where some gravel was mixed in with the sand base. This transition to entirely sand occurred at similar elevations in the reference area.

Sand comprised a larger component of the substrate in the northern half of the project area, presumably due to the expansive stream delta that extends into the northernmost portion of the project area. Moving offshore from the top of the beach in the northern half of the project area, the substrate consists of a sand and gravel mix along the upper intertidal zone near deposited drift log, then switches to a sand, gravel, and cobble mix or a cobble and gravel mix throughout the remainder of the upper and middle intertidal zones. At intertidal elevations below the gradient break (at approximately +3 to +4 feet MLLW) where the beach flattens, the substrate is a mix of sand and gravel (Photo 7). At approximately +2 feet MLLW and extending to the offshore limit of the project area, the substrate transitions to entirely sand.



Scattered Riprap

Substrate

- Mixed Sand, Gravel, and Cobble
- Sand
- Sand and Cobble
- Sand and Gravel
- Gravel and Cobble

Photo Source: USGS 2002

0 150
Scale in Feet

Oct 24, 2005 8:23am cdavidson K:\Jobs\020202-Seattle Corps\02020201\0202020131.dwg FIG 5

ANCHOR ENVIRONMENTAL, L.L.C.

Figure 5
Substrate and General Bathymetry
Year-1 Post-Construction Eelgrass Survey
Seahurst Park Nearshore Restoration Project

Photo 6. Transition from mid-intertidal beach mix of gravel and cobble to a lower intertidal flat of sand with cobble and gravel in the southern half of the project area.

Photo 7. Transition from mid-intertidal beach mix of gravel and cobble to a lower intertidal flat of sand and gravel in the northern half of the project area.

4 DISCUSSION

An extensive eelgrass bed and numerous patches of eelgrass occur along the project area and reference area. This survey documented no observations of construction-related impacts to the eelgrass bed and patches.

Some future eelgrass colonization into the lower intertidal zone can be expected in the southern half of the project area where eelgrass currently only grows inshore to 0 feet MLLW. The area has larger substrate and less sand than the low intertidal areas in the northern half of the project area; however, there are some suitably sandy areas that may support eelgrass colonization to +1 feet MLLW or higher. The anticipated changes (improvements) to energy conditions in the southern portion of the project area through the removal of rock gabions that reflected wave energy may also allow for more sand material to accumulate in the area and provide substrate for eelgrass colonization. Future monitoring planned for Years 3 and 5 (2007 and 2009, respectively) will investigate whether such eelgrass colonization occurs.

It appeared that the cobble and gravel material placed to restore the beach was staying in place because throughout the project area there was a distinct break in substrate composition from the gravel and cobble to a sandy mix. Substrate sizes and distributions in the reference area were similar to those documented in the project area, particularly the southern half of the project area. The northern half of the project area had more sand, presumably due to the expansive stream delta that forms the northernmost part of the project area.

5 REFERENCES

Anchor Environmental. 2005. Pre-Construction Eelgrass Survey for the Seahurst Park Nearshore Restoration Project. Prepared for the Seattle District U.S. Army Corps of Engineers.

Washington Department of Fish and Wildlife (WDFW). 1996. Intermediate Eelgrass/Macroalgae Habitat Survey Guidelines. Prepared by the Washington Department of Fish and Wildlife. January 12, 1996.

Seahurst Park, South – Physical Beach Monitoring: Year 4 Post Restoration, Spring 2009

Prepared for:
Burien Parks, Recreation and Cultural Services
425 SW 144th Street
Burien, WA 98166

August 13, 2009

Prepared by: Coastal Geologic Services Inc.
Bellingham, WA

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Executive Summary

Coastal Geologic Services Inc. (CGS) was contracted to provide a topographic survey, physical beach profiles, and sediment characterization of the South Seahurst Park Nearshore Restoration Project area to continue previous monitoring, and allow for future comparisons. This was accomplished by conducting a field topographic survey using a high accuracy total station, sediment sampling, and grain-size analysis.

On March 30th and 31st, 2009, CGS performed the ground survey using existing survey control (Sheet 1). The survey began approximately 450 ft south of the south park boundary and went approximately 250 ft north of South Central Creek for a total length of approximately 2,400 ft alongshore. The beach restoration project area (Phase I) extends approximately 1,100 ft starting at the south park boundary. The beach was surveyed from +16 ft MLLW down to 0 ft MLLW or lower.

The nourishment sediment has remained quite stable, according to beach profile data. The beach face above +10 ft MLLW was more dynamic due to seasonal buildup and erosion of storm berms and swash bars. The low tide terrace showed very little change, and therefore the nourishment sediment has little or no impact at this beach elevation.

The reference beach area (Profiles 1–3) contained small pockets of both erosion and accretion since 2008. These areas were approximately 0.8 ft lower than the 2008 beach face, while minor accretion occurred low on the beach face between Profiles 2 and 3. The low-tide terrace was generally erosional, with up to 0.6 ft of vertical lowering seen in the vicinity of Profiles 2 and 3.

In the nourishment area, between Profiles 3 and 8, isolated pockets of erosion on the order of 0.5 to 1.0 ft vertical were seen above MHHW with as much as 2.0 ft lowered near Profile 8. Several, small areas of minor accretion were seen very high on the beach (Sheet 2). Between Profiles 3 and 4, where the backshore trail comes back down to the beach, an area of erosion was seen with up to 2.0 ft vertical lost near the now-complete trail end. Very little change was seen on the upper beach between Profiles 8 and 10 and on the low tide terrace.

Overall, from September 2008 (year 3) to March 2009 (year 4) 83% of the area compared was stable; with less than 0.25 ft of vertical change (Sheet 2). The area of greatest change was in and around the stream delta north of the project, apparently due to continued northward avulsion of the channel in the backshore and intertidal. Throughout the surface change comparison area, a total of 940 cubic yards (cy) of sediment has been lost between September 2008 and March 2009. Within just the original nourishment area a total of 248 cy of sediment was eroded since 2008, mostly from the southern end.

Since initial beach nourishment in 2005, 65% of the comparison area has seen less than 0.25 ft of vertical change. South of the park (Profiles 1-3) several pockets of minor accretion were seen on the upper beach. Minor to moderate amount of erosion occurred high on the upper beach within the nourishment area where imported sediment was originally placed in a distinct berm, which had eroded some since 2007 (year 2). The constructed berm area remains 1 to 2 ft below the As-built elevation. North of the nourishment area, near the large picnic shelter, accretion of up to 1 ft vertical was seen, likely the result of northward sediment transport of nourishment sediment. The total amount of sediment lost from within the nourishment area was 872 cy of the total beach nourishment of approximately 9,000 cy placed in 2005. Much of the erosion was high on the beachface, where the constructed berm was quickly eroded by storm waves.

Overall the large majority of the beach nourishment sediment appears to have remained within the original nourishment area. The beach profile has remained relatively stable throughout the nourishment area, and is similar in slope to the Reference Beach. Some amount of sediment transport out of the project area is to be expected, and has been documented since construction. Averaged since the As-built survey, the nourishment area has lost 218 cy/yr. An area of accretion was seen at the northern tip of the nourishment area, and is likely comprised of nourishment sediment. North of the project, the creek delta dominates beach dynamics as the creek has shifted position over a roughly 250 ft wide area.

Surface sediment samples on the lower high-tide beach (+8.5 ft MLLW) were all very similarly pebble dominant (Figure 4). The upper samples (+8.5 ft MLLW) were of a range of pebble to coarse sand dominant throughout the reference beach and the nourishment area (Figure 5). Sediment samples from +5 ft MLLW were also very similarly cobble-dominant throughout the study area (Figure 6). Overall, surface sediment have become increasingly well sorted within the nourishment area, and more closely resemble those seen at the reference beach.

With the exception of the upper sample at Profile 1, all samples collected from below the surface pebble layer were considerably finer than the surface (Figure 7). Both lower sub-surface samples collected contained a large proportion of 0.5–8 mm (33% and 65% at Profiles 1 and 7 respectively). Profile 7 in particular contained considerably more than the 40% typically considered as being high quality surf smelt spawning substrate (Johannessen 1998). The upper samples also contained a large proportion of finer sediment in the sub-surface layer at 51% and 60%. The shallow subsurface sediment layer appears to provide adequate forage fish spawning substrate despite the coarser surface layer of pebble.

Sediment sorting has continued into Year 4 of the post-construction monitoring period. Coarse sediment has been worked to the surface of the beachface to form a thin pebble veneer over finer granule and coarse sand. The coarsest sediment has moved to the lower beachface, while sand and small pebbles have been pushed into berms high on the beachface.

The nourishment project has performed quite well given the moderate wave energy at this site. Given the current rate of sediment transport through the area, it is very unlikely that the project area will need renourishment in the near future. Future physical beach monitoring will help determine the long-term trends, and assist in determining maintenance requirements. Future monitoring and sediment collection, currently scheduled to occur in September 2010, will aid in determining the success of beach rehabilitation.

Introduction and Purpose

Coastal Geologic Services Inc. (CGS) was contracted to provide a topographic survey, physical beach profiles, and sediment characterization of the South Seahurst Park Nearshore Restoration Project area to continue previous beach monitoring, and allow for future comparisons. This was accomplished by conducting a field topographic survey using a high accuracy total station with direct rod measurements, data reduction, sediment sampling, and grain-size analysis.

Bulkhead removal and beach restoration at the south end of Seahurst Park was initiated to restore natural processes and the beach profile for the benefit of Pacific salmon and other species that depend on the Puget Sound nearshore area (the zone that extends from the lower limit of submerged vegetation up to the bluff crest), and to augment the park visitors' experience through a more natural beach environment and improved trails (Hummel et al. 2005). Removal of the gabions (rock-filled wire baskets) and rock revetment at south Seahurst Park took place between December 2004 and February 2005. As-built surveying was conducted as soon as removal of the gabions and beach nourishment was completed in February 2005. No monitoring occurred during Year 1. Monitoring for Years 2 and 3 was carried out in late March 2007 and September 2008, respectively. This report documents monitoring from Year 4, which occurred in March 2009.

The study area for this monitoring survey was consistent with the pre-construction physical monitoring, which occurred in April 2004 (Johannessen and Chase 2004a) and October 2004 (Johannessen and Chase 2004b). The study area for all physical monitoring included the southern gabion area and surrounding beach both to the north and south in order to provide data for quantitative change comparisons, and comparison to the reference beach south of the park.

Methods

On March 30th and 31st, 2009, CGS performed a ground survey with a high accuracy total station (Leica TCR-1105) and direct rod measurement using existing survey control (Sheet 1). The survey of beach topography and physical features was performed in the Washington State Plane NAD 83 coordinate system, using Mean Lower Low Water (MLLW) as the (vertical) datum. The survey began approximately 450 ft south of the south park boundary and went approximately 250 ft north of South Central Creek for a total length of approximately 2,400 ft alongshore. The beach nourishment restoration project area (Phase I) extends from Profile 3 to 100 ft beyond Profile 8 for a total length of approximately 1,100 ft. The beach was surveyed from the bluff toe down to -1 ft MLLW or lower. The survey points were processed within AutoCAD Civil 3D 2008 in order to create a surface model representing March 2009 conditions. Topographic datasets used for analysis are described in Table 1.

Table 1. Datasets used for analysis and their sources. April 2004 and earlier are described in detail by Johannessen and Chase (2004a).

Date	Collected By:
Sep 1973	John R Ewing and Associates (for King County)
Mar 2002 (4 Profiles)	Duncanson Company Inc.
Oct 2002	USACE
Apr 2004	CGS
Oct 2004	CGS
Feb 2005 (As-built)	CGS
Mar 2007 (Year 2)	CGS
Sep 2008 (Year 3)	CGS
Mar 2009 (Year 4)	CGS

Results

Beach profiles are described in the direction of net shore-drift, from south to north (Schwartz et al. 1991). The drift cell that includes Seahurst Park originates 1.8 miles north of Three Tree Point, 0.5 miles south of South Central Creek. Net shore-drift continues north all the way to the east side of Duwamish Head (Schwartz et al. 1991). The report will discuss analyzing changes between all monitoring data from October 2004 (pre-construction) to March 2009 (Year 4). Measured surface change is reviewed secondly, and beach substrate is discussed at the end.

Beach Profiles

Beach profiles are presented on Sheet 1 (attached). Photos at profile locations are presented in Photo Page 1, with the reference beach photos in Photo Page 2.

The reference beach area surveyed south of the park boundary (Profiles 1-3) was fairly stable overall. Profile 1 showed only minor vertical change on the high-tide beach between 2008 and 2009. Profile 2 was very slightly below the 2007 elevation above +10 ft MLLW, and very slightly higher below that, but still above 2005 as-built conditions. Above +12 ft MLLW the beachface at Profile 3 had returned to the 2007 elevation, while below +10 ft MLLW the beachface was slightly higher than in 2008. The trend across the low-tide terrace at the reference beach was one of minor vertical lowering. This has resulted in the toe of the high-tide beach being further waterward than in either the 2007 or 2008 surveys.

The beach along the southern 650 ft of the project area (Profiles 4-6; former low gabion area) remained relatively stable, with only minor lowering of the very upper beach (Sheet 1). Profile 4 remained very close to the 2008 elevation. Between +10 and +12 ft MLLW Profile 5 was up to 0.7 ft below the 2007 elevation where a berm had been seen in 2008, but was gone in 2009. Below +10 ft MLLW the beachface had lowered by approximately 0.2 ft. Profile 6 was slightly lower than the 2008 elevation except where a minor storm berm at +11 ft MLLW had been seen, and is now gone. The beachface remained 2-3 ft higher post-nourishment as compared to 2002-2004 in the former low gabion area.

The northern portion of the project area, Profiles 7-8 (the former high gabion area), was stable to slightly erosional. Profile 7 was slightly below the 2007 elevation above +8 ft MLLW, and very similar further waterward. Profile 8 experienced minor erosion where a berm was seen in 2008 at +13 ft MLLW, with only minor erosion below that. The beachface remained 1-2 ft higher than pre-nourishment conditions on the former high gabion area.

North of the project area (Profile 9), the beach continued the trend seen at the other profiles, minor erosion very high on the beachface with minor changes lower. The creek delta area (Profiles 10-12) has been the most dynamic of all areas, primarily due to the avulsion of the channel across approximately 300 ft of delta and the associated sedimentation and erosion. The 2009 creek channel flowed northward through the backshore to the most northerly location point seen, where it turned sharply waterward through the upper beach. The more southerly position of the 2008 channel location was mostly filled, but still contained ponded water at low tide. The beach at Profile 12 (at the perched beach) was 0.1 ft higher waterward of the riprap, up to 0.5 ft higher immediately landward of the riprap, and 0.5 ft lower further landward as compared to 2008.

Overall, beach profile data show that the nourishment sediment has remained quite stable. Above +10 ft MLLW the beachface was more dynamic as storm berms and swash bars have been eroded and built up, but minor upper beach erosion has occurred in the south and central portions of the former gabion area. Very little change has occurred on the low-tide terrace, indicating that the nourishment sediment has had little or no impact there.

Beach Surface Analysis and Summary of Beach Change

Surface change analysis was carried out between February 2005 (As-built) and March 2009 (year 4) and also between September 2008 (Year 3) and March 2009 (Year 4). Both general erosion/accretion trends and total change in sediment volume are covered.

Sep 2008 to Mar 2009 - Overall, 83% of the area compared was stable, with less than 0.25 ft of vertical change (Sheet 2). The area of greatest change was in and around the stream delta north of the project, apparently due to continued northward avulsion of the channel in the backshore and intertidal.

The reference beach area (Profiles 1–3) contained small areas of both erosion and accretion. Erosion was seen high on the upper beachface within the driftlog zone including against the south end of the nourishment area (by Profile 3). These areas were as much as 0.8 ft lower than the 2008 beachface. Minor accretion was mostly seen low on the beachface such as between Profiles 2 and 3 on the mid beachface. The low-tide terrace was generally erosional, with up to 0.6 ft of vertical lowering seen in the vicinity of Profiles 2 and 3.

Between Profiles 3 and 4 where the backshore trail comes back down to the beach, an area of erosion was surveyed. Minor accretion occurred on the mid beachface, while erosion of up to 2.0 ft was seen near the now-complete trail end. Waterward of the trail, landslide colluvium seen in 2007 has continued to be eroded, resulting in up to 0.7 ft in vertical lowering.

Throughout the nourishment area, between Profiles 3 and 8, isolated pockets of erosion on the order of 0.5 to 1.0 ft vertical were seen above MHHW. The sandy backshore area immediately waterward of the stairs near Profile 8 lowered by as much as 2.0 ft. Several, small areas of minor accretion were seen very high on the beach (Sheet 2). The low-tide terrace in that area remained very stable, with only minor pockets of erosion and small areas of accretion due to change in the broad sand flats. Very little change was seen on the upper beach between Profiles 8 and 10, although several small pockets of erosion were seen on the low-tide terrace.

Channel avulsion has resulted in the greatest range of vertical change north of Profile 9 with between 3 ft of erosion and 2 ft of accretion in the immediate vicinity of the stream channel. A berm that resembles a small spit formed immediately waterward of the stream, and appears to have caused the stream to exit the

backshore at its most northerly location since monitoring began. Just north of the creek (Profiles 11-12) the beach was 1 ft or more above or below the 2008 elevation. While some of the accretion there may have resulted from nourishment sediment transport, it is likely that a dynamic creek channel had the greatest influence there. Therefore, the trend of minor study area wide erosion appears to match the general Central King County trend.

Throughout the comparison area a total of 940 cubic yards (cy) of sediment has been lost between September 2008 and March 2009. Most (83%) of that volume change occurred in areas of minor erosion and accretion (less than 0.25 vertical change). Within just the original nourishment area a total of 248 cy of sediment has been eroded, mostly from the upper beachface.

Feb 2005 to Sep 2008 - Since initial beach nourishment 65% of the entire comparison area has seen less than 0.25 ft of vertical change. South of the park (Profiles 1-3) several pockets of minor accretion were seen on the upper beach. Within the nourishment area, minor to moderate erosion occurred high on the upper beach where nourishment sediment was originally placed in a distinct berm. The berm had eroded some by Year 2 monitoring in 2007, and remains up to 2 ft below the As-built elevation. North of the nourishment area, near the large picnic shelter, accretion of up to 1 ft vertical was seen, likely the result of northward transport of nourishment sediment.

North of the project area, the creek delta has been highly dynamic as the channel across the beachface has shifted position numerous times. Various sections of the creek delta were 2–3 ft or more above or below the 2005 elevation. The vicinity of the southern perched beach was up to 1 ft above the 2005 elevation, possibly due to northward transport of nourishment sediment as well as some input from the creek.

The entire comparison area has lost 1,287 cy of sediment since the as-built survey in February 2005. The amount lost from within the nourishment area was 872 cy during the same period. Much of the erosion was high on the beachface, where the constructed berm crest was quickly eroded by storm waves. This equates to 218 cy/yr since 2005.

Erosion/Accretion Rates at Selected Locations

Specific locations near the former gabion wall were selected early in the monitoring period for examining trends in vertical change (erosion/accretion) since 1973. The area of data overlap used for this analysis starts just south of the former gabion wall through where the former gabion wall was low on the beach, but does not include the creek delta. Locations were selected using pre-construction elevations at +1, +5, +8, and +11 ft MLLW along Profiles 3, 4, and 5 (Sheet 1), where data existed.

Profile 3, located at the southern park boundary south of the former gabion structures, documented conditions immediately south of the nourishment area (Sheet 1). Recent, minor lowering was seen at the +11 ft MLLW location, although the beachface remains 1.3 ft above pre-construction conditions (Figure 1, Table 2). Consistent accretion occurred at the +8 ft MLLW location, which is now 0.6 ft above pre-construction. The +5 and +1 ft MLLW locations on the beachface have been more variable, and have remained within 1.0 ft of the pre-construction elevation since nourishment. Overall, all locations at Profile 3 have remained above their 1973 elevation.

