# Strategic Identification of Areas and Projects for Nearshore Restoration throughout Key Peninsula-Gig Harbor-Islands Watershed, WRIA 15, Washington

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Prepared for Salmon Recovery Funding Board and West Sound Watershed Lead Entity (WRIA 15)

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## Executive Summary

Grant funding was awarded by the Salmon Recovery Funding Board to assess and prioritize restoration opportunities throughout the nearshore environment of the Key Peninsula-Gig Harbor-Islands (KGI) Watershed, within Water Resource Inventory Area 15 (WRIA 15), South Puget Sound, Washington. The study area encompasses approximately 179 miles of shoreline comprised of a diverse suite of nearshore environments and conditions. To prioritize restoration opportunities throughout the KGI Watershed, we developed and applied a step-wise methodology to assess existing nearshore habitat conditions in conjunction with information filters from which to prioritize restoration opportunities of perceived highest importance. Our assessment methodology applied model-based inferences to identify nearshore areas of highest benefit to salmonids, on-the-ground validation, and post-processing of assembled information measures to ultimately derive a suite of areas most in need of nearshore restoration. The assessment results provide information on existing habitat conditions that can be catalogued according to nearshore habitat features and associated human-induced habitat alterations. The use of habitat-based model scoring schemes allowed us to identify areas of greatest benefit in terms of existing habitat preferred by salmon, while also assessing related stressors in the form of human-induced habitat alterations. Ultimately, assessment results provide a catalogued source of data based within a GIS framework that lends itself to further analyses investigations and assessment updates. Additionally, our assessment builds upon and incorporates previous assessment efforts conducted in the year 2003. A total of 67 nearshore restoration projects were identified, with the majority of these concerning modification and/or removal of bulkhead-armoring, with second being protection of relatively intact marine estuaries. Given the annual funding cycle for nearshore restoration we also identified and detailed pre-project plans for six targeted near-term restoration projects. The value and utility of this updated assessment is furthered in acknowledging inherit limitations in prioritizing restoration according to 'ecosystem process-based' criteria. Through our assessment efforts, the need for additional work is recognized and warranted toward more holistic landscape scale considerations from which to better determine appropriate restoration strategies and ultimately the likelihood of achieving desired restoration goals.

## Acknowledgements

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Squaxin Island Tribe Natural Resources Department

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The West Sound Watershed Council / WRIA 15 Lead Entity Group

Washington State Parks

Waterfall Engineering

## Acronyms

| | |
|---|---|
| AU | Assessment Unit (Pentec Environmental 2003) |
| EMU | Ecological Management Unit (Pentec Environmental 2003) |
| ESA | Endangered Species Act |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| KGI | Key Peninsula – Gig Harbor - Islands |
| NMFS | National Marine Fisheries Service |
| NAIP | National Agricultural Imagery Program |
| NOAA | National Oceanic and Atmospheric Administration |
| NPST | Nearshore Project Selection Tool |
| PSNERP | Puget Sound Nearshore Ecosystem Restoration Project |
| WRIA | Water Resource Inventory Areas |

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# 1.0 Introduction

## 1.1 Study Area

The study area encompasses what is referred to as the Key Peninsula – Gig Harbor – Islands (KGI) Watershed. This area encompasses the southeastern portion of East Kitsap Watershed as part of Water Resources Inventory Area (WRIA) 15. The KGI Watershed lies between the northern end of Case Inlet on the west and the Tacoma Narrows and Dalco and Colvos passages on the east, including several islands in the eastern portion of Deep South Sound. The study area lies almost entirely within Pierce County with the exception of a small portion of the area located in the northeast corner of Mason County at the head of Case Inlet (North Bay). Overall, the area encompasses approximately 101,000 acres (158 square miles) and 179 miles of shoreline (Pentec Environmental 2003). The study area includes the shorelines of the Key Peninsula, the Gig Harbor Peninsula, Fox, McNeil, Ketron and Anderson Islands, and several smaller islands throughout (Figure 1 Study Site Map).

The KGI Watershed contains numerous streams generally categorized as low-elevation and low-gradient, which are relatively small in size in comparison to other river systems throughout the greater Puget Sound region (Haring 2000). Given the low elevation, the natural hydrology of these streams are dependent on precipitation and groundwater contribution. The small streams throughout the KGI Watershed are of productive value for salmonids, particularly populations of chum and coho salmon, steelhead, and cutthroat trout; these streams are not considered typical Chinook streams (Haring 2000).