Profiles 4 and 5 were located at the former low gabion area. Prior to February 2005, there were no data for comparison at +11 ft MLLW because that elevation was within riprap and/or the gabion structure. Between 2008 and 2009 all elevations at Profile 4 remained stable, with between 0.0 and 0.1 ft of change (Figure 3,

Table 2). Profile 5 was stable at the +1 ft MLLW, and lowered slightly at the +5 and +8 ft MLLW elevations (Figure 3). The beachface was still above the pre-construction beachface by between 1.7 and 2.2 ft at both profiles at elevations +5 and +8 ft MLLW (Figures 2 and 3, Table 2).

Examination of vertical erosion rate data at the selected location at Profiles 3-5 (Table 3) shows that neither accretion nor erosion predominated since the As-built survey (February 2005). Of the 12 measurements in the nourishment footprint, seven showed erosion and five showed accretion.

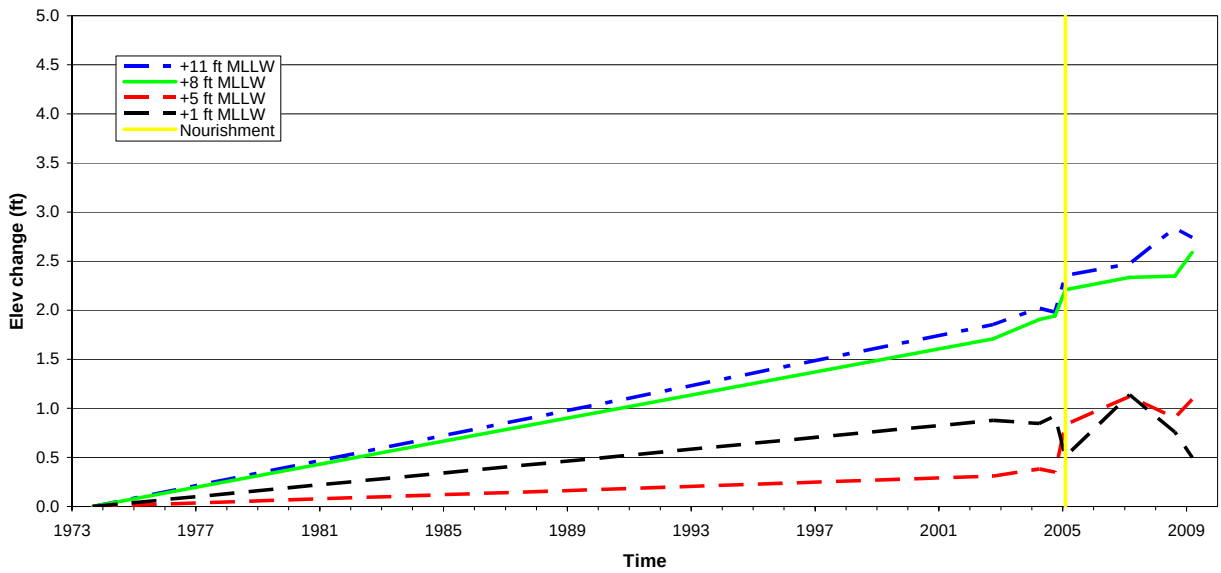

Figure 1. Cumulative vertical change (ft), relative to September 1973 along Profile 3 at south park boundary. Positive slopes indicate accretion, negative slopes indicate erosion. Vertical, yellow line indicates timing of nourishment. Data is in Table 2.

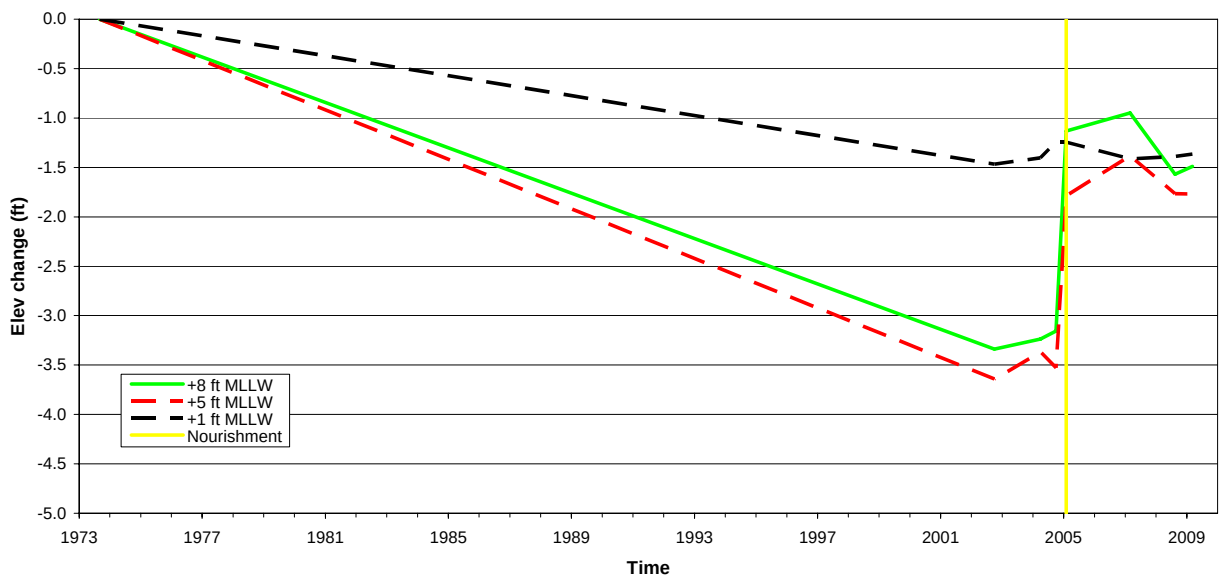

Figure 2. Cumulative vertical change (ft), relative to September 1973 along Profile 4. Positive slopes indicate accretion, negative slopes indicate erosion. Vertical, yellow line indicates timing of nourishment. Data is in Table 2.

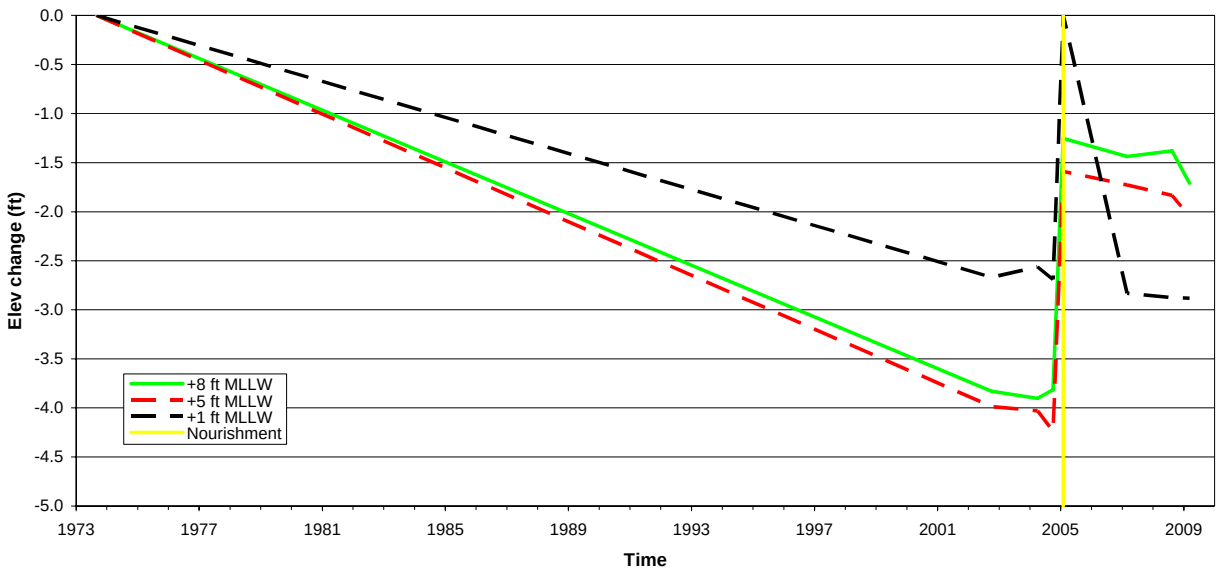

Figure 3. Cumulative vertical change (ft), relative to September 1973 along Profile 5. Positive slopes indicate accretion, negative slopes indicate erosion. Vertical, yellow line indicates timing of nourishment. Data is in Table 2.

Table 2. Vertical change (ft) relative to previous monitoring period. Positive numbers are accretion, negative numbers are erosion. Location of measurement points were based on April 2004 topography along Profiles 3, 4, and 5.

a) +11 ft MLLW

Date	PR3		
Sep-73	0.00		
Oct-02	1.85		
Apr-04	0.17		
Oct-04	-0.04		
Feb-05	0.37		
Mar-07	0.12		
Aug-08	0.36		
Mar-09	-0.09		

b) +8 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	1.71	-3.34	-3.83
Apr-04	0.20	0.10	-0.07
Oct-04	0.04	0.08	0.09
Feb-05	0.27	2.03	2.56
Mar-07	0.12	0.18	-0.19
Aug-08	0.01	-0.62	0.06
Mar-09	0.24	0.08	-0.33

c) +5 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	0.31	-3.64	-3.99
Apr-04	0.07	0.27	-0.04
Oct-04	-0.03	-0.16	-0.21
Feb-05	0.49	1.74	2.65
Mar-07	0.28	0.40	-0.14
Aug-08	-0.22	-0.38	-0.11
Mar-09	0.19	0.00	-0.22

d) +1 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	0.88	-1.47	-2.67
Apr-04	-0.03	0.06	0.11
Oct-04	0.08	0.16	-0.13
Feb-05	-0.41	0.00	NA
Mar-07	0.63	-0.17	-0.14
Aug-08	-0.38	0.02	-0.05
Mar-09	-0.26	0.02	-0.01

NA= The area of measurement was outside of one or both of the two surveys compared
*: Change data based on Oct-04 to Mar-07 due to lack of Feb-05 data at this location

Table 3. Vertical change rate (ft/yr), relative to previous monitoring period. Positive numbers are accretion, negative numbers are erosion. Locations of data points were based on April 2004 topography along Profiles 3, 4, and 5.

a) +11 ft MLLW

Date	PR3		
Sep-73	0.00		
Oct-02	0.06		
Apr-04	0.11		
Oct-04	-0.08		
Feb-05	1.12		
Mar-07	0.11		
Aug-08	0.24		
Mar-09	-0.19		

b) +8 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	0.06	-0.11	-0.13
Apr-04	0.13	0.07	-0.05
Oct-04	0.07	0.16	0.17
Feb-05	0.80	6.08	7.68
Mar-07	0.11	0.17	-0.17
Aug-08	0.01	-0.41	0.04
Mar-09	0.49	0.16	-0.65

c) +5 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	0.01	-0.13	-0.14
Apr-04	0.05	0.18	-0.03
Oct-04	-0.06	-0.32	-0.42
Feb-05	1.46	5.23	7.95
Mar-07	0.26	0.37	-0.13
Aug-08	-0.15	-0.26	-0.07
Mar-09	0.38	-0.01	-0.43

d) +1 ft MLLW

Date	PR3	PR4	PR5
Sep-73	0.00	0.00	0.00
Oct-02	0.03	-0.05	-0.09
Apr-04	-0.02	0.04	0.07
Oct-04	0.15	0.31	-0.26
Feb-05	-1.24	0.00	NA
Mar-07	0.58	-0.15	-0.13
Aug-08	-0.25	0.02	-0.03
Mar-09	-0.52	0.05	-0.01

NA= The area of measurement was outside of one or both of the two surveys compared
*: Change data based on Oct-04 to Mar-07 due to lack of Feb-05 data at this location

Beach Substrate

Substrate data were analyzed using standard grain size analysis methods for coarse sediment, which consisted of screening sediment through progressively finer wire squares and sieves, and weighing the various size fractions. Results are given in the Wentworth Scale (Wentworth 1922; Table 4).

Table 4. Sediment size classes used in this report based on the Wentworth Scale (Wentworth 1922), and those used by WDFW in previous work.

Phi Size	Sediment Type	Grain Size (coarser than)		Equivalent Tyler Screen Size (mm)
		(inches)	(mm)	
- 6	Cobble	2.5	64	53.8
- 5	Cobble	1.25	32	26.7
- 4	Pebble	0.6	16	13.3
- 3	Pebble	0.3	8	6.7
- 2	Pebble	0.16	4	3.33
- 1	Granule	0.08	2	1.65
0	Very coarse sand	0.04	1	0.83
+1	Coarse sand	0.02	0.5	0.42
+2	Med. Sand	0.01	0.25	0.21
+3	Fine sand	0.005	0.125	0.1
> +3	Fine sand, silt, clay	<0.005	<0.125	<0.1

Sixteen sediment samples were collected and analyzed from the beach surface (to 0.1 ft deep) March 30–31, 2009 at Profiles 1 through 8, excluding Profiles 3 and 4. Two samples were collected from each profile within the “band” of potential forage fish spawning habitat. Sediment samples were collected from elevations +11.0 ft and +8.5 MLLW, referred to in the text as upper and lower respectively. Additionally, sediment was collected from +5 ft MLLW to characterize mid-lower beach conditions. Recent benthic invertebrate monitoring identified this area as having very low numbers of benthic organisms (Toft 2007). Four sub-surface samples were collected and analyzed from Profiles 1 and 7. These samples were collected at elevations +8.5 and +11.0 ft MLLW, and included the shallow sub-surface (0.1-0.2 ft deep), or just below the typically more coarse beach surface. Forage fish have been shown to spawn within the sub-surface layer (Pentilla pers. comm.).

As-Built data were from February 2005. Baseline data were averaged from March and October 2004, and April 2002. Sediments at Profile 1 were collected and processed for the first time in February 2005. Sediments were not collected at the upper elevation for Profiles 5 and 6 prior to February 2005 because that elevation was previously within the riprap/gabion structures. The April 2002 upper sediment was collected at +9.5 ft MLLW and the lower sediment was collected at +6.0 ft MLLW (note different elevations).

Surface Sediments - The lower sediments were all very similar. Large pebble dominated the sediment mix, with very small amounts of granule and sand (Figure 4). The reference beach sediment was within the range of sizes found in the nourishment area. This indicates that the nourishment sediment has remained similar to the reference beach, and was therefore appropriately sized for nourishment.

Upper beach sediment samples (+11.0 ft MLLW) exhibited more variation, with Profiles 1 and 6 similarly pebble dominant, Profiles 2 and 7 consisting of primarily coarse sand, and Profiles 5 and 8 bimodal with large pebble and lesser amounts of coarse sand (Figure 5). Visual examination showed a pattern of

alternating pebble swash bars and sandy patches high on the beachface throughout the study area (Photo Page 1).

The lower surface sediment samples did not contain large enough proportions of 0.5–8 mm grain sizes to be considered very good forage fish spawning substrate. The samples averaged only 13% 0.5–8 mm, although the average was higher than the 9% seen in 2008. The upper surface sediment samples at Profiles 2 and 7 did contain large enough proportions of 0.5–8 mm grain sizes to be considered very good forage fish spawning substrate. Those samples contained 44% and 59% respectively. The other upper beach surface sediment samples contained a lesser amount of coarse sand, so do not contain good forage fish spawning substrate. The upper samples averaged 31%, decidedly more than the 18% seen in 2008. Qualitative observation of the beachface near +11 ft MLLW showed that large patches of very good potential spawning substrate do exist on the surface.

On the lower beachface, at +5 ft MLLW, the surface sediment was dominated by small cobble with minor amounts of pebble and sand (Figure 6).

A comparison of +5.0 and +8.5 ft MLLW surface sediment samples (+8.5 ft MLLW) was undertaken in 2007 and continued into 2009 to determine if sediment differences could be correlated to a lack of benthic invertebrates found by Toft (2007). All Profiles sampled contained sediment only slightly coarser at +5.0 ft MLLW than at +8.5 ft MLLW (Figure 6). Coarser sediment may produce a less than favorable environment for the survival of benthic invertebrates, although it is likely that some species are well adapted to living in those conditions (Toft pers. comm.). During both topographic surveys of 2007 and 2008 it was noted that the upper extent of freshwater seepage on the beachface was at approximately +5.0 ft MLLW. The twice-daily shift from salt to fresh and back may be more of a limitation for organisms adapted to one environment or the other rather than differences in sediment grain size (Toft pers. comm.). During the 2009 survey the extent of seepage at +5 ft MLLW was considerably less than previous years, perhaps as a result of trail construction and diversion of surface runoff through a trailside ditch. Examination of the extent of seepage during benthic sampling would assist in determining the influence of the seepage on the benthic community.

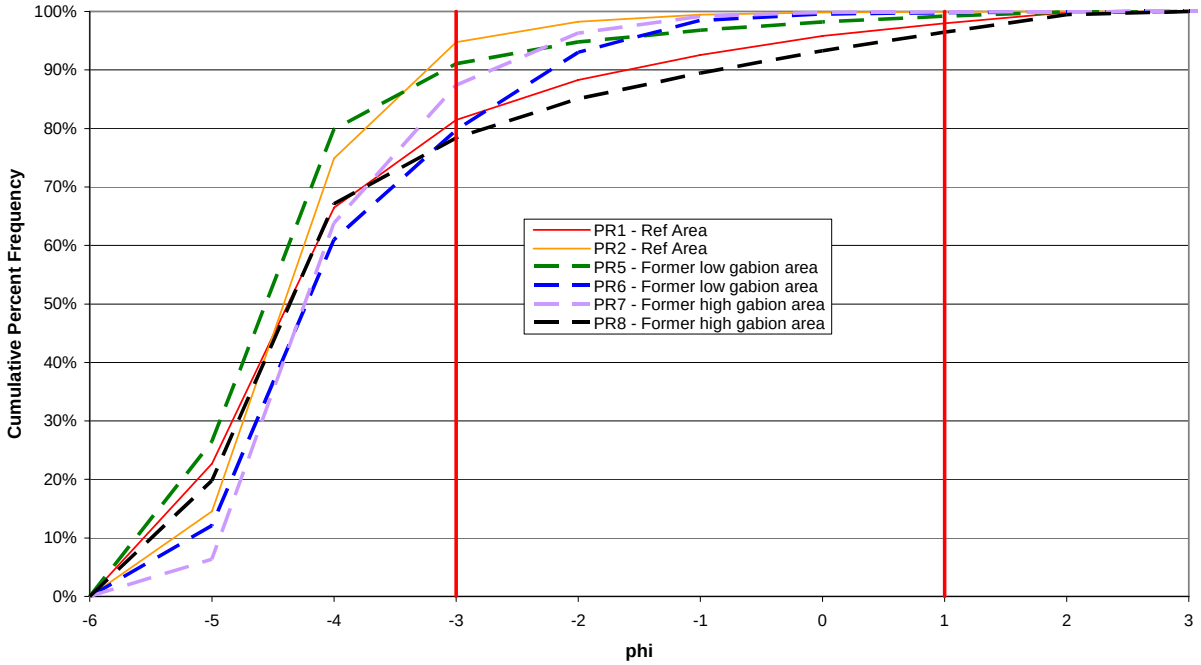

Figure 4. Cumulative percent frequency for lower (+8.5 ft MLLW) sediment samples from March 2009. Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

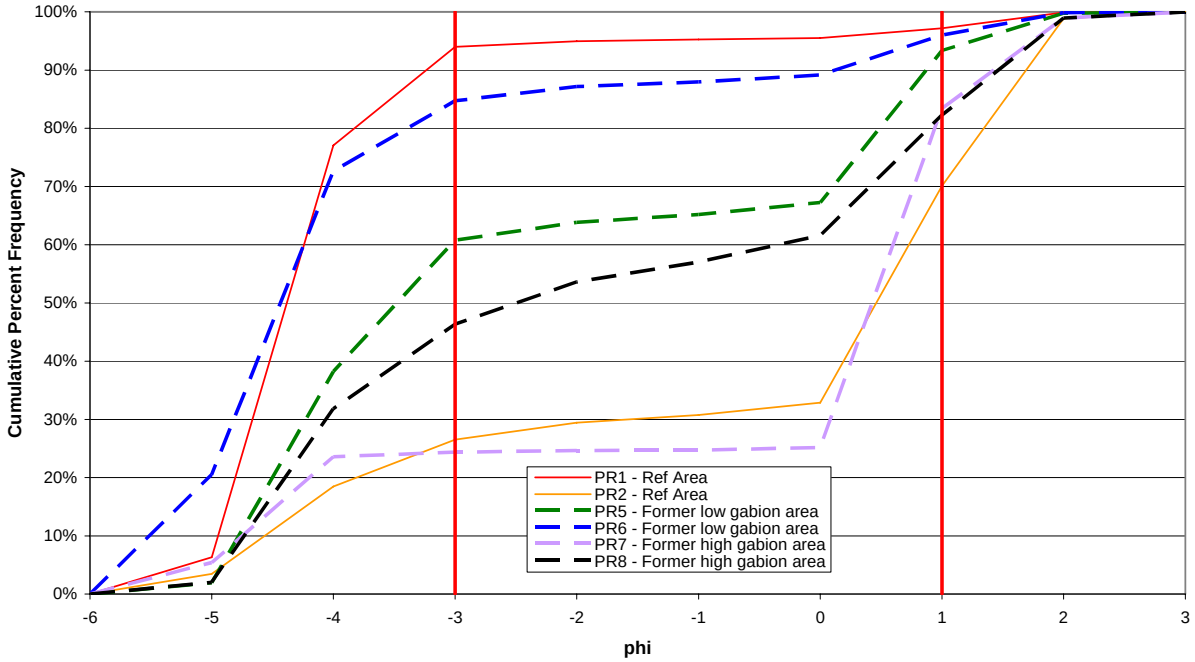

Figure 5. Cumulative percent frequency for upper (+11.0 ft MLLW) sediment samples from March 2009. Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

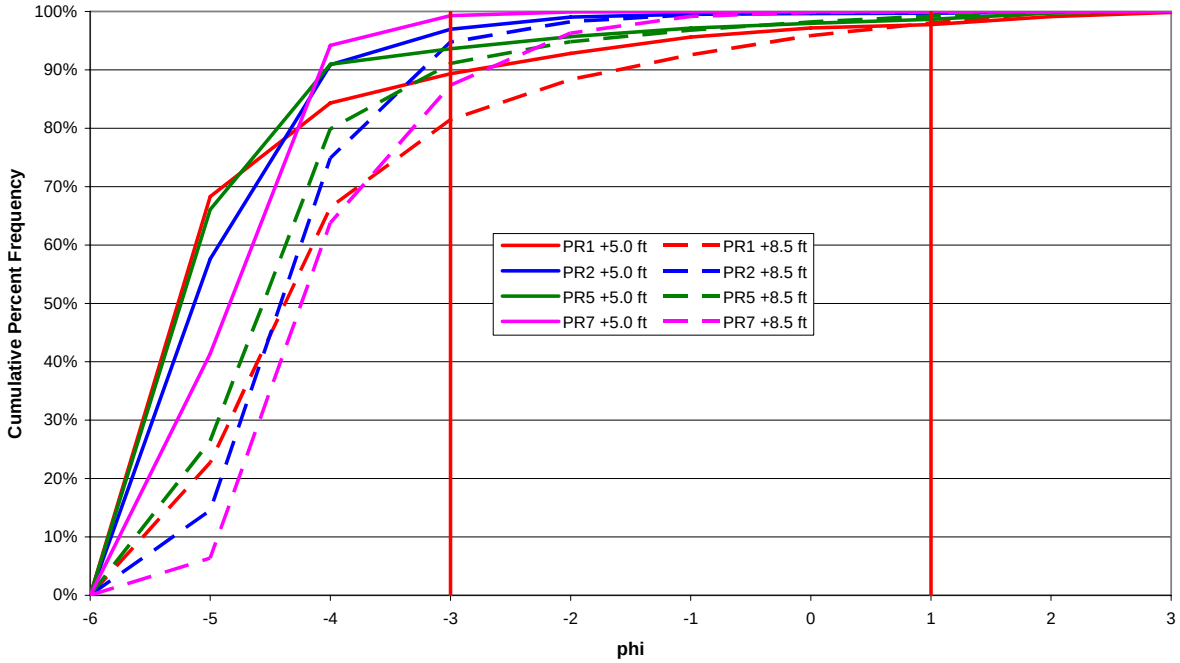

Figure 6. Cumulative percent frequency plot for +5.0 and +8.5 ft MLLW sediment samples from March 2009. Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

Sub-surface Sediments - The upper beachface of Puget Sound area beaches often contains a pebble-rich veneer, or natural beach armor (Johannessen and MacLennan 2007). Surf smelt eggs have been observed on beaches where suitable spawning substrate is found just below this coarse veneer (Pentilla pers. comm.). The surface (0–0.1 ft) and sub-surface (0.1–0.2 ft) where sampled at south Seahurst Park to examine the grain-size distribution of these layers.

With the exception of the upper sample at Profile 1 all samples collected from below the surface pebble layer were considerably finer than the surface (Figure 7). Both lower sub-surface samples collected contained a large proportion of 0.5–8 mm (33% and 65% at Profiles 1 and 7 respectively). Profile 7 in particular contained considerably more than the 40% typically considered as being high quality surf smelt spawning substrate (Johannessen 1998). The upper samples also contained a large proportion of finer sediment in the sub-surface layer at 51% and 60%. The shallow subsurface sediment layer appears to provide adequate forage fish spawning substrate despite the coarser surface layer of pebble.

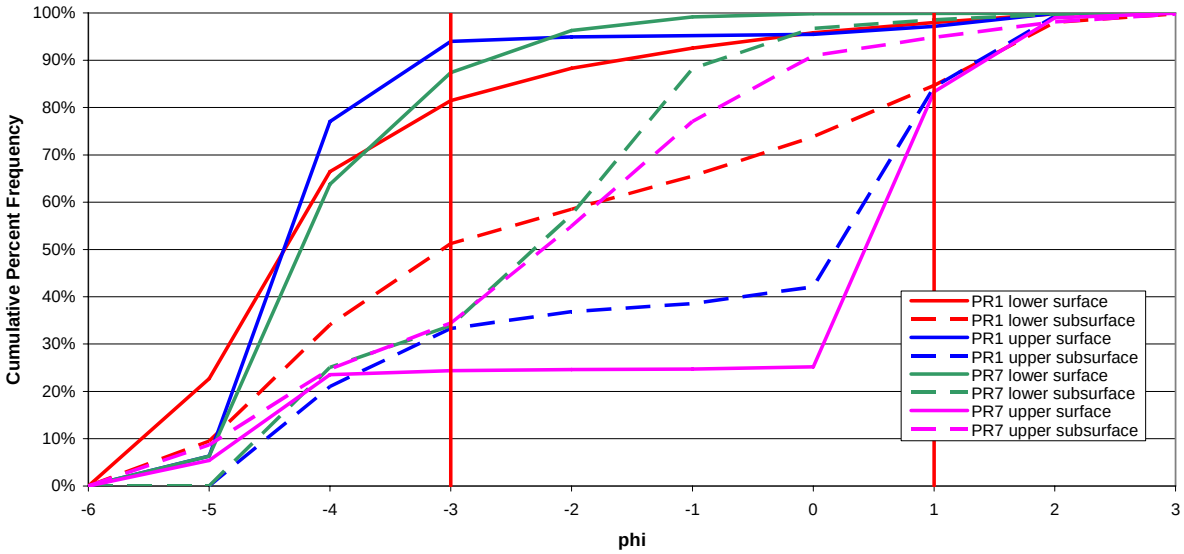

Figure 7. Cumulative percent frequency plot for paired surface (0-1 in) and sub-surface (1-2 in) sediment samples taken at +8.5 ft MLLW (lower) and +11.0 ft MLLW (upper) in March 2009. Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

As-built to March 2009 - The average upper sediment (+11.0 ft MLLW) was similar for all periods sampled in the Reference Beach since nourishment, but coarsened slightly (Profiles 1-3; Figure 8). The lower sediment had coarsened considerably since 2007, trending toward the -3 to -4 phi (pebble) range.

The lower and upper 2009 sediment in the former Low Gabion Area (Profiles 5-6) have coarsened somewhat since 2005 (Figure 9). Both were very similar to each other, indicating that the nourishment sediment has become well mixed throughout the beachface. Sediment has remained finer than the baseline average, although it is likely that the baseline average was very coarse due to quarry spall rock spilled from gabions on the upper beach. No sediment was collected for the upper elevation prior to February 2005 because that elevation was covered with riprap/gabion structures.

The lower 2009 sediment sample in the former High Gabion Area (Profiles 7-8) has coarsened somewhat since 2005 (Figure 10). Although a bit coarse, the similarity to the As-Built sediments indicates that nourishment sediment has remained within the nourishment area. The upper sediment sample was considerably finer than previous years, and more closely resembled baseline conditions. This is likely due to the sample being taken from a sandy patch high on the beachface, although pebble dominant swash bars were present to either side.

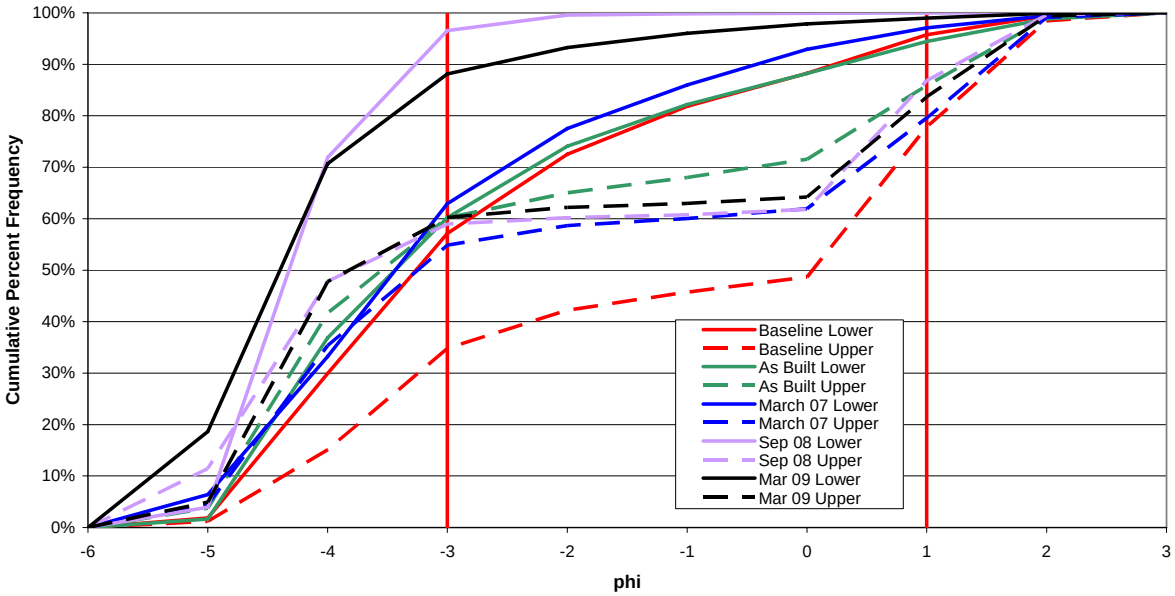

Figure 8. Cumulative percent frequency for Reference area (Profiles 1-3). 2007 and 2008 data from Profiles 1 and 2 only. As-Built data were from February 2005. Baseline data were averaged from March and October 2004, and April 2002. Sediment at Profile 1 were collected and processed for the first time in February 2005. April 2002 data were at Profile 3 and the upper sediment was collected at +9.5 ft MLLW and the lower sediment was collected at +6.0 ft MLLW (note different elevation). Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

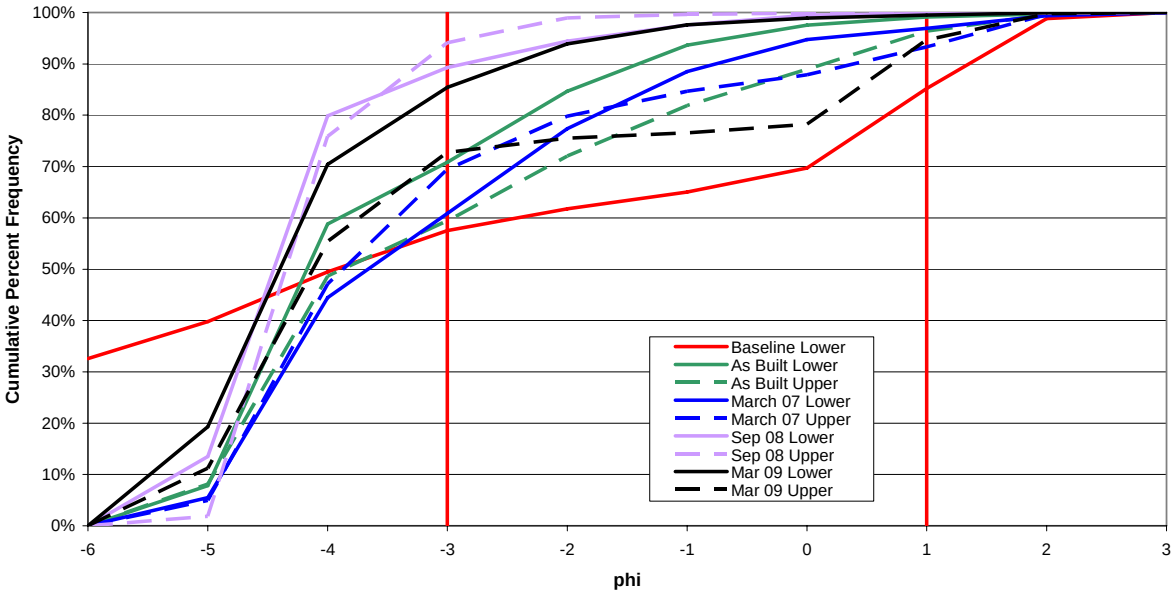

Figure 9. Cumulative percent frequency for former Low Gabion area (Profiles 5-6). As-Built data were from February 2005. Baseline data were averaged from March and October 2004, and April 2002. Sediment were not collected at the upper location for Profiles 5 and 6 prior to February 2005 because that elevation was previously within the riprap/gabion structures so there is no Baseline Upper average. April 2002 data were at Profile 3 and the upper sediment was collected at +9.5 ft MLLW and the lower sediment was collected at +6.0 ft MLLW (note different elevation). Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); see Table 1 for explanation of phi sizes.

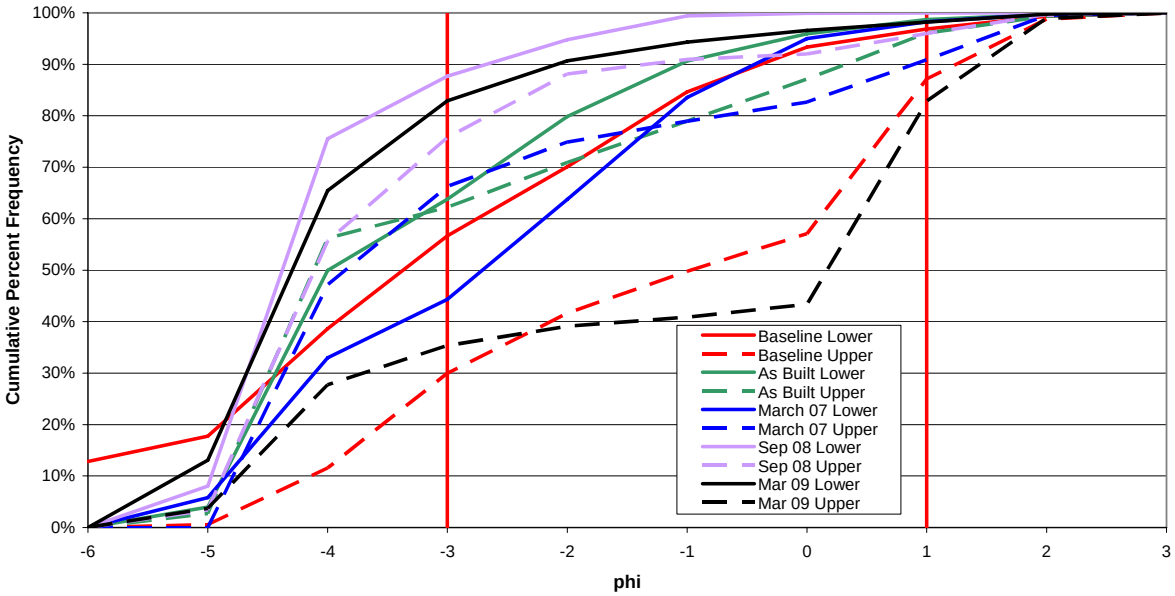

Figure 10. Cumulative percent frequency for former High Gabion area (Profiles 7-8). As-Built data were from February 2005. Baseline data were averaged from March and October 2004, and April 2002. Area between red lines represents grain sizes ideal for surf smelt and sand lance spawning substrate; steep curves in this range indicate abundance of these sediment sizes (0.5-8.0 mm). Phi size -6 is cobble (left) and phi size +3 is fine sand (right); See Table 1 for explanation of phi sizes.

Analysis - Surface sediment analysis in March 2009 revealed some patterns. The nourishment sediment has been well sorted throughout the nourishment area. Coarser sediment has been worked to the surface of the beachface to form a pebble veneer with finer sediments just below the surface (Photo Page 4). Some of the coarsest sediment (cobbles) moved to lower elevations, leaving finer sediment on the upper high-tide beach except where storm waves have pushed pebble and cobble into berms high on the beachface. As is common at beaches of this type throughout the Sound, the upper beachface consisted of a sandy surface alternating with pebble swash bars.

In general, the lower samples contained less 0.5–8 mm sized sediment than did the upper samples. The amount of 0.5-8 mm sized sediment ranged from 5 to 20% for the lower samples and 3 to 59% for the upper samples. Sediment with greater than 40% 1-8 mm has been shown to be suitable for high-utilization spawning by surf smelt in northern Puget Sound (Johannessen 1998). Two of the surface sediment samples (Profiles 1 and 7) contained more than 40% 0.5–8 mm sediment. Below the surface layer a finer layer of sediment did present good forage fish spawning substrate. Three of the four sub-surface samples collected contained more than 40% 0.5–8 mm sediment, while the fourth sample contained 33%.

Beach nourishment sediment used to construct the beach was similar to the reference area and was suitable for the site in terms of upper beach habitats. Surface beachface sediment in the beach nourishment has coarsened slightly in 2009 in most areas of the project. Future monitoring and sampling will help determine the persistence of various grain sizes in surface sediment and the longevity of the various sizes of nourishment sediment.

Conclusions

Overall the large majority of the beach nourishment sediment appears to have remained within the original nourishment area. The beach profile has remained relatively stable throughout the nourishment area, and

is similar in slope to the Reference Beach. North of the project, the creek delta dominates beach dynamics as the creek has shifted position over a roughly 250 ft wide area.

Some amount of sediment transport out of the project area is to be expected, and has been documented since construction. Averaged since the As-built survey, the nourishment area has lost 218 cy/yr, nearly the same amount lost between 2007 and 2008. An area of accretion was seen at the northern tip of the nourishment area, and is likely comprised of nourishment sediment.

Sediment sorting has continued into Year 4 of the post-construction monitoring period. Coarse sediment has been worked to the surface of the beachface to form a thin pebble veneer over finer sediment (pebble to coarse sand). The coarsest sediment has moved to the lower beachface, while sand and small pebbles have been pushed into berms high on the beachface.