The KGI Watershed is defined by approximately 179 miles of marine shoreline. Although the degree of shoreline development is high in some discrete locations, associated uplands are predominantly comprised of mixed forest, pasture land, and a low percentage of impervious surface areas. Furthermore, the overall area lacks large urban and industrial developments that have significantly altered nearby areas such as the Puyallup estuary/Commencement Bay. However, known water quality impairments exist throughout the KGI Watershed; documented areas include Gig Harbor, Carr Inlet, Henderson Bay, Wollochet Bay, between the Nisqually Delta and Anderson Island, and additional isolated areas off Anderson and McNeil Islands. As is typical with water quality issues, impaired locations are associated with increased impervious surface area, overwater structures, urban centers, agricultural land, wastewater treatment plants, and lack of riparian vegetation (ESA Adolfson 2009).

The marine shoreline and associated nearshore environments throughout the KGI Watershed encompass a diverse suite of habitats such as salt marsh, embayments, erosive feeder bluffs, riparian fringe beaches, and submerged aquatic nearshore vegetation. A comprehensive inventory-assessment of nearshore habitats was conducted by Pentec Environmental (2003) for the greater KGI Watershed. The Pentec assessment of nearshore salmon habitat reiterates the

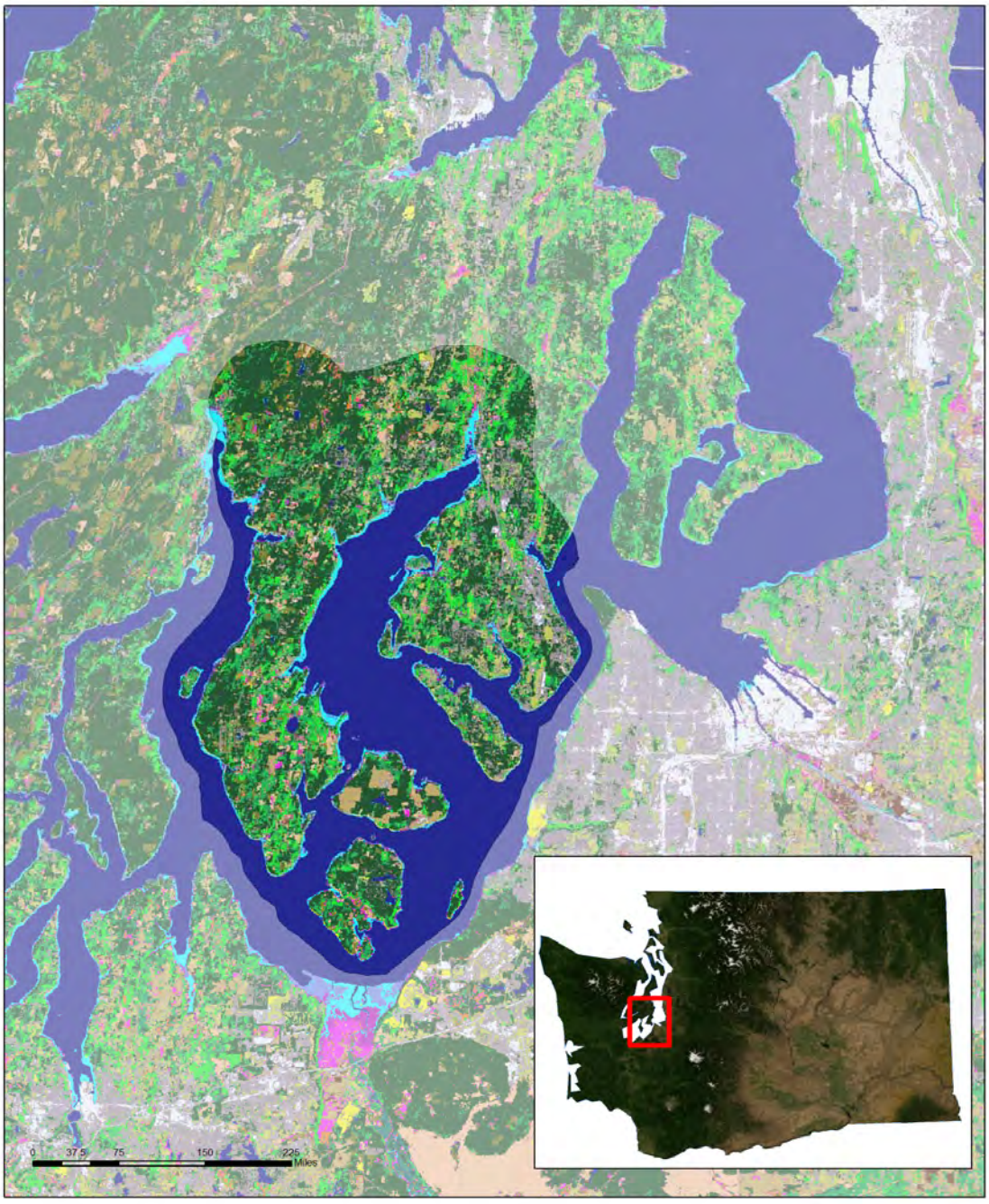


**Figure 1. Study area (highlighted) encompassing the Key Peninsula-Gig Harbor-Islands watershed, south Puget Sound, Washington.**

conventional understanding that nearshore environments throughout the KGI watershed are of medium to high importance for both juvenile and adult salmonids, both as rearing-refugia-feeding functions and as ocean migration corridors (Pentec Environmental 2003, Fresh 2006); threatened Chinook salmon populations particularly from south and central Puget Sound watersheds are believed to rely on this area for critical life-history functions (Duffy et al. 2010, Ellings and Hodgson 2007, Haring 2000, National Marine Fisheries Service 2007).

## 1.2 Project Objectives

Objectives of this project were to identify and prioritize project-areas for potential nearshore restoration activities throughout the KGI Watershed marine interface. This project had a particular focus on salmon in relation to nearshore habitats with perceived benefits, and therein ecosystem dynamics that benefit life-history performance of both juvenile and adult salmonids . The primary objectives of this project were to:

- Synthesize habitat information provided by existing nearshore assessments with field reconnaissance surveys to identify projects in high priority WRIA 15 shorelines.
- Acquire landowner approval for project development and produce ~30% engineering designs for up to eight of the projects on the list that target restoration of key nearshore processes and demonstrate habitat benefit.
- Present implementation-worthy projects for funding consideration to the Lead Entity and other stakeholders.

Results from this project are to be considered a living-document, where additional information and improved understanding can be incorporated to refine and re-evaluate our results. As part of this, we identify information gaps and next-steps towards a more refined assessment of restoration opportunities throughout the KGI Watershed.

## 1.3 Assessment Approach – Background

As part of the objectives for this project, we reviewed previous assessment work pertinent to the area of interest in the KGI Watershed including: available data information, tools for assessing nearshore conditions, and emerging nearshore science for defining restoration strategies.

### 1.3.1 Pertinent Nearshore Assessments for the KGI Watershed

Nearshore science is an emerging and rapidly evolving discipline. As such, data relevant to the nearshore environment is becoming increasingly more robust and available with the use of associated technologies and approaches for the application of remote sensing techniques (i.e. Geographic Information Systems). This also infers that the content of available nearshore assessments is varied and ever-evolving.

At the time of this report, the most area-relevant assessment available was the 2003 assessment of nearshore salmon habitat throughout the KGI Watershed (Pentec Environmental 2003), prepared for

Pierce County. The Pentec assessment incorporated remote sensing techniques and field verification surveys in conjunction with an evaluation model ('Tidal Habitat Model') for inventorying existing nearshore habitat, and resulted in modeled habitat functions for salmonid life-histories. Assessment results were according to 15 large sub-regions termed 'Ecological Management Units' (EMUs), with 413 nested sub-units or 'Assessment Units' (AUs). Results from the Pentec Environmental Assessment identified a range of nearshore conditions in terms of human disturbance and areas with high potential for habitat restoration. Potential restoration activities identified in the 2003 assessment include bulkhead and fill removal, riparian enhancement, removal of derelict structures, and restoration of connectivity between the nearshore and freshwater "mini-estuaries."