The nourishment project has performed quite well in this moderate wave energy site. The beach was erosional in the natural condition, and was also negatively impacted by earlier fill and armoring. Given the current rate of sediment transport through the area, it is very unlikely that the project area will need renourishment in the near future. Future physical beach monitoring will help determine the long-term trends, and assist in determining maintenance requirements.

Future Monitoring

This report describes beach conditions at south Seahurst Park in March 2009, as well as changes through time between 1973 and 2009. Future monitoring and sediment collection, currently scheduled to occur in September 2010, will aid in determining the success of beach rehabilitation.

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Coastal Geologic Services Inc.

Jim Johannessen, Licensed Engineering Geologist, MS Jonathan Waggoner, BS

ATTACHMENTS:
Photo Page 1. Profiles 1 through 8 beachface
Photo Page 2. Reference beach
Photo Page 3. Sediment samples
Sheet 1. Site plan: Seahurst Park –March 2009 Topography (2x4 ft sheet)
Sheet 2. Site plan: Seahurst Park – Surface Change (2x4 ft sheet)

Profile 1

Profile 2

Profile 3

Profile 4

Profile 5

Profile 6

Profile 7

Profile 8

Photo Page 1. Profiles 1 through 8 beachface

Profile 1 looking east

Profile 1 looking northeast

Profile 1 looking north

Profile 1 looking south

Profile 2 looking west

Profile 2 looking southeast

Photo Page 2. Reference beach

Construction near Profile 4 - southeast

Construction near Profile 4 - northeast

Construction near Profile 4 - north

Upper beachface seawall installation - south

Upper beachface seawall installation - southeast

Upper beachface seawall installation - north

Photo Page 3. Beach construction activities during September 2008 survey

Profile 1 +5.0 ft MLLW

Profile 1 +8.5 ft MLLW

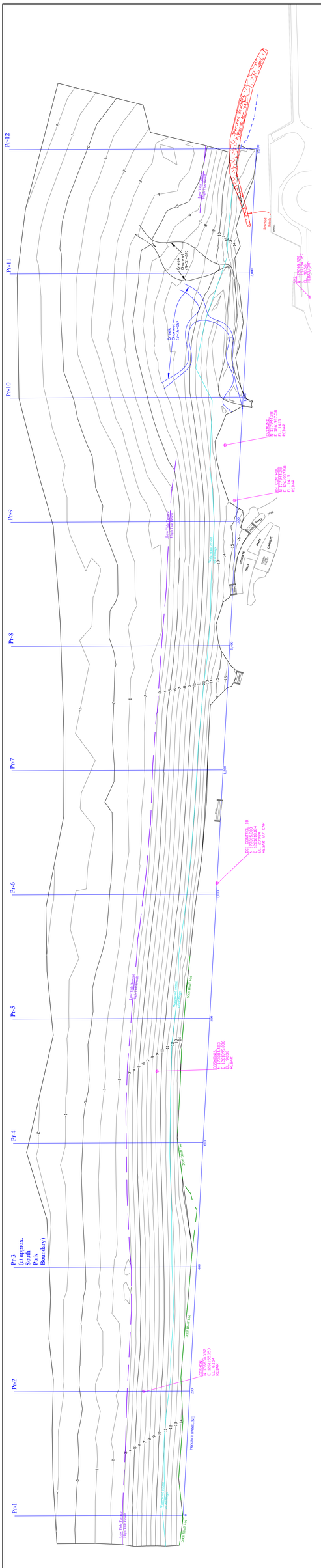
Profile 1 +11.0 ft MLLW

Profile 7 +5.0 ft MLLW

Profile 7 +8.5 ft MLLW

Profile 7 +11.0 ft MLLW

Photo Page 4. Sediment samples



Data Sources:
1. John R. Ewing and Associates
   Paper survey map copies (Sept. 1973)
   Sheets 4, 5, and 6; Scale: 1"=20'
2. Walker and Associates
   Digital CAD file of photogrammetry from aerial photo (Dec. 2001)
3. USACE
   Digital CAD file of field survey (Oct 2002)

Notes:
1. Monuments SP2-4 set by Duncanson Company Inc. (April 2002).
2. Monuments D7-8 set by Duncanson Company Inc. (Feb 2005)
3. Monument 'DC1 Control' found March 2007.
4. Monument 'RH Control' found September 2008.

COASTAL GEOLOGIC SERVICES
701 Wilson Ave, Bellingham, WA, 98225
(P) 360-647-1845, jim@coastalgeo.com
www.coastalgeo.com

Date Surveyed: March 30 and 31, 2009.
Date Drawn: August 12, 2009.

Seahurst Park - March 2009 Topography

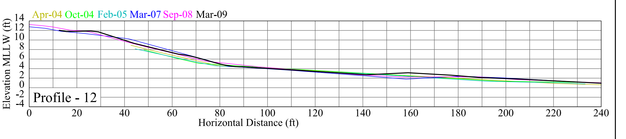
For: City of Burien, WA
King County Conservation District

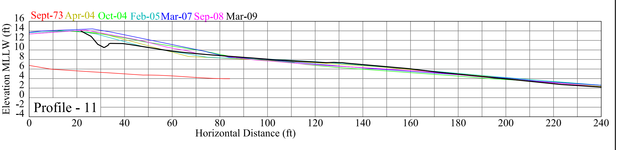
Coordinate System: WA State Plane North, NAD 83.
Vertical Datum: Mean Lower Low Water

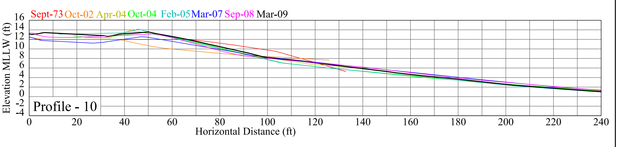
SITE PLAN — Sheet: 1 of 2

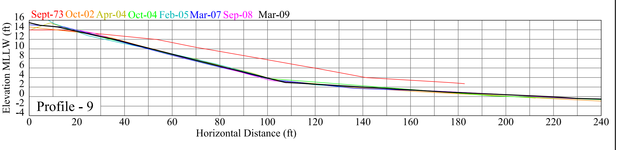
Scales:
1. Map: 1"=50'
2. Sections: V: 1"=10'; H: 1"=20'

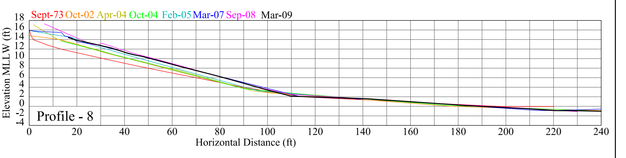
Cross Sections - CGS

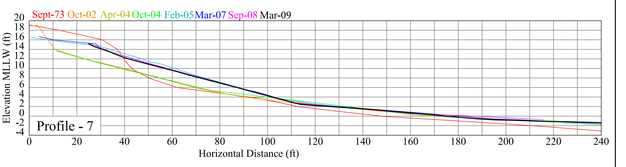


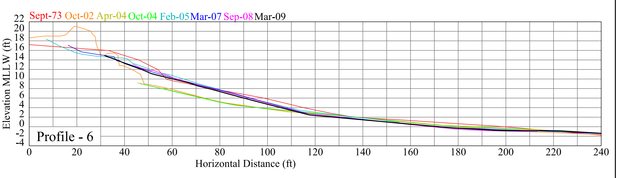


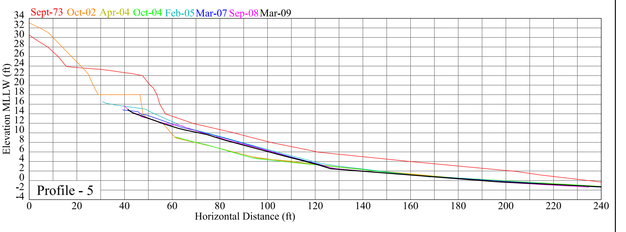


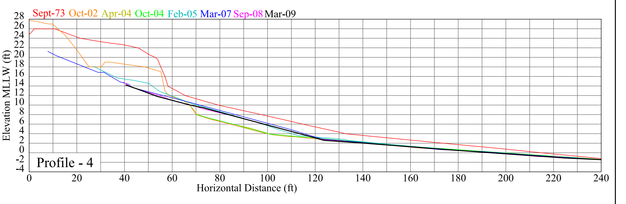


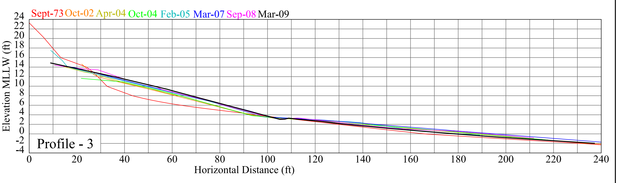


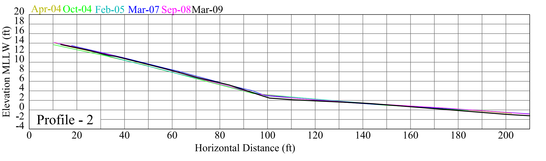


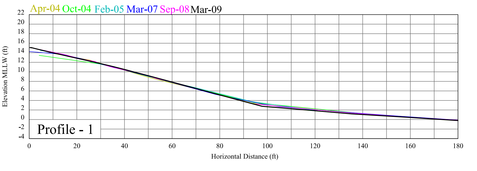


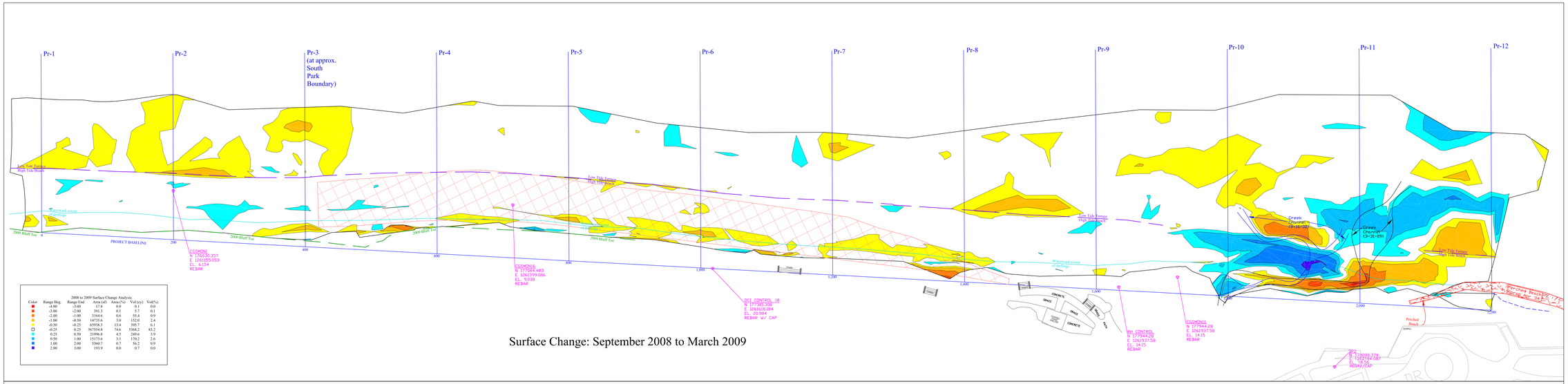








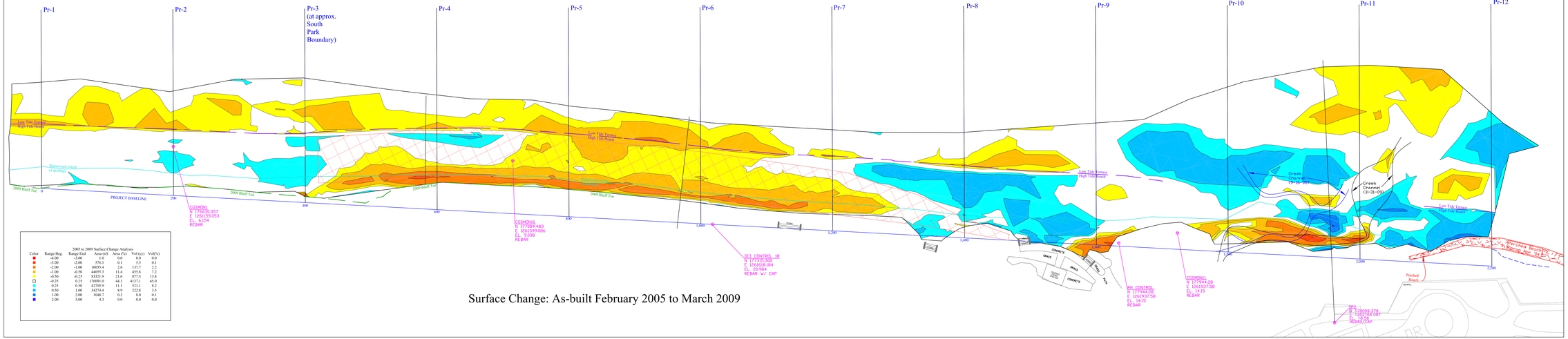




2008 to 2009 Surface Change Analysis

Color	Range Beg.	Range End	Area (sf)	Area (%)	Vol (cy)	Vol(%)
	-4.00	-3.00	17.8	0.0	0.1	0.0
	-3.00	-2.00	391.3	0.1	5.7	0.1
	-2.00	-1.00	3164.6	0.6	55.4	0.9
	-1.00	-0.50	14735.6	3.0	152.0	2.4
	-0.50	-0.25	65938.3	13.4	395.7	6.1
	-0.25	0.25	367554.8	74.6	5368.2	83.2
	0.25	0.50	21996.8	4.5	249.6	3.9
	0.50	1.00	15173.6	3.1	170.2	2.6
	1.00	2.00	3360.7	0.7	56.2	0.9
	2.00	3.00	193.9	0.0	0.7	0.0

Surface Change: September 2008 to March 2009



2005 to 2009 Surface Change Analysis

Color	Range Beg.	Range End	Area (sf)	Area (%)	Vol (cy)	Vol(%)
	-4.00	-3.00	1.0	0.0	0.0	0.0
	-3.00	-2.00	576.1	0.1	5.5	0.1
	-2.00	-1.00	10035.4	2.6	137.7	2.2
	-1.00	-0.50	44055.3	11.4	455.8	7.2
	-0.50	-0.25	83321.9	21.6	877.5	13.8
	-0.25	0.25	170091.0	44.1	4137.1	65.0
	0.25	0.50	42705.9	11.1	521.1	8.2
	0.50	1.00	34274.4	8.9	222.8	3.5
	1.00	2.00	1048.7	0.3	8.0	0.1
	2.00	3.00	4.3	0.0	0.0	0.0

Surface Change: As-built February 2005 to March 2009

COASTAL GEOLOGIC SERVICES
Dr. Peter A. Bromirski, Ph. D. #6022
Dr. Robert Guza, Ph. D. #6023
Dr. Jon Lockwood, Ph. D. #6024

Seahurst Park - Surface Change 2009

For: City of Burien
King County Conservation District

Elevation: Mean Lower Low Water, North, NAVD 88
Horizontal: Washington State Plane North, NAD83/91 Coordinates, US Survey Feet

SITE PLAN

Sheet 2 of 2

1"=50'

Date Drawn: August 12, 2009

Notes:
1. Topography: GPS Survey Data Company Inc. (April 2002)
2. Monument D2-5 by Dunnemon Associates (July 2002)
3. Monument D2-6 by Dunnemon Associates (July 2002)
4. Monument 5X1 Control found March 2007.

* The Oct 2004 data were a combination of DGPS data from the top of the gabion structures and manual measurements (TS) from the toe of the gabion structures landward.

2008 to 2009 Surface Change Analysis

Color	Range Beg.	Range End	Area (sf)	Area (%)	Vol (cy)	Vol(%)
	-4.00	-3.00	17.8	0.0	0.1	0.0
	-3.00	-2.00	391.3	0.1	5.7	0.1
	-2.00	-1.00	3164.6	0.6	55.4	0.9
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	-0.25	0.25	367554.8	74.6	5368.2	83.2
	0.25	0.50	21996.8	4.5	249.6	3.9
	0.50	1.00	15173.6	3.1	170.2	2.6
	1.00	2.00	3360.7	0.7	56.2	0.9
	2.00	3.00	193.9	0.0	0.7	0.0

USACE 2004 Gravel Nourishment Area

2005 to 2009 Surface Change Analysis

Color	Range Beg.	Range End	Area (sf)	Area (%)	Vol (cy)	Vol(%)
	-4.00	-3.00	1.0	0.0	0.0	0.0
	-3.00	-2.00	576.1	0.1	5.5	0.1
	-2.00	-1.00	10035.4	2.6	137.7	2.2
	-1.00	-0.50	44055.3	11.4	455.8	7.2
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	1.00	2.00	1048.7	0.3	8.0	0.1
	2.00	3.00	4.3	0.0	0.0	0.0

SAFS-UW-0903
July 2009

Benthic Macroinvertebrate Monitoring at Seahurst Park 2008, Year 3 Post-Restoration of Seawall Removal

Jason D. Toft

Wetland Ecosystem Team
School of Aquatic and Fishery Sciences
University of Washington

Prepared for the City of Burien

Funded by the King Conservation District

University of Washington
SCHOOL OF AQUATIC
& FISHERY SCIENCES

King Conservation District

Executive Summary

This report describes year 3 post-construction restoration monitoring of benthic invertebrates at Seahurst Park, located on Puget Sound in the City of Burien. Shoreline modifications have altered many of the natural habitats in nearshore areas of Puget Sound. Efforts to restore intertidal areas have increased in recent years, with listing of Chinook salmon as threatened under the Endangered Species Act in 1999. Monitoring has been limited in many cases, leading to a lack of rigorous studies that measure effects of completed restorations and guide future efforts. Restoration completed in February 2005 at Seahurst Park removed a section of seawall and created an intertidal beach. This study describes an initial assessment of the restoration by monitoring paired project/reference sites in 2008 and comparing to previous samplings in 2004 and 2006. Benthic macroinvertebrates were used as a biological measure, due to their importance in intertidal beach ecology and prey for nearshore fish.

Ideally, the project site will one day closely match the reference site in terms of invertebrate densities, assemblages, and taxa richness. Increased densities means that the numbers of invertebrates will have increased since restoration, and improved assemblages and taxa richness means that the types and diversity of taxa will be similar to the reference beach. These improved conditions will presumably benefit juvenile salmon by providing increased prey resources for feeding.

Benthic cores were taken during three months (June, July, September) and at three tidal heights (+12, +8 and +5' MLLW), identical to previous monitoring. Results indicated that some aspects of the invertebrate community have improved since pre-restoration conditions and shifted towards those at the reference site, while others are still in development. Beach-wrack formation at high tidal elevations occurred at the project site, with development of +12 invertebrate assemblages that were typical of the reference beach and unique to those at the highest tidal elevation. Although overall densities at +8 and +5 were still not as high as the reference site, taxa richness was greater, signifying a good colonization of a diversity of invertebrates that will hopefully continue to increase in number with time. Furthermore, the previously modified seawall elevations of +12 and +8 have shown improvements compared to pre-restoration levels, as illustrated by higher densities, taxa richness, and assemblage structure. The +5 elevation seems to be most affected by the regrading of the beach, with distinct differences in invertebrate assemblages as compared to those from pre-restoration and reference beach samples. It is unknown whether this is indicative of an early restoration stage, or due to physical alterations caused by the beach regrade.

The 118 taxa sampled in this monitoring detail the diversity that can be obtained within mid to upper intertidal realms, exclusive of lower intertidal elevations. Some are important in processing organic debris, such as talitrids (beach-hoppers) at higher elevations which break down beach-wrack, and oligochaetes and nematodes which live

within sediments. Others are good potential prey items for nearshore fish, including aquatic amphipods and polychaetes which are fed upon by juvenile salmonids.

A major goal of nearshore restoration in Puget Sound should be to establish and maintain connections between terrestrial riparian and aquatic intertidal zones. When this occurs, it facilitates development of secondary responses including natural feeding processes and assemblage interactions. Monitoring in this report has shown that although there are still some differences between the restored and reference sites at Seahurst Park, the restoration has resulted in a positive initial response of the benthic invertebrate community. It will be important to continue to monitor in future years in order to assess long-term site development, especially at the +8 and +5 tidal elevations which were most affected by the beach regrade and sediment nourishment. This monitoring is currently funded for year 5 (2010) and planned for year 10 (2015). Such monitoring will be useful to help guide other restoration opportunities along shorelines of Puget Sound, including the planned restoration of the north seawall at Seahurst Park.

Representative Invertebrates

talitrid amphipod *Traskorchestia traskiana*

aquatic amphipod *Eogammarus confervicolus*

glycerid polychaete worm *Hemipodia simplex*

oligochaete and nematode worms

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Introduction

Shoreline modifications have become a prevalent feature in many aquatic systems worldwide, especially in areas dominated by human populations. In Puget Sound, one third of the natural habitats in nearshore areas are modified by retaining structures, with increased levels near urban centers (Bailey et al. 1998). These retaining structures are usually composed of vertical seawalls and riprap boulder fields. Efforts to restore or enhance intertidal areas have increased in recent years, with listing of Chinook salmon as threatened under the Endangered Species Act in 1999. Endangered ocean-type juvenile Chinook salmon (*Oncorhynchus tshawytscha*) in the Pacific Northwest use estuarine and nearshore habitats early in their outmigration and rearing period (Simenstad et al. 1982). Since juvenile Chinook salmon and other nearshore fishes utilize shoreline areas, the different habitat types that are represented can affect fish abundance, distribution, and behavior patterns (Toft et al. 2007), and survival of eggs in beach spawning surf smelt (Rice 2006). Additionally, removal of supralittoral vegetation correspondent with retaining structures also affects some nearshore fish species (Romanuk & Levings 2006). Negative impacts can also apply to invertebrates, which are an important prey component of many fish (Romanuk & Levings 2003; Sobocinski 2003). Nearshore habitat restoration often emphasizes improving conditions for these important invertebrates, with the goal of enhancing their production to more natural levels and increasing ecological function of the site.

Impacts of shoreline modifications on invertebrate assemblages have been shown to affect community patterns in other systems as well, predominantly in a negative way with decreased or altered assemblages, but with occasional positive interactions attributed to an increase in unique structures that can attract certain organisms (Glasby 1998: Peterson et al. 2000, Spalding & Jackson 2001; Davis et al. 2002; Chapman 2003; Chapman & Bulleri 2003; Cruz Motta et al. 2003). Underlying mechanisms for negative effects are often related to physical alterations associated with truncating and retaining the intertidal zone, such as degrading intertidal habitat and shoreline vegetation, limiting the sediment supply, and reflecting wave energy which can increase erosion and coarsen sediments (Thom et al. 1994; Douglass & Pickel 1999). Research has been lacking to test whether these altered systems can be restored towards natural conditions with removal of the modifications and enhancement of the intertidal beach.

This study describes 2008 year 3 post-restoration monitoring of the benthic invertebrates along the shoreline at Seahurst Park in the City of Burien, where restoration activities completed in February 2005 replaced a 300-m section of seawall/riprap with a more gradual and natural slope, removing the seawall by barge and importing gravel and cobble with upland plantings of riparian vegetation (Fig. 1; USCOE 2003). By incorporating a paired project/reference sampling design and comparing to pre-restoration monitoring in 2004 (Toft 2005) and year 1 post-restoration monitoring in 2006 (Toft 2007), we will be able to begin to assess the restoration effort. Benthic invertebrates in Puget Sound have been shown to be closely linked to physical

characteristics in the benthos, thus making them a suitable metric for analysis (Dethier & Schoch 2005). Benthic cores were taken during three months (June, July, September) and at three different tidal heights (+5, +8 and +12' MLLW) in all years of sampling. Therefore, the main goal of this study was to compare the benthic macroinvertebrate assemblage structure at the restoration site and a nearby reference beach, in order to provide an initial measurement of restoration success.

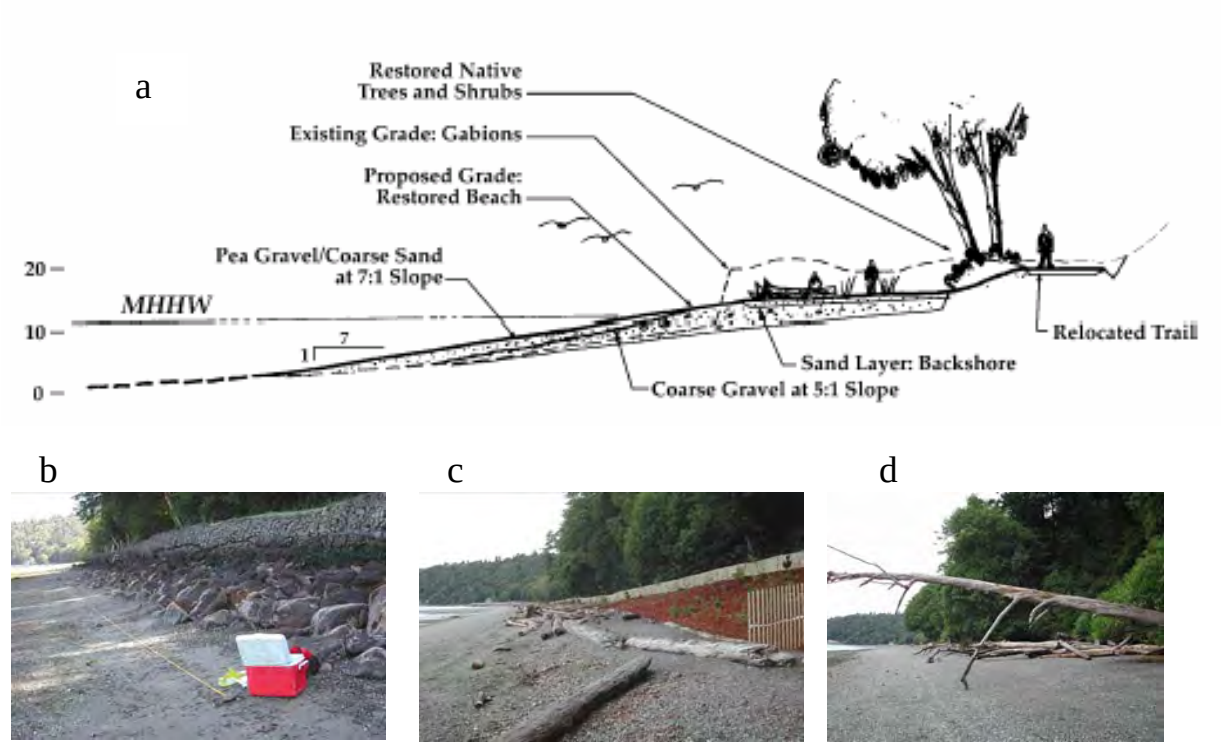

Figure 1. Typical cross section (a) of the plan for restoration at Seahurst Park (USCOE 2003), with photographs of the project site pre- (b) and post-restoration (c), and reference beach (d).

Methods

Two sites were sampled: (1) the seawall removal project site at Seahurst Park (Proj), and (2) the reference beach (Ref) immediately south (~200-m) of Seahurst Park (Fig. 2). Sampling was conducted in June, July and September 2008, identical to past years of sampling (2004 and 2006). June and July represent peak periods of juvenile Chinook and coho (*Oncorhynchus kisutch*) salmonid migration, and September typically represents higher vegetation-wrack depositions (the accumulation of debris deposited by an ebbing tide, consisting mostly of marine algae and organic matter from terrestrial riparian sources such as wood and leaves). Invertebrates were collected at three different tidal heights that spanned the elevations affected by restoration:

(1) +12' MLLW (hereafter +12), approximately the level of MHHW. This area is where beach-wrack is typically formed, and is at an elevation where seawall material was removed at the project site. Thus, during pre-restoration monitoring only the Reference site was sampled at +12, as there was no benthic substrate to sample at the Project site due to the seawall.
(2) +8' MLLW (hereafter +8), the approximate elevation at the foot of the previous shoreline modification at the project site. This elevation provides comparable data where the shoreline modification interacted with the water.
(3) +5' MLLW (hereafter +5), the low elevation of the beach regrade.

Figure 2. Location of Project and Reference transects at Seahurst Park, pre-restoration.

Seven samples were randomly collected with a benthic core along a 30-m transect at each site and tidal elevation. Benthic cores were 10 cm in diameter and taken to a depth of 15 cm. Samples were fixed in 10% formalin and dyed with rose-bengal to aid in sorting and identification. Cobble, mud, wood, and other detritus were removed to the extent possible with sieving at 500 microns, and macroinvertebrates were identified and counted using a dissecting microscope.

Data was entered into Microsoft Excel, and univariate ANOVA tests (alpha = 0.05) were used to analyze total invertebrate densities in the statistical program S-Plus (Zar 1996). Densities were log-transformed to satisfy assumptions of normality and homogeneous variances, and analyzed with a Model I ANOVA (fixed, balanced sampling design with equal replication). Taxa richness was measured as the total number of taxa recorded at each site.

Invertebrate assemblages were analyzed using multivariate statistics: nonmetric multidimensional scaling (NMDS) ordination, analysis of similarity (ANOSIM), and similarity percentage (SIMPER) analysis (Primer version 6 software, Clarke and Warwick 2001). These analyses uncover patterns in multivariate groupings of the data, which is useful when analyzing assemblage datasets with multiple species compositions. Densities were log-transformed for ordination, and species that did not account for more than 3% of the total abundance of any one sample not included. NMDS was used to graphically plot differences in species assemblages onto two-dimensional charts in multidimensional space based on a Bray-Curtis similarity matrix. ANOSIM has been used for testing hypotheses about spatial differences and temporal changes in species

assemblages as well as for detecting environmental impacts (Valesini et al. 2004; Wildsmith et al. 2005). ANOSIM gives a p-value similar to an ANOVA, with values of $p < 0.05$ indicating significance. ANOSIM also generates a value of R to determine biological importance. The R value is scaled between -1 and +1, with a value of zero representing no difference among a set of samples, and the closer the value to 1 the greater the biological importance of the differences. R values above 0.4 are typically found to have biological importance. If differences were found using ANOSIM, then SIMPER analysis was used for identifying which species primarily accounted for observed differences in invertebrate assemblages between sites. SIMPER generates a ranking of the percent contribution of the species that are most important to the significant differences between factors.

Results

General Taxa Composition

A total of 118 taxa were identified during the entire sampling regime. Graphs and analysis are grouped into major taxa groupings, with discussion of species where appropriate. General classification of sampled taxa groupings and species are listed in Table 1. For taxa grouped into general categories, the groups with the highest percent composition were oligochaetes, aquatic amphipods and isopods, terrestrial amphipods, polychaetes, nematodes, and nemertea/turbellaria (Fig. 3). Oligochaetes were the most abundant taxa, and were present at every site. Nematodes were relatively abundant at most sites, except for low percent compositions at Ref +5 2006 and Ref +12 2004 and 2008. Nemertea and turbellaria tended to have highest percent compositions at Ref +8 sites. Densities of terrestrial amphipods and isopods (mostly beachhopper amphipods in the family Talitridae) were most abundant at the +12 elevation, with lower densities at +8, and only four occurrences at +5. While juvenile talitrids usually dominated beachhopper numbers, adults of three species occurred: *Traskorchestia georgiana, Traskorchestia traskiana,* and *Megalorchestia pugettensis* (listed in order of increasing maximum size). As a group, insects (adults and larvae), arachnids (mites-acarina and spiders-araneae), and collembolans (springtails in families Hypogastruridae, Isotomidae, and Sminthuridae) had overall fairly low numbers, with insect adults and larvae mostly at higher elevations, collembola mostly at lower, and arachnids (almost all mites) evenly distributed at all elevations. As would be expected, aquatic crustaceans were most abundant at the lower +5 tidal elevations. Similar to crustaceans, almost all polychaetes had highest densities at the +5 elevation, except for the small archiannelid *Protodriloides chaetifer* which occurred mostly at +8. Mollusks also were present mostly at lower tidal elevations, although overall densities were very low compared to other taxa.

Table 1. Species listing of sampled invertebrates and taxa groups, listed in descending densities within each grouping.

Taxa Grouping	Taxa
Terrestrial amphipods	*Traskorchestia traskiana, Traskorchestia georgiana, Megalorchestia pugettensis,*and juveniles
Terrestrial isopods	*Detonella papillicornis*, and juveniles
Arachnids	Acarina, Araneae
Collembola	Isotomidae, Hypogastruridae, Sminthuridae
Insects	Staphylinidae, Coleoptera larvae, Ephydridae larvae, Chironomidae larvae, Empididae larvae, Chironomidae, Ephydridae, Empididae, Sphaeroceridae, Coleoptera, Muscidae larvae, Coccinellidae, Aphididae, Psocoptera, Chironomidae pupae, Cicadellidae, Formicidae, Hydrophilidae, Ceratopogonidae larvae
Aquatic amphipods	*Eogammarus confervicolus, Allorchestes angusta*, *Paramoera bousfieldi*, *Paramoera mohri*, *Monocorophium acherusicum*, *Grandidierella japonica*, *Americorophium* sp., *Photis* sp., and juveniles
Aquatic isopods	*Gnorimosphaeroma oregonense*, *Exosphaeroma inornata*, *Gnorimosphaeroma insulare*, *Idotea wosnesenskii*, Epicaridea, and juveniles
other rare Crustacea	*Hemigrapsus oregonensis*, Ostracoda, Crangonidae, *Nitokra* sp., Ectinosomatidae, *Cumella vulgaris*, Euphausiacea zoea, *Amonardia perturbata*, *Diosacchus spinatus*, *Harpacticus* sp., *Huntemannia jadensis*, Laophontidae, *Paralaophonte* sp., *Parathalestris californica*, *Amphiascus cinctus*, Porcellidium, Leptastacidae, *Zaus* sp.
Mollusks	*Mytilus edulis*, *Littorina scutulata*, Lottiidae, Cardiidae, and juveniles
Glyceridae polychaetes	*Hemipodia simplex*
Nereidae polychaetes	*Neanthes limnicola, Nereis vexillosa, Platynereis bicanaliculata,* and juveniles
Archiannelid polychaetes	*Protodriloides chaetifer, Nerilla sp.*
other rare Polychaetes	Capitellidae, Spionidae*,* Hesionidae, *Pseudopolydora kempi*, *Armandia brevis,* Phyllodocidae*, Paleanotus occidentale, Eteone californica*, *Pygospio elegans*, *Phyllodoce longipes*, Sabellidae, *Syllis elongata* and juveniles
General taxa groupings	Oligochaete, Nematode, Turbellaria, Nemertea, Foraminifera, Phoronida, Anthozoa

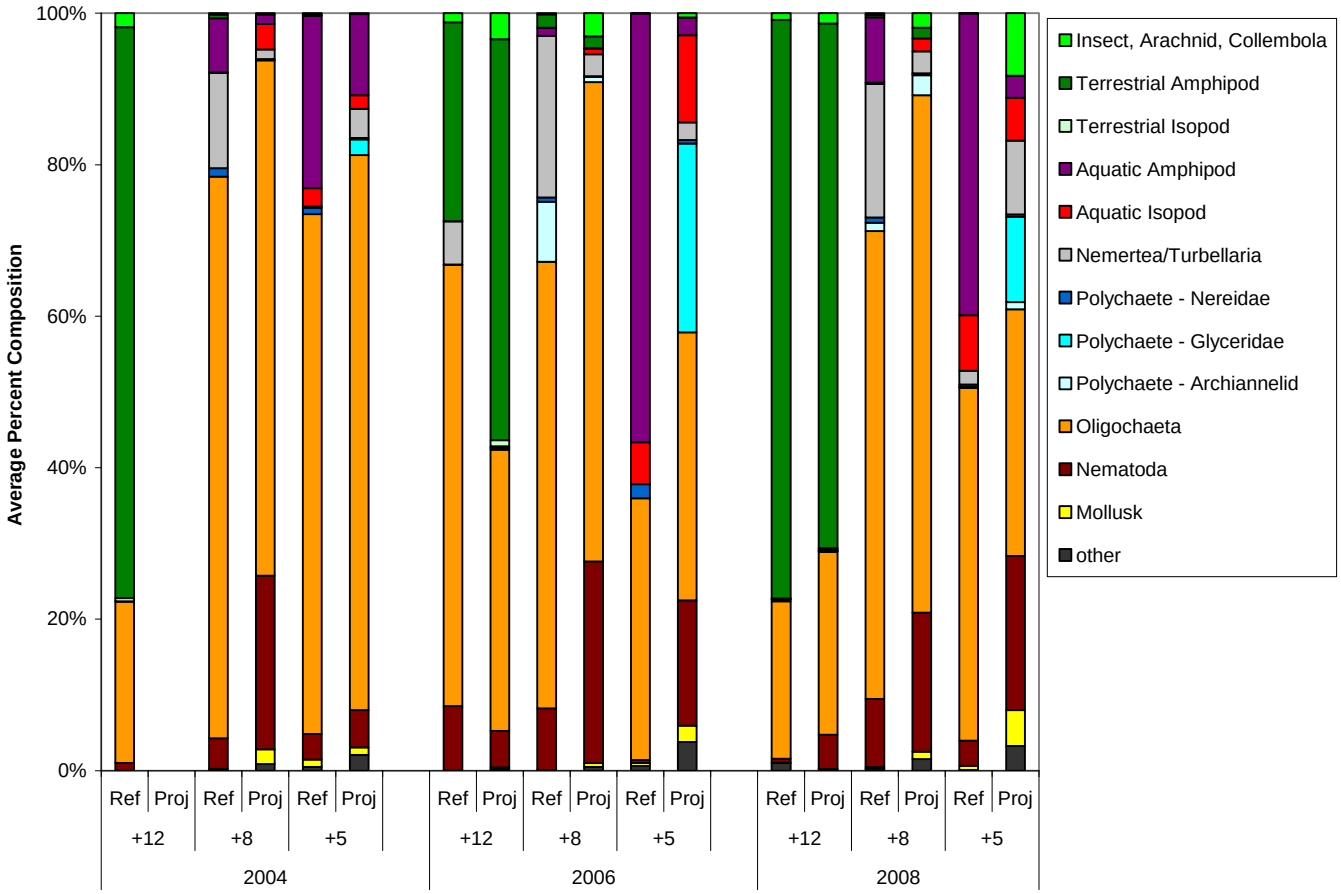

Figure 3. Numerical Percent taxa composition of all sampled invertebrates, showing major taxa groups averaged over June, July, and September for each year. Order in legend reflects that in columns, Ref = Reference, Proj = Project.

<u>2008 Post-Restoration Invertebrates</u>

Results from a 2-way site x month ANOVA with interactions on log-transformed total densities at each elevation showed significantly greater Reference densities at the +8 and +5 elevations, with no site differences at +12 (Table 2, Fig. 4). Although there were also significant site x month interaction differences at +5, separate ANOVAs for each month still showed significantly greater densities at Reference. Month was significant at all elevations, illustrating some seasonal differences in densities. In contrast, the Project site exceeded the Reference site in taxa richness for every elevation (Fig. 5).