Since the 2003 assessment by Pentec Environmental, Pierce County recently made available their Shoreline Master Program Update Plan (ESA Adolfson 2009). The program update relies heavily upon the 2003 Assessment by Pentec Environmental for identifying areas for preservation, restoration and development throughout the KGI Watershed. As part of the Pierce County shoreline program update, guidelines are presented defining restoration versus protection scenarios and overarching management strategies.

### 1.3.2 The Juvenile Salmonid Nearshore Project Selection Tool (NPST)

To update assessment work completed by Pentec Environmental in year 2003, we evaluated available inventory model tools by which to assess nearshore environments in relation to perceived life-history requirements for salmonids (particularly at the juvenile stage). In doing so, a model-tool we favored was a product of the WRIA 13 salmon technical team in the form of a GIS based product called the Nearshore Project Selection Tool (NPST 2009). In general, the purpose of the technical team, and ultimately an end product, was to map and rate habitat types at the Shore Zone unit level (Washington State Department of Natural Resources 2001) using a weighted scoring scheme.

The NPST built upon work done in the Chinook and Bull Trout Recovery Approach for South Puget Sound (NMFS 2007) which outlined discrete habitat types found along the shoreline that were hypothesized to be beneficial to juvenile salmonids. Each of these habitats are believed to contribute to the four essential nearshore eco-system functions beneficial to juvenile salmonids, as described by Simenstad et al. (1982) and William and Thom (2001). The habitat types identified and mapped were:

- Known forage fish spawning beaches
- Feeder bluffs
- Pocket estuaries
- Salmonid bearing freshwater tributaries
- Eelgrass beds
- Emergent Marsh

This NPST further refines the spatial mapping by evaluating the attributes of:

- Saltmarsh
- Inter-tidal vegetation
- Eelgrass
- Documented forage fish spawning areas
- Proximity to salmon bearing streams
- Proximity to fresh water inputs
- Embayments/pocket estuaries

Feeder bluffs were not included in the scoring analysis because a sufficiently robust dataset encompassing all of south Puget Sound, particularly the KGI Watershed, was not available at the time of model development (NPST 2009).

The NPST can also be used to not only evaluate perceived benefits to juvenile salmonids ('Benefits Model') but also attribute-factors indicating the degree of degraded habitat ('Limiting Model'). A scoring scheme was used within the model to define the degree of habitat degradation due to:

- Shoreline armoring
- Boat ramps
- Docks
- Small and/or recreational boat slips
- Large boat slips
- Railways adjacent to shoreline reaches
- Absence / loss of overhanging nearshore riparian vegetation

Thus, application of the NPST can be used to evaluate both perceived benefits and/or human-induced alterations in the nearshore environment that impair habitat function in terms of benefits for juvenile salmonids. Our impression of the NPST in comparison to the methodology used by the 2003 assessment by Pentec Environmental was that both assessment approaches had commonalities, and in many instances used similar if not the same information data sources. In particular, both assessment approaches relied heavily upon the Washington State Shore Zone Inventory (Washington Department of Natural Resources 2001).Furthermore, inventoried habitat attributes and their perceived functional relationship to juvenile salmonids were similar, presumably because both methodology approaches were based upon the best available science. This is evident in that the two assessment methodologies both focus upon environmental attributes such as embayments (i.e. pocket estuaries), eelgrass, forage fish spawning beaches, riparian vegetation and impairment attributes such as the degree of shoreline armoring, presence of piers, docks and marinas. Upon review, we favored the NPST tool given that 1) the model incorporated data-information more recent than the Pentec Environmental (2003) assessment, 2) the GIS data structure of the NPST was more compatible for incorporating existing and future GIS data where Shore Zone units are the primary unit of analysis, and 3) the scoring scheme of the NPST was more transparent and repeatable (see Appendix C, NPST model scoring criteria).

### 1.3.3 Defining 'Restoration" Strategies

The following excerpts from published documents outline and develop strategies for defining restoration. In general they invoke concepts of the degree of ecosystem impairment versus ecosystem dynamics and therein ecosystem resilience, self-maintenance, and ecosystem recovery. These concepts have direct translation to the probability of restoration projects being successful over time. The concept implications are important considerations for managers in implementing best-suited restoration strategies depending upon ecosystem conditions and desired restoration outcomes. Johnson et al. (2003) discuss the realized success of restoration efforts in relation to the degree of environmental disturbance:

> *The success of a restoration project will vary depending on the level of disturbance (anthropomorphic or natural) of the site and the landscape within which the site resides (NRC 1992). Using the findings of the National Research Council and a review of the literature on estuarine habitat restoration, Shreffler and Thom (1993) concluded that the strategies of restoration, enhancement, and creation should be applied depending on the degree of disturbance of the site and the landscape (Figure 2.3). For example, sites with a high degree of disturbance on both scales, in general have a low probability for restoration, and creation of a new habitat or ecosystem or enhancement of selected attributes would be the only viable strategies to apply in these situations. In contrast, where the site and landscape are essentially intact, restoration to historical (i.e., humans present, but insignificant disturbance) or pre-disturbance (i.e., before man) conditions would be viable options and the probability of success would be high.*

Johnson et al. (2003) further provide an illustrative figure to the above concepts relating environmental conditions at the site versus landscape scale, in the context of estuarine restoration strategies and therein potential for success (Figure 2).

These documents promote defined restoration strategies contingent upon environmental conditions at varying landscape scales. As restoration science continues to evolve, some general concept tenants concern further definition of 'restoration'. Johnson et al. (2003) provide definition-criteria in determining appropriate 'restoration' strategies (Table 1).

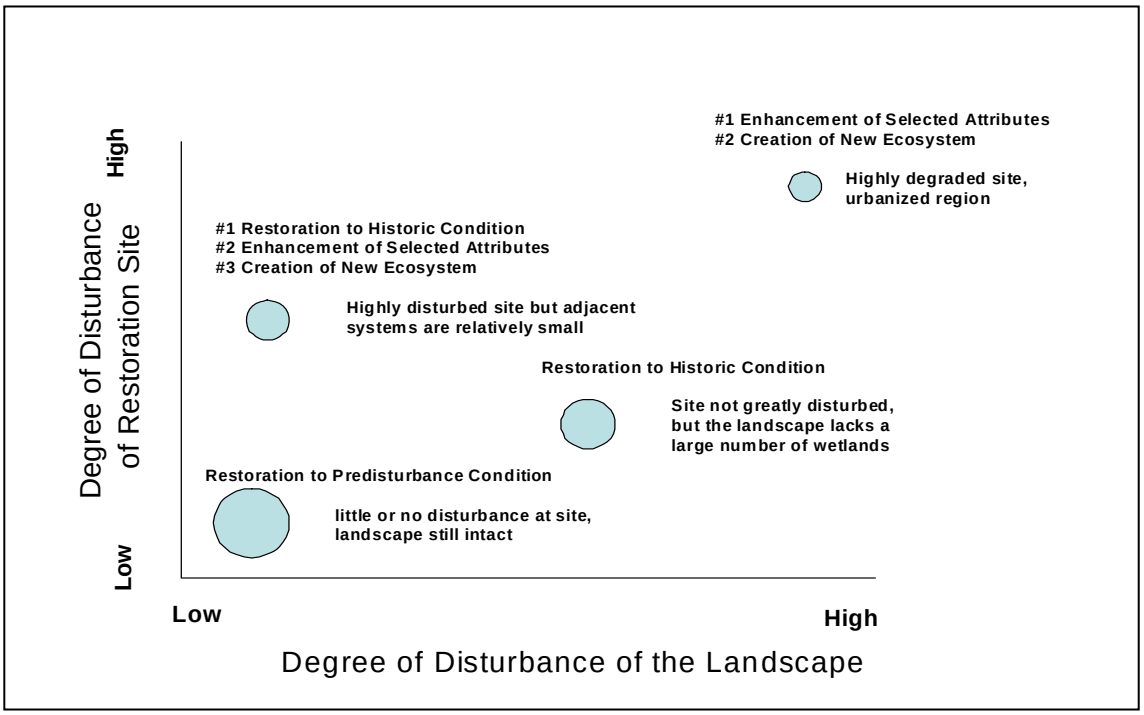


**Figure 2. (Johnson et al. 2003 page 19, figure 2.3): Restoration Strategies for Estuarine Systems Relative to Disturbance Levels at the Site and in the Landscape (from Shreffler and Thom 1993). The relative chance of success increases with the size of the dot.**

In general, the presented concepts for restoration strategies concern the degree of human disturbance in relation