Multivariate analysis of the 2008 benthic invertebrate assemblages based on densities proved to be a “useful” model according to statistical guidelines, showing a NMDS ordination 2-d stress of 0.18 (Fig. 6a). The three different elevations grouped distinctly, with separation between the Reference and Project sites at +5, some overlap between the sites at +8, and more overlap at +12. Further analysis with a 1-way ANOSIM on site

showed significant overall results on the Global test, with significant meaningful differences between the Reference and Project sites at the +5 and +8 elevations (Table 3). Although the p-value was also significant at the +12 elevation between Reference and Project, the R-value was low (well below 0.4) showing little biological importance. The subsequent SIMPER analysis details the taxa differences for these significant results (Table 4): (1) at +8 elevation, greater densities of turbellaria, nemertea, and the amphipod *Paramoera* sp. at Ref, with also minor increases in densities of oligochaetes and nematodes at Ref, and (2) at the +5 elevation, greater densities of the amphipods *Eogammarus confervicolus* and *Allorchestes* sp. at Ref, and the Glyceridae polychaete *Hemipodia simplex* at Proj, with minor differences in oligochaetes and nematodes.

As an example of these post-restoration invertebrate assemblage characteristics, the same ordination plot in Figure 6a is shown with bubble plots of the densities of four key taxa identified in SIMPER results (juvenile Talitridae, turbellaria, aquatic amphipod *Eogammarus confervicolus*, and the Glyceridae polychaete *Hemipodia simplex;* Fig. 6b). There is a clear separation at +5 between *E. confervicolus* at Reference and Glyceridae at Project. The +8 elevation shows most of the turbellaria inhabiting Reference sites. And, at +12 juvenile Talitridae amphipods are distributed among both Reference and Project sites.

<u>2004/2008 Pre- and Post-Restoration Invertebrates</u>

Results from a 1-way ANOVA of log-transformed total densities on year for comparable Project +8 and +5 sites from each month showed two months at +8 where 2008 was greater than 2004 (June and September), and two months at +5 where 2004 was greater than 2008 (July and September; Table 2; Fig. 4). Taxa richness was much higher post-restoration at Proj +8, and slightly higher at Proj +5 (Fig. 5).

Multivariate analysis of the benthic invertebrate assemblages pre- and post restoration based on densities proved to be a “useful” model according to statistical guidelines, showing a NMDS ordination 2-d stress of 0.18 (Fig. 7). The three different elevations grouped distinctly, using Project sites from both 2004 and 2008 and Ref +12 from 2004, as there wasn’t a comparable +12 Project site pre-restoration. Proj +12 2008 clustered similar to Ref +12 2004 and away from the pre-restored highest elevation Proj +8 2004. The +5 elevation clustered apart between years, but there was a fair amount of overlap at +8. Further analysis with a 1-way ANOSIM on site showed significant overall results on the Global test (Table 3). At Proj +12, there was no significant differences compared to Ref +12 pre-restoration, but there was compared to the pre-restored highest elevation Proj +8 2004. Proj +8 had few differences 2008 compared to 2004 (low R-value), and Proj +5 had moderately meaningful differences (R-value close to 0.4). The subsequent SIMPER analysis details the taxa differences for these significant results (Table 4), summarized as: (1) much higher densities of Talitrids at Proj +12 2008 compared to the pre-restored highest elevation Proj +8 2004, and (2) at +5, more oligochaetes and juvenile amphipods in 2004, and more of the Glyceridae *Hemipodia simplex* in 2008.

Table 2. Summary ANOVA p-values of total invertebrate significant density differences, p < 0.05 in bold.

2008

2-way ANOVA on site x month

Elevation	Month	Site	Interaction
12'	**0.008**	0.13	**0.002**
8'	**0.0002**	**1.0E-08** (Ref > Proj)	0.35
5'	**0.000002**	**1.0E-09** (Ref > Proj)	**0.005**

Project 2004 and 2008

1-way ANOVA on site

Elevation	Month	
Proj +8'	June	**0.0001** (2008 > 2004)
	July	0.73
	Sept	**0.001** (2008 > 2004)
Proj +5'	June	0.24
	July	**0.0000009** (2004 > 2008)
	Sept	**0.003** (2004 > 2008)

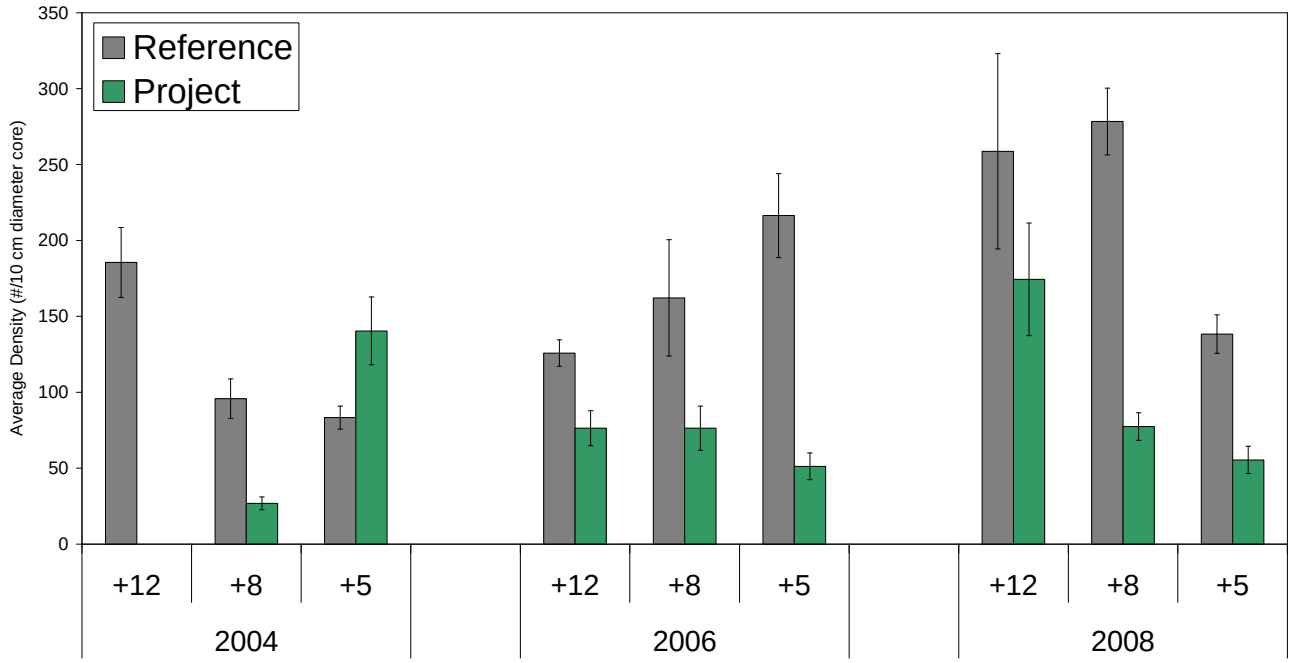

Figure 4. Total average invertebrate densities for all sites in 2004 (pre-restoration), 2006 and 2008 (years 1 and 3 post-restoration). Error bars represent Standard Error.

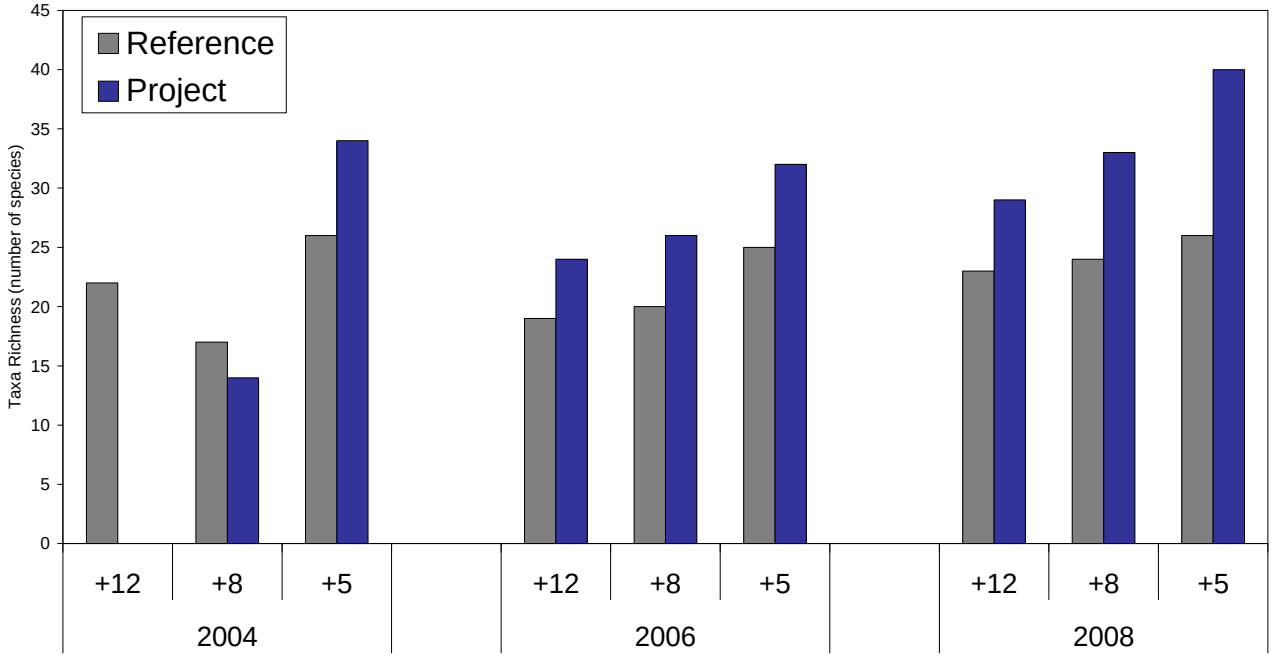

Figure 5. Overall taxa richness for all sites and years.

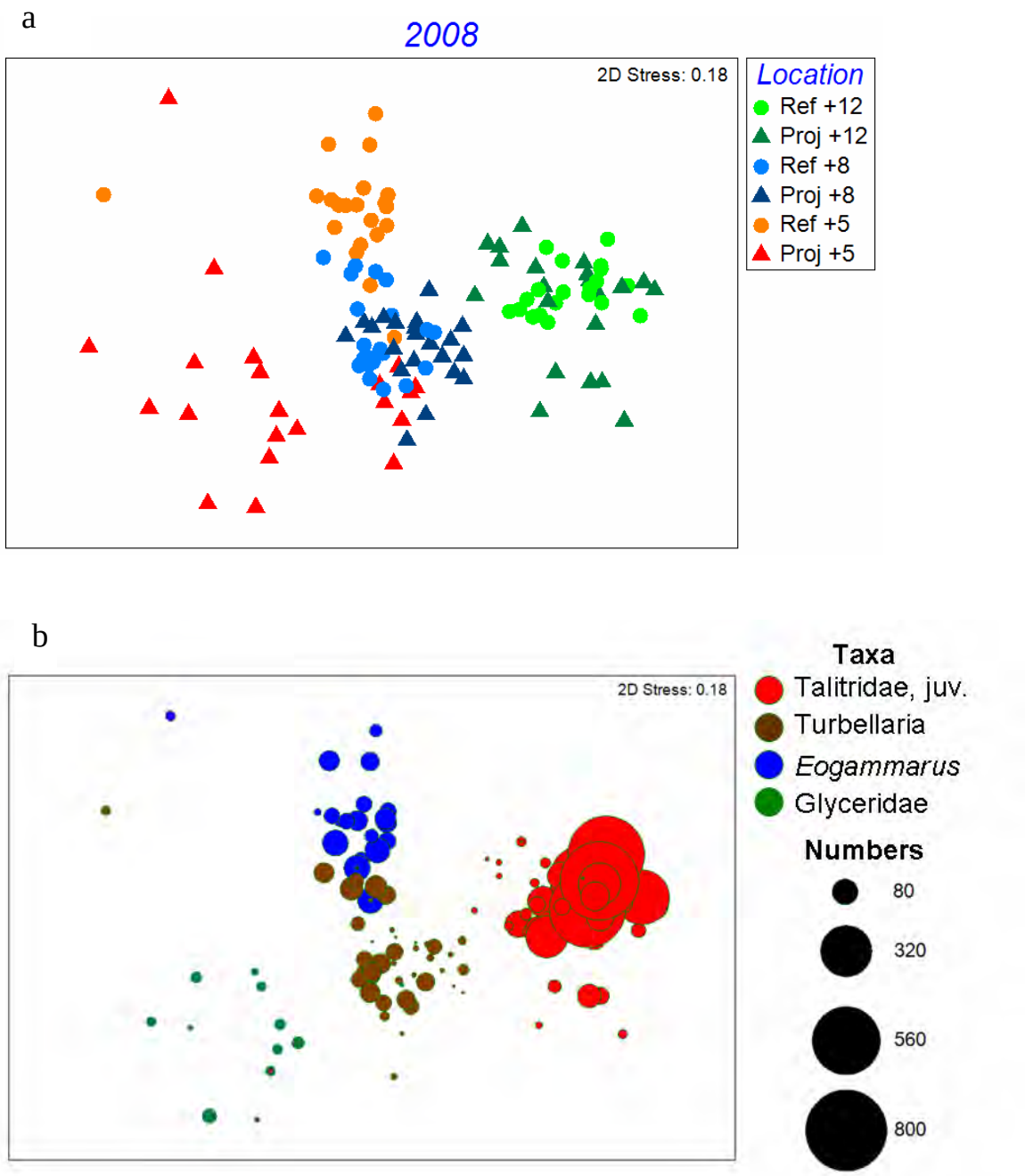

Figure 6. Multivariate analysis using NMDS ordination of the benthic invertebrate data (each symbol represents the invertebrate assemblage in a single sample) in (a) 2008, and (b) corresponding bubble plot of numbers of representative taxa, positions of bubbles correspond to points on 2008 NMDS ordination. Taxa: juvenile terrestrial amphipods (Talitridae), flatworms (Turbellaria), aquatic amphipods (*Eogammarus confervicolus*), and the polychaete *Hemipodia simplex* (Glyceridae).

Table 3. Summary ANOSIM statistics using multivariate analysis on invertebrate assemblages. ANOSIM is equivalent to a univariate ANOVA, with high biological importance illustrated by R > 0.4 and significant differences p < 0.05.

2008		
Site Comparison	R-value	p-value
Global test	0.68	0.001
+12 Proj & Ref	0.08	0.022
+8 Proj & Ref	0.68	0.001
+5 Proj & Ref	0.57	0.001

Project 2008 and 2004		
Site Comparison	R-value	p-value
Global test	0.53	0.001
Proj+12 2008 & Ref +12 2004	0.001	0.387
Proj+12 2008 & Proj +8 2004	0.65	0.001
Proj+8 2008 & 2004	0.21	0.001
Proj +5 2008 & 2004	0.38	0.001

Table 4. Summary SIMPER statistics using multivariate analysis on invertebrate assemblages. SIMPER analyzes the taxa that have the largest contributions to statistical differences (top 5 in each category included).

2008	Average log-densities		
+8 Proj & Ref (avg. dissimilarity 48.5)	**Project**	**Reference**	% Contribution
Turbellaria	0.69	3.39	20.2
Nemertea	0.11	2.28	16.6
Oligochaeta	3.79	5.07	10.0
Paramoera sp.	0	1.2	7.5
Nematoda	2.52	2.77	7.3
+5 Proj & Ref (avg. dissimilarity 71.1)			
Eogammarus confervicolus	0.12	3.35	17.1
Oligochaeta	1.83	3.89	13.1
Hemipodia simplex	1.28	0.05	7.1
Allorchestes sp.	0.47	1.11	6.5
Nematoda	2.08	1.38	6.4

Table 4 continued

Project 2008 and 2004	Average log-densities		
Proj+12 2008 & Proj +8 2004 (avg. dissimilarity 69.1)	**2008**	**2004**	% Contribution
Talitridae, juv.	3.56	0	29.2
Traskorchestia traskiana	1.9	0	14.9
Oligochaeta	2.96	2.52	14.5
Nematoda	0.99	1.51	12.8
Traskorchestia georgiana	1.13	0	8.3
Proj +5 2008 & 2004 (avg. dissimilarity 70.2)			
Oligochaeta	1.83	3.66	15.4
Hemipodia simplex	1.28	0.49	7.6
Nematoda	2.08	1.42	7.6
Amphipod, juv.	0	1.42	7.5
Turbellaria	0.9	1.4	7.4

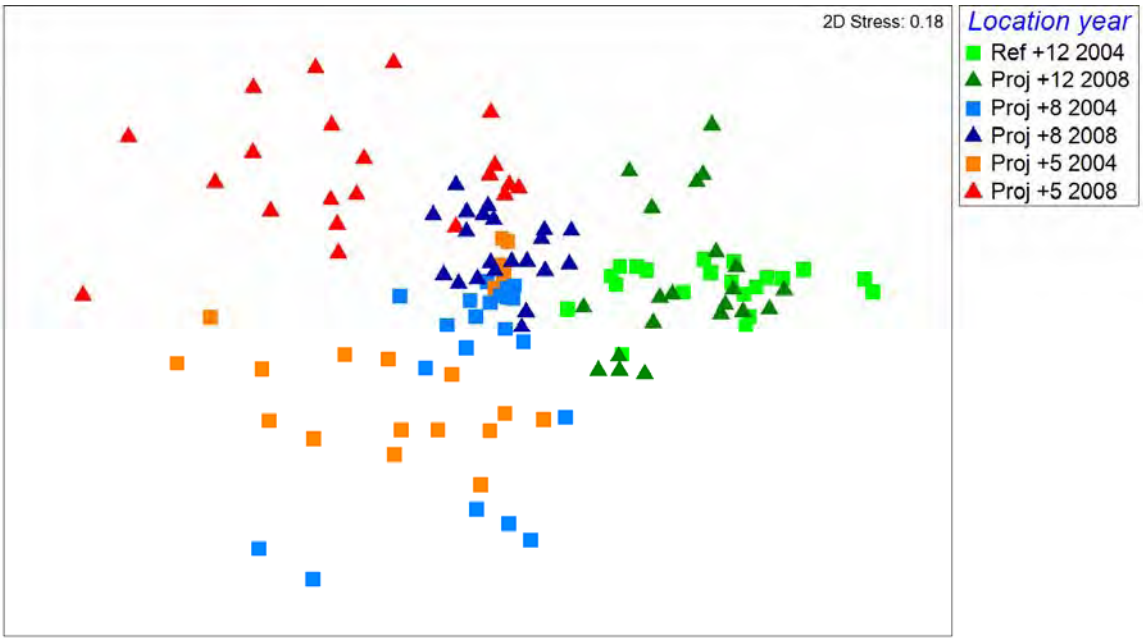

Figure 7. Multivariate analysis using NMDS ordination of the benthic invertebrate data for Project sites in 2008 (post-restoration) versus 2004 (pre-restoration), with Ref +12 2004 as a comparison since no Proj +12 site existed pre-restoration.

Discussion

It is clear that after the third year of beach restoration at Seahurst Park that some aspects of the invertebrate community have improved since pre-restoration conditions and shifted towards those at the reference site, while others are still in development. Before restoration, the seawall truncated the supratidal and high intertidal zone, causing lack of shoreline riparian vegetation and preventing formation of beach-wrack deposition that is typical of a natural gradual sloping beach. By removing the seawall and restoring the natural beach gradient along with plantings of terrestrial vegetation, the processes that were negated by the presence of the seawall can begin to re-develop. Beach-wrack formation at high tidal elevations now occurs at the project site, with development of invertebrate assemblages that are typical of the reference beach and unique to those at the highest tidal elevation. Although overall densities at lower tidal elevations are still not as high as the reference site, taxa richness is greater, signifying a good initial colonization of a diversity of invertebrates that will hopefully continue to increase in number with time.

Results of the invertebrate sampling can best be discussed in relation to the different tidal elevations characterized by the restoration activities at each elevation. At the +12 elevation, there was previously a seawall that prevented wrack formation and a benthic assemblage prior to restoration. Since restoration, an initial colonization of invertebrates has occupied this site with high taxa richness and similar invertebrate assemblages to the Reference site, with equal densities. Terrestrial amphipods (beachhoppers in the family Talitridae) are typical of this elevation, thriving on beach wrack deposition. This wrack-dependent community has been found to be unique in other systems as well, with important links to terrestrial zone productivity (Dugan et al. 2003; Ince et al. 2007). Overall, invertebrate assemblages at this elevation have been restored to the conditions at the reference beach, progressing to this status since the initial year 1 monitoring (Toft 2007).

The +8 elevation was previously the location at the base of the seawall, and therefore subject to physical alterations in sediments and wave activity that altered the invertebrate community. Taxa richness was low, and invertebrate assemblages were different than comparable elevations at the Reference site, with lower densities (Toft 2007). Invertebrates have occupied this elevation since restoration, resulting in high taxa richness that was almost double that of pre-restoration levels and higher than the reference site. However, even though two of the months had higher densities than pre-restoration levels, the densities are still lower than the Reference site. Hopefully these encouraging initial trends will continue to develop in future years, mainly in numbers of amphipods and other invertebrates.

The +5 elevation was below the base of the seawall, at the low level of the regrade of the restored beach. There were no major significant differences between densities or assemblages before restoration, with taxa richness actually being highest at the project site. This could possibly be due to invertebrate colonization being hindered by physical

alterations at the base of the seawall at Proj +8 and thereby occupying lower tidal elevations, additionally supported by sediment samples which showed higher sediment sizes (gravel) at the project site than at the reference site (medium sand; Sobocinksi 2003). The necessary regrade of the beach at this elevation as part of the restoration affected the invertebrate community, leading to reduced densities and a dramatic shift in invertebrate assemblages, albeit with high taxa richness. The restored site had less amphipods and oligochaetes and more Glyceridae polychaete worms in both years of monitoring post-restoration. The reasons for these alterations in the invertebrate community are unknown, and could be indicative of an early restoration stage. However, the differences could also be the result of different habitat qualities specific to the restored and reference sites, such as physical alterations caused by the beach regrade and changes in sediment size. Physical properties sampled at the beach have shown that beach profiles and sediments are similar between the restored and reference beaches, with minor changes over time (Johannessen and Waggoner 2008). The same report noted that this elevation is at the upper extent of freshwater seepage, so interchange between freshwater and saltwater environments may be different between the two sites. Future sampling could help to explain these types of differences: if invertebrate communities converge with time, or if more physical data can be collected at this elevation.

It is important to acknowledge that these initial responses have occurred in just a few years – baseline monitoring in 2004, seawall removal and restoration in 2005, and post-restoration monitoring in 2006 and now 2008. A five-year timeline has been suitable for measuring effects of the seawall and early development of the site after beach restoration, but it is clear that long-term monitoring will be necessary to completely gauge aspects of restoration success or failure especially at the +8 and +5 elevations. However, it does appear that after a relatively short post-restoration recovery period an invertebrate community can partially recruit and establish on a restored beach, with questions remaining on the stability of those communities and their development through time.

Initial responses of nearshore beach restoration may be comparable to those of beach nourishment, in which sediment is added to beaches in order to prevent erosion of coastal habitats. Research on impacts of beach nourishment has shown mixed results (Nordstrom 2005), with effects on sediments and invertebrates being linked to local conditions (Colosio et al. 2007). It remains unknown whether beach restorations such as at Seahurst Park will require additional beach nourishment over time, or if sediments and beach slope will remain stable. However, physical monitoring has indicated that beach renourishment should not be required in the near future based on current rates of sediment transport (Johannessen and Waggoner 2008).

Since the removal of the seawall, presumably both benthic invertebrates and terrestrial insects have been made more available to juvenile salmonids and other nearshore fish as potential prey items. The type of indirect measure of productivity measured with invertebrate assemblages in our study can be said to increase the “opportunity” that juvenile salmon have to access and benefit from the site (Simenstad & Cordell 2000).

Although insects have not been sampled since restoration, previous efforts showed that the Seahurst reference site had a productive riparian zone, with greater taxa richness and differences in density and diversity of insects as compared to the pre-restoration seawall (Sobocinksi 2003). Studies from other systems have shown similar results of reduced supralittoral insect communities in association with armoring (Romanuk & Levings 2003). Datasets from fish netting in the surrounding area have shown major prey items of juvenile Chinook salmon to be epibenthic/benthic invertebrates and terrestrial insects (Brennan et al. 2004), with a decrease in riparian insect feeding when shorelines have artificial retainments (Toft et al. 2007). This entire context places emphasis on restoration of nearshore processes, in order to increase the opportunity of nearshore feeding by juvenile salmonids.

Two large scale organizations have recently been initiated to help guide the restoration of Washington State's Puget Sound waters: The Puget Sound Partnership (PSP), and the Puget Sound Nearshore Ecosystem Restoration Partnership (PSNERP). Both list shoreline armoring as a major threat to the health of Puget Sound. The goal of PSP is to create a comprehensive action agenda to restore Puget Sound by the year 2020, and they list shoreline armoring as one of the major threats to ecosystem processes in Puget Sound (PSP 2009). PSNERP also is creating guidelines and conceptual models at the ecosystem processes level, and they further state that shoreline armoring is a source of stress to the nearshore and that bulkhead removal should be a focus of restoration actions (Simenstad et al. 2006). It is clear that a more complete understanding of shoreline armoring removal and restoration of the nearshore will add greatly to the knowledge of whether the goals of these programs can be reached.

In summary, it becomes apparent that a major goal of nearshore restoration in Puget Sound should be to establish and maintain connections between terrestrial riparian and aquatic intertidal zones. When this occurs, it facilitates development of secondary responses including natural feeding processes and assemblage interactions. Monitoring in this report has shown that although there are still some differences between the restored and reference sites at Seahurst Park, the restoration has resulted in a positive initial response of the benthic invertebrate community. It will be important to continue to monitor in future years in order to assess long-term site development, currently funded for year 5 (2010) and planned for year 10 (2015). Such monitoring will be useful to help guide other restoration opportunities along shorelines of Puget Sound, including the planned restoration of the north seawall at Seahurst Park.

Acknowledgements

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APPENDIX G
LANDSLIDE DEBRIS MANAGEMENT DOCUMENT

Seahurst Park
Standard Maintenance Practice

Clean-up of Slide Materials

The upland slopes surrounding Seahurst Park are seated on unstable soils and prone to experience shallow landslides approximately once every other year. Winter weather conditions saturate soils on the sleep slopes exacerbating the condition by making the unstable slopes even more prone to minor slides. Most slides are small consisting of 10 to 100 yards of material. It is common for these small shallow landslides to incorporate trees and other woody materials into the slide.

Consistent with the effort to restore natural processes that create ideal marine habitat, the City of Burien will allow materials from landslides to remain on the beach where there exists no hazard to public use of the park. Where landslide materials interfere with the trail, maintenance access road or other appurtenant structures located in the backshore of the Southern beach, the City will restore public access by removing the slide materials. These materials, including large woody debris will be retained on site and deposited in the upper backshore, between the upper backshore at +15' MLLW but no lower than +11.6' MLLW (MHHW). The City will re-vegetate slide areas with native plant species as part of the City's ongoing effort to eliminate invasive plant species within the park.

This policy was developed with the understanding that slide materials and associated vegetation should be retained within the nearshore to nourish the beach with new sand, gravel and woody debris that create ideal habitat for salmon, eelgrass and forage fishes found naturally in the Puget Sound. In its effort to balance the benefits of public recreational access and environmental sensitivity, the City will make every effort to not interfere with the natural processes that support ideal marine habitat.

APPENDIX H
SUBSTANTIVE COMPLIANCE FOR SECTION 404 OF THE CLEAN WATER ACT AND THE RIVERS AND HARBORS ACT

Substantive Compliance for Section 404 of the Clean Water Act and the Rivers and Harbors Act

Seahurst Park Nearshore Restoration Burien, King County, Washington
Substantive Compliance for Section 404 of the Clean Water Act and the Rivers and Harbors Act

The purpose of this document is to record the Corps' evaluation and findings regarding this project pursuant to Section 404 of the Clean Water Act (CWA) and the Rivers and Harbors Act (RHA). This document covers the removal of existing intertidal obstructions and placement of sand and gravel substrate from an upland source on the beach along the southern shoreline of Seahurst Park in the City of Burien, King County, Washington.

This document addresses the substantive compliance issues of the Clean Water Act 404(b)(1) Guidelines [40 CFR §230.12(a)] and the Regulatory Programs of the Corps of Engineers [33 CFR §320.4(a)].

1. BACKGROUND

1.1 **Project Location**

The project area is located along the beach on the east shore of East Passage, Puget Sound, within the City of Burien, King County, Washington (SE¼, Section 13, Township 23 North, Range 3 East, Willamette Meridian). Seahurst Park is a wooded 153-acre park located on the shoreline of Puget Sound. The park was transferred from King County to the City of Burien upon its incorporation in 1972. The park is used for community recreation and includes beach access, picnic structures, educational features and walking paths.

1.2 **Project History**

Seahurst Park's approximately 4,500 linear feet of shoreline include a mix of bulkheaded and unbulkheaded conditions stemming from park development in the early 1970s. This park development has negatively impacted the ecological functions of the park habitats. Specifically, shoreline armoring has displaced the park's natural intertidal and riparian habitats and disrupted beach stability and the sediment supply regime. Seahurst Park is the largest park in the City of Burien and attracts residents, visitors, and school groups from the Puget Sound metropolitan area. The large open space at Seahurst Park provides residents and other visitors with beautiful vistas of the water, beaches, and upland forests. The park's north shoreline is home to the Marine Technology Lab building (MTLB) educational facility, which provides training for high school students in marine related vocational skills. An environmental education center was completed in 2009 near the MTLB, called the Environmental Science Center (ESC), to provide a home for programs currently being held at the park for K-12 students and families by a non-profit organization called the Environmental Science Center Foundation.

In order to address a wide range of community and environmental issues, a master plan was developed with extensive public involvement and resulted in an integrated approach to shoreline habitat restoration, recreation improvements, and environmental education support facilities. Improvements in these three areas were identified at the north and south portions of the park's shoreline. Preservation of existing natural habitats along the park's shoreline and upland areas is also a key component of the Master Plan.

Implementation of the Master Plan began with the south shoreline portion of the park. Restoration of the south shoreline was a high priority for the City and USACE. The failing bulkheads in this portion of the park were unsafe to beach users and negatively impacted shoreline habitat for federally listed threatened species such as Puget Sound Chinook salmon (*Oncorhynchus tshawytscha*), and forage fish such as Pacific sand lance (*Ammodytes hexapterus*) and surf smelt (*Hypomesus pretiosus*), which are key food resources for listed salmon (Anchor 2002). The City and USACE subsequently entered into a project partnership agreement (PPA) to restore the southern 1,400 linear feet of the park shoreline. Federal funding came from the Puget Sound and Adjacent Waters (PSAW) program in 2004 and construction began late that year, ending in early 2005. The restoration removed a gabion bulkhead with riprap toe protection and restoring a natural sand and gravel beach. Extensive physical and biological monitoring of the south shoreline started prior to 2004 and is continuing. Monitoring has demonstrated that the restoration is performing well and that targeted habitats and species are colonizing and using the south shoreline.

1.3 **Project Authority**

The proposed Project is authorized by Section 544 of the Water Resources Development Act of 2000 (Public Law 106-541, December 11, 2000), which authorizes implementation of critical restoration projects in the watersheds that drain directly into Puget Sound.

1.4 **Need and Purpose**

Shoreline alterations and shoreline development have contributed to the marked decline of the Puget Sound ecosystem. Among the most common modifications to the nearshore is the installation of shoreline armoring (*e.g*., bulkheads and revetments), which disconnects coastal bluffs and riparian habitats from the intertidal zone and often encroaches into the intertidal zone, thereby reducing aquatic habitat. Along the eastern shoreline of South Central Puget Sound, shoreline armoring is present in more than 60 percent of the shoreline. Seahurst Park is situated near the "up-drift" end of the longest net shore drift or "drift cell" in South Central Puget Sound. In fact, the drift cell extends north more than 10 miles to Duwamish Head in Seattle. In the drift cell in which Seahurst Park is located, more than 87 percent of the shoreline is armored and more than 70 percent of the armoring extends into the intertidal zone. The extensive shoreline armoring in the drift cell has severely reduced sediment supplies into the nearshore system.

The alterations to Puget Sound and its nearshore environments have directly reduced the amount of nearshore habitat and otherwise impaired the natural processes that create and sustain habitats. Restoration of Puget Sound shorelines has been a priority of ecosystem based restoration planning, such as the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) underway by the Seattle District of the USACE and Washington

Department of Fish and Wildlife (WDFW). In Seahurst Park, restoration is needed because extensive shoreline armoring present in the park has interrupted natural sediment transport processes and significantly degraded habitat function within and beyond the park boundaries. A seawall and riprap occur along approximately 2,075 linear feet of the Project Area, preventing coastal bluff sediment supplies from reaching the intertidal zone, thereby reducing the amount of beach sediment. The structures also alter wave energy dissipation along the shoreline and cause more longshore and cross-shore (offshore) transport of sediment than would occur naturally.

2.0 Availability of Less Environmentally Damaging Practicable Alternatives to Meet the Project Purpose.

The alternatives evaluated for this project were as follows:

2.1. Alternative 1 (No Action). Under the "No Action Alternative," shoreline armoring removal would not take place. No additional substrate would be placed at Seahurst Park. Damage to existing shoreline armoring structures would continue and the beach conditions, over time, would continue to be degraded and net shore drift impeded. The beach would gradually become steeper and the area and value of intertidal habitat would be reduced as a result. Maintenance costs to repair the structures would increase over time. Intertidal habitat loss would continue through lack of material normally provided by littoral drift. The "No Action Alternative" would not meet the need and purpose of the project, the local sponsors or the environment. Therefore, the no action alternative is considered to be a less practicable alternative to nearshore restoration.

2.2. Alternative 2 (Proposed Action). Alternative 2 consists of removal of approximately 84 percent of the Project Area armoring. In addition to the armor (concrete wall and rock) protecting the MTLB, the armor for the North Picnic Shelter (wall and rock) immediately south of the MTLB is left in place as well. This latter section of shoreline includes beach nourishment over the armor. Most of the armor is removed, and other shoreline restoration goals are largely achieved. Armor rock waterward of the MTLB is relocated landward to the toe of the wall to maximize the extent of beach restoration. Tidepools are proposed in this toe armor rock for educational purposes and habitat diversity. In addition to the approximately 84 percent armor removal, beach nourishment, topographic restoration, and revegetation are included. A drift sill is included in order to reduce long-term maintenance of the restored beach to the south. Partial beach nourishment is proposed at three locations north of the MTLB in conjunction with groin removal. The northern groin will be removed by the sewer district as mitigation for their shoreline sewer upgrade. For the southern groin, partial removal is proposed with shortening and reconstruction into a shorter drift sill in association with the nourishment described above. This alternative creates a restored North Creek mouth with a freshwater wetland of a small scale, while responding to site constraints. This freshwater wetland approach is intended to address uncertainties and risks associated with creating a regularly tidally-inundated wetland in this location, particularly with the armoring in place and new return wall for the North Picnic Shelter. The outlet of North Creek is proposed to be oriented in a southwesterly direction downstream of the proposed culvert under the main path. The wetland will consist of a shallow, widened swale that collects the freshwater from North Creek and two small perennial streams to the south. The wetland swale would be 15 to 35 feet wide and approximately 300 feet long. The outlet of the

proposed freshwater wetland would be designed to flow through the backshore berm to the foreshore beach face in a natural manner, without any hard structures, similar to the existing creek mouth at South Creek. Riparian vegetation would border the wetland on the upland side, and backshore vegetation would border the wetland on the beach side. Full riparian/backshore restoration is proposed in all areas except where armoring remains. Where armoring remains, partial riparian/backshore revegetation is proposed. This alternative allows for continued use of the park for both recreational and educational purposes. A replacement, off-channel fish ladder and holding pond for the MTLB hatchery operations is provided. It is located on the water side of the MTLB, separate from the North Creek. Recreation facilities are relocated at the south end of the Project Area, near the restroom. These facilities include a relocated lawn, play area, and parking area. These relocations allow park uses to be consolidated in a location where topography and shoreline conditions do not require extensive armoring. Relocated parking is proposed to use pervious paving to infiltrate water and include rain gardens for water quality treatment.

2.3. Alternative 3. (Varying degrees of shoreline removal along with beach nourishment). Under this alternative, varying degrees of shoreline armor is proposed for removal, and beach material of a composition similar to areas found updrift would be placed in front of the shoreline armoring structures to recreate appropriate grain size and slope characteristics. In many areas around Puget Sound, planners have looked towards placing beach nourishment in front of hardened structures to mimic natural processes and although the success of these measures varies, the concept appears to return some natural function to degraded beaches for varying lengths of time. The beach bluffs updrift of the project site would be relied upon to continue feeding the placement site and contribute to its longevity. Benefits from this alternative should be seen in improved juvenile salmonid habitat as well as increased invertebrate production. Forage fish spawning is a potential benefit so long as sediment longevity and wave action don't preclude spawning success. Tributary conditions would remain unchanged although the placement of nourishment may contribute to sediment aggregation at the tributary mouth since it is located downdrift of the placement site. Vegetation benefits would be minimal, as recruitment to the nearshore of woody debris would be restricted by the remaining shoreline armoring. Over the long term the nourishment material would be moved along the littoral drift cell and the beach would return to its pre-project composition. The shoreline armoring would remain an impediment to upper intertidal production and upland connectivity. Additional material would be required periodically to achieve desired results at the site. Therefore, this alternative is considered to be a less practicable alternative to maximum nearshore restoration.

Findings. The Corps rejected Alternatives 1, and 3 because they would either not meet the authorized project objectives, or they were not considered less environmentally damaging alternatives than the proposed action.

3.0 Significant Degradation, Either Individually or Cumulatively, To the Aquatic Environment

3.1 Impacts on Ecosystem Function. Intertidal habitats on and adjacent to the project area at Seahurst Park will be disturbed by the restoration construction. The Corps has assessed potential impacts from the construction and determined that they will generally be highly localized in

nature, short in duration, and minor in scope. Impacts of the work on salmonids, other fish, and intertidal communities will be reduced and/or avoided through implementation of timing restrictions and BMP's, including pre-construction forage fish monitoring. Due to these measures, impacts to these important resources should not be significant either individually or cumulatively.

3.2. Impacts on Recreational, Aesthetic and Economic Values. Construction equipment may temporarily disrupt recreational use in Seahurst Park in the vicinity of the project area. However, no significant adverse effects on recreation, aesthetics, or the economy are anticipated. The removal of intertidal fill and placement of material onto the beach will eliminate the conversion of current high intertidal beach to subtidal beach and improve nearshore connectivity and function allowing for continued use of the shore for recreational purposes.

Findings. The Corps has determined that there would be no significant adverse impacts to aquatic ecosystem functions and values or recreational, aesthetic, and economic values.

4.0 Appropriate and Practicable Measures to Minimize Potential Harm to the Aquatic Ecosystem

4.1. Impact Avoidance Measures. Potential impacts of the proposed work on salmonids will be avoided through the implementation of timing restrictions. For the protection of bull trout and out migrating juvenile salmonids, work will not occur during the juvenile outmigration period or the bull trout work closure period, 15 February through 15 July. To avoid impacts to forage fish, pre-construction monitoring will be conducted at the site. To avoid impacts to water quality, all beach fill material shall be placed in the dry during periods of low tide and earthmoving equipment shall remain landward of the toe of the beach fill at all times (except to retrieve non-native angular rock in the lower intertidal zone for disposal). To further avoid potential impacts, washing of material from barges or placement of fill by hydraulic means is prohibited and no part of any beached barge may rest on the bottom below an elevation of –2.0' MLLW.

4.2 Impact Minimization Measures. Transportation of material between the beach and the barge must be carried out within a clearly marked 50-foot-wide access zone. The access zone shall remain unchanged throughout construction. Beach nourishment material will be placed in the intertidal zone, thereby mimicking natural sediment erosion and transport processes to the maximum extent practicable.

4.3. Compensatory Mitigation Measures. The beach nourishment program is considered to be self-mitigating. Environmental monitoring will be conducted to confirm both benefits and impacts of the project.

Findings. The Corps has determined that all appropriate and practicable measures have been taken to minimize potential harm.

5.0 Other Factors in the Public Interest.
5.1. Fish and Wildlife. The Corps has coordinated with State and Federal agencies to assure

careful consideration of fish and wildlife resources. The Corps will continue to coordinate with State Fish and Wildlife agencies and has prepared a Biological Evaluation in accordance with the Endangered Species Act. The Corps will assure full compliance with the Endangered Species Act prior to project implementation.

5.2. Water Quality. A Public Notice will be prepared and will serve as an application for a Section 401 Water Quality Certification from the Washington Department of Ecology (Ecology). Ecology is expected to issue a Water Quality Certification for the work proposed for the fall of 2011. The Corps will abide by the conditions of the State issued Water Quality Certification to ensure compliance with State water quality standards.

5.3. Historic and Cultural Resources. No vehicle, equipment, staging or other direct or indirect disturbances are planned near any known sites. Direct soil disturbances as part of this project would occur entirely on top of fill placed originally in the 1970's. Beach substrate placement on the existing beach profile would not result in loss or damage of any unknown cultural resources sites. The work would not adversely affect salmonid populations or impair fishing sites reserved by treaties for Native American use. Although Native Americans historically used the area for collection of shellfish and for fishing, the tribes do not currently use Seahurst Park directly for such purposes. The project has been coordinated and approved by the Washington State Historic Preservation Office.

5.4. Activities Effecting Coastal Zones. The proposed action will restore the project area to a state comparable to its natural condition. Rock removal work will remain within the footprint of the original project, and will not cause substantial adverse effects to shore resources or the environment. Beach material placement will consist of clean materials suitable in size and quantity for natural beach processes. Pursuant to Section 173-27-040 and 173-27-060 of the Washington Administrative Code, the Corps determined that this proposal is consistent to the maximum extent practicable with the State of Washington Shoreline Management Program. A consistency statement will be prepared and submitted to the Department of Ecology for review and concurrence.

5.5. Environmental Benefits. The proposed nourishment project would stop the conversion of the beach along Seahurst Park from a gravel intertidal beach to a subtidal gravel, cobble and clay beach and improve upland connectivity and littoral transport. The removal of fill and improvements to the beach profile would maintain the range of intertidal elevations necessary to support forage fish spawning, epibenthic invertebrates which serve as prey for a wide variety of birds and increase productivity for marine fishes.

5.6. Navigation. No adverse effects to navigation will occur as a result of the proposed restoration work.

Findings. The Corps has determined that this project is within the public interest.

6.0 Conclusions. Based on the analyses presented in project NEPA documents, as well as the following 404(b)(1) Evaluation and General Policies for the Evaluation of Permit Applications analysis, the Corps finds that this project complies with the substantive elements of Section 404

of the Clean Water Act and the Rivers and Harbors Act.

7.0. 404(b)(1) Evaluation [40CFR§230]- Potential Impacts on Physical and Chemical Characteristics (Subpart C)

7.1 Substrate [230.20]. The existing intertidal beach substrate consists of small gravel with patches of coarse sand, cobble and boulder. On average, the beach material grain size gradations for the intertidal beach will mimic those of the natural material. The size of the new material will closely mimic that which was naturally present.

7.2 Suspended Particulate/Turbidity [230.21]. Any increases in turbidity resulting from the proposed action would as a result of the grain size of the beach material. The material will be selected to minimize excessive amounts of fines. Any sediment plumes attributable to the resultant material would be temporary, localized, and equivalent to those created by natural sediment transport processes. Water quality monitoring during construction will be conducted to ensure adequate water quality protections.

7.3 Water Quality [230.22]. No significant water quality effects are anticipated (see 7.2 above).

7.4 Current Patterns and Water Circulation [230.23]. The removal of the nearshore structures and placement of beach materials will not obstruct flow, change the direction or velocity of water flow/circulation, or otherwise notably change the dimensions of the receiving water body. The material to be placed on the intertidal beach is expected to contribute to the littoral drift system and has been specifically selected to mimic the native sediment characteristics. In the vicinity of the project, the net alongshore drift appears to be toward the north.

7.5 Normal Water Fluctuations [230.24]. The discharge of nourishment materials will not impede normal tidal fluctuations. Beach material will be placed high in the intertidal zone, thereby mimicking natural sediment erosion and transport processes to the maximum extent practicable. The proposed project would restore the conversion of the beach from a high intertidal beach to a subtidal bench. Loss of material to littoral drift and wave action is expected to occur but is not expected to cause degradation of the Seahurst Park beach.

7.6 Salinity Gradients [230.25]. The discharge of beach materials will not divert or restrict tidal flows or affect salinity gradients (see 7.5. above).

8.0 404(B)(1) EVALUATION [40 CFR §230]- Potential Impacts on Biological Characteristics of the Aquatic Ecosystem (Subpart D)

8.1 Threatened and Endangered Species [230.30]. Pursuant with Section 7 of the Endangered Species Act, the Corps prepared a Biological Evaluation (BE) to assess potential impacts of the proposed work on species protected under the Act. This document concluded that the Seahurst Park Restoration Phase II project may affect, but is not likely to adversely affect Puget Sound (PS) Chinook (*Oncorhynchus tshawytscha*), PS steelhead (*O. mykiss*), coastal/PS bull trout (*Salvelinus confluentus*), marbled murrelet (*Brachyramphus marmoratus*), and southern resident killer whale (*Orcinus orca*). The project will have no effect on Steller sea lion (*Eumetopias*

jubatus), humpback whale (*Megaptera novaeangliae*), and leatherback sea turtle (*Dermochelys coriacea*). The project may affect, but is not likely to adversely affect critical habitat for Chinook, bull trout, and leatherback sea turtles. The project will have no effect on designated critical habitat for the marbled murrelet, Steller sea lion, or killer whale. The BE was sent to the National Marine Fisheries Service (NMFS) and US Fish and Wildlife Service for concurrence.

8.2. Aquatic Food Web [230.31]. The proposed action is not expected to have a significant affect on the eelgrass and algae in the vicinity of project area. Construction activities would likely disturb the upper edge of the intertidal zone where *Ulva* and other algaes have been observed. Substantial impacts to eelgrass are not anticipated due to the low elevation at which eelgrass occurs in the work zone. Any realized impacts to algae would be temporary and conducted during the onset of fall and winter, typically the period of least growth. Within several months, any disturbed algae are expected to recover. By burying the existing beach surface, the proposed work would temporarily decrease populations of epibenthic organisms within the project footprint. Potential adverse effects would be minimal, as the work would occur in the fall as epibenthic production seasonally decreases and the project footprint represents only a small proportion of the available foraging habitat in the vicinity. Any dip in epibenthic abundance would be short-term. Peak abundance of juvenile salmonids at the project site occurs in the spring allowing for recovery time of epibenthic communities. Adult salmon may occur in the vicinity of the project when the work would occur but these fish are larger and not as directly dependent upon the upper intertidal nearshore environment. Forage fish spawning habitat for herring, surf smelt, and sand lance is present at the project area. The purpose of the project is to improve in the long term the conditions for forage fish spawning by improving substrate that sand lance and surf smelt prefer. To minimize impacts to possible forage fish spawn, pre-construction monitoring will be conducted. Adverse effects to other marine fish are not anticipated since the work would occur at relatively high elevations and the disturbance would be temporary.

8.3. Wildlife [230.32]. Noise associated with disposal operations may have an effect on bird and marine mammals in the project vicinity. The impacts of any sound disturbance would likely result in temporary displacement of animals rather than injury. Disposal operations are not expected to result in a long-term reduction in the abundance and distribution of any prey items. No breeding or nesting areas will be directly impacted. The work window avoids sensitive nesting and wintering periods for bald eagles.

9.0. 404(B)(1) EVALUATION [40 CFR §230]- Potential Impacts to Special Aquatic Sites (Subpart E)

9.1. Sanctuaries and Refuges [230.40]. The proposed project will not impact any designated sanctuary or refuge area.

9.2. Wetlands [230.41]. Nourishment material will not be discharged in wetland areas. The project will not alter the inundation patterns of wetlands.

9.3. Mudflats [230.42]. Nourishment material will not be discharged in or near mudflat areas. The project will not alter the inundation patterns of mudflats.

9.4. Vegetated Shallows [230.43]. A variety of algal species occur in the project area but most of the colonization occurs in the lower intertidal elevations. At lower elevations, the substrate changes to cobble. *Ulva* and *Enteromorpha* dominate the zone between about +6.0' and –2.0' MLLW. Between +2.0'and –2.0' MLLW and lower, a mix of *Laminaria*, *Iridea*, and *Zostera*, can be found covering the substrate. No Macrocystis or Nereosystis was found off the project area. Construction activities would likely disturb the upper edge of the intertidal zone where *Ulva* and *Enteromorpha* have been observed. Substantial impacts to eelgrass are not anticipated due to low elevation at which eelgrass occurs in the work zone. The impacts to algae would be temporary and conducted during the onset of fall and winter, typically the period of least growth. Within several months, disturbed vegetation would be expected to recover. The project will not change circulation patterns, increase nutrients, or result in any chemical contamination. As described in the Aquatic Food Web section, the placement of beach substrate material is not expected to reduce the value of the area as nesting, spawning, nursery, cover, or forage habitat. The proposed work would cause temporary and minor disturbance to the macroalgae and eelgrass areas in and directly adjacent to the construction area. However, due to the small scope of the proposed project and prudent management of the barge, substantial adverse impacts or permanent loss to the existing eelgrass and macroalgal communities are not anticipated.

9.5. Coral Reefs [230.44]. Not applicable.

9.6. Riffle and Pool Complexes [230.45]. Not applicable.

10. 404(B)(1) EVALUATION [40 CFR §230]- Potential Effects on Human Use Characteristics (Subpart F)

10.1. Municipal and Private Water Supplies [230.50]. Not applicable.

10.2. Recreational and Commercial Fisheries [230.51]. The project is not expected to affect recreational or commercial fisheries.

10.3. Water Related Recreation [230.52]. Construction vehicles will not likely disrupt recreational use of the Seahurst Park beach in the project area. During the fall, most visitors to Seahurst Park utilize the upland areas rather than the shoreline. Given the timing, duration and size of the project, substantial impacts to recreation are not anticipated during the construction period. After construction, recreational use of the park and shoreline would be similar or slightly more intense than before construction.

10.4. Aesthetics [230.53]. Localized, temporary increases in noise and turbidity will occur while construction equipment is operating. Prior to final grading, small stockpiles of gravel will be present on the upper beach. These stockpiles will not block views of the East Passage of Puget Sound, nor mar the view of the Seattle shoreline from points West. After project completion, the project area will rapidly become indistinguishable from adjacent, undisturbed beach areas.

10.5. Parks, National and Historic Monuments, National Seashores, Wilderness Areas, Research Sites, and Similar Preserves [230.54]. The project is located within a City of Burien park. Seahurst Park offers picnic areas, water access, and hiking trails. To minimize disruption to park use, construction vehicles may access the beach from barges only and will be restricted to beach areas with the project footprint. Given the timing, short duration of construction, and small size of the project, substantial impacts to recreation are not anticipated during the construction period. After construction, recreational use of the park and shoreline would be similar to before construction.

11. 404(B)(1) EVALUATION [40 CFR §230]- Evaluation and Testing (Subpart G)

11.1. General Evaluation of Dredged or Fill Material [230.60]. The fill material will be composed of clean coarse sand, gravel, and other naturally occurring inert material obtained from upland borrow sources for which all state and local permits have been obtained.

11.2. Chemical, Biological, and Physical Evaluation and Testing [230.61]. The extraction site is sufficiently removed from sources of pollution to provide reasonable assurance that the proposed discharge material is not a carrier of contaminants. Therefore, the required determinations pertaining to the presence and effects of contaminants can be made without testing.

12. 404(B)(1) EVALUATION [40 CFR §230]- Action to Minimize Adverse Effects (Subpart H)

12.1. Actions Concerning the Location of the Discharge [230.70]. The effects of the discharge will be minimized by limiting discharge volume to the maximum practicable extent. The discharge will not disrupt tidal flows, nor create standing bodies of water. The location and timing of the proposed discharge has been planned to minimize impacts to marine organisms.

12.2. Actions Concerning the Material to be Discharged [230.71]. No treatment substances nor chemical flocculates will be added to the beach materials before disposal. The material will be sorted at the borrow site to reduce the concentration of fines.

12.3. Actions Controlling the Material after Discharge [230.72]. Methods for reducing the potential for erosion, slumping, or leaching will not be employed, since the discharge material is intended to create a natural beach with very limited need for maintenance. Final grading of the discharged material will occur in the dry during low tides to avoid direct fishery and water quality impacts. Discharge will not occur during periods of high wind and wave action.

12.4. Actions Affecting the Method of Dispersion [230.73]. Fill removal and beach nourishment material will be placed high in the intertidal zone, thereby mimicking natural sediment erosion and transport processes to the maximum extent practicable. Beach material will be sorted at the borrow site to minimize the release of suspended particulates.

12.5. Actions Related to Technology [270.74]. Appropriate machinery and methods of transport of the material for removal and discharge will be employed. To minimize disturbance of areas outside of the project footprint, the new substrate will be delivered to the project site via barge

and discharged onto the upper beach with a conveyor. All machinery will be properly maintained and operated.

12.6. Actions Affecting Plant and Animal Populations [270.75]. The timing of the proposed discharge operations will minimize the potential for adverse effects to animal populations, particularly juvenile salmonids. The placement of the substrate is designed to create intertidal beach habitat for salmonids, other marine fish, and their prey resources.

12.7. Actions Affecting Human Use [230.76]. The discharge will not result in damage to aesthetically pleasing features of the aquatic landscape. The discharge will not increase incompatible human activity in remote fish and wildlife areas.

12.8. Other Actions [230.77]. Not applicable.

13. General Policies for the Evaluation of Permit Applications [33 CFR §320.4]
Public Interest Review [320.4(a)]. The Corps finds these actions to be in compliance with the 404(b)(1) guidelines and not contrary to the public interest.

13.1. Effects on Wetlands [320.4(b)]. No existing wetlands will be altered by the proposed project.

13.2. Fish and Wildlife [320.4(c)]. U.S. Fish and Wildlife Service and the National Marine Fisheries Service were consulted to ensure that direct and indirect loss and damage to fish and wildlife resources attributable to the proposed maintenance work will be minimized.

13.3 Water Quality [320.4(d)]. The Corps will abide by conditions of a Section 401 Water Quality Certification upon issuance by the Washington Department of Ecology to ensure compliance with Washington water quality standards.

13.4. Historic, Cultural, Scenic, and Recreational Values [320.4(e)]. No wild and scenic rivers, historic properties, National Landmarks, National Rivers, National Wilderness Areas, National Seashores, National Recreation Areas, National Lakeshores, National Parks, National Monuments, estuarine and marine sanctuaries, or archeological resources will be adversely impacted by the proposed restoration work.
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13.5. Effects on Limits of the Territorial Sea [320.4(f)]. The proposed maintenance work will not alter the coastline nor baseline from which the territorial sea is measured for the purposes of the Submerged Lands Act and international law.

13.6. Consideration of Property Ownership [320.4(g)]. Not applicable.

13.7. Activities Affecting Coastal Zones [320.4(h)]. The proposed work complies with the policies, general conditions, and general activities specified in the King County Shoreline Management Master Plan and Washington Administrative Code to the maximum extent practicable.

13.8. Activities in Marine Sanctuaries [320.4(i)]. Not applicable.

13.9. Other Federal, State, or Local Requirements [320.4(j)]
a. National Environmental Policy Act. An environmental assessment (EA) has been developed to satisfy the documentation requirements of NEPA.

b. Endangered Species Act. In accordance with Section 7(a)(2) of the Endangered Species Act of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species. A Biological Evaluation (BE) has been prepared and will be submitted to USFWS and NMFS. The NMFS and USFWS are expected to respond to the determinations made in the BE for effects to threatened and endangered species.

c. Clean Water Act. The Corps must demonstrate compliance with the substantive requirements of the Clean Water Act. This document records the Corps' evaluation and findings regarding this project pursuant to Section 404 of the Act. Public Notice CENWS-PL-02-06 dated 1 July 2003 served as an application for a Section 401 Water Quality Certification from the Washington Department of Ecology. Ecology is expected to issue a Water Quality Certification for the project prior to construction in fall of 2003. The Corps will abide by the conditions of the State issued Water Quality Certification to ensure compliance with State water quality standards.

d. Coastal Zone Management Act. The Coastal Zone Management Act of 1972, as amended, requires Federal agencies to carry out their activities in a manner which is consistent to the maximum extent practicable with the enforceable policies of the approved Washington Coastal Zone Management Program. The proposed action will restore the southern portions of Seahurst Park to a fully functioning nearshore condition. Rock removal work will remain well within the footprint of the original project, and will not cause substantial adverse effects to shore resources or the environment. Pursuant to Section 173-27-040 and 173-27-60 of the Washington Administrative Code, the Corps determined that this proposal is consistent to the maximum extent practicable with the State of Washington Shoreline Management Program.

e. Rivers and Harbors Act. This document records the Corps' evaluation and findings regarding this project pursuant to the Rivers and Harbors Act. No adverse effect to navigation is anticipated.

f. National Historic Preservation Act. The National Historic Preservation Act (16 USC 470) requires that the effects of proposed actions on sites, buildings, structures, or objects included or eligible for the National Register of Historic Places must be identified and evaluated. The project is working with applicable agencies and tribes to ensure the project will have no effect on historic or cultural resources.

g. Fish and Wildlife Coordination Act. The Fish and Wildlife Coordination Act (16 USC 470) requires that wildlife conservation receive equal consideration and be coordinated with other features of water resource development projects. This goal is accomplished through Corps funding of U.S. Fish and Wildlife Service habitat surveys evaluating the likely impacts of proposed actions, which provide the basis for recommendations for avoiding or minimizing such

impacts. A Fish and Wildlife Coordination Act Report is not required for restoration work although members of the FWCA group have been consulted throughout project development.

13.10. Safety of Impoundment Structures [320.4(k)]. Not applicable.

13.11. Floodplain Management [320.4(l)]. The proposed maintenance work will not alter any floodplain areas.

13.12. Water Supply and Conservation [320.4(m)]. Not applicable.

13.13. Energy Conservation and Development [320.4(n)]. Not applicable.

13.14. Navigation [320.4(o)]. No adverse effects to navigation will occur as a result of the proposed maintenance work.

13.15. Environmental Benefits [320.4(p)]. The proposed nourishment project would eliminate the conversion of the southern Seahurst Park beach from an intertidal gravel beach to a subtidal beach. The proposed project would provide a range of intertidal elevations necessary to support the epibenthic invertebrates which serve as prey for a wide variety of marine fishes and allow for better continuity to upland sediment and food sources.

13.16. Economics [320.4(q)]. During the feasibility study the preferred alternative as described above was economically justified.

13.17. Mitigation [320.49(r)]. Potential impacts of the maintenance work on salmonids will be avoided through implementation of timing restrictions. The use of rounded gravels of similar size to the native substrate presently on the nearby reference beach will minimize habitat impacts of the proposed action. Impacts to forage fish will be mitigated by conducting pre-construction surveys at the site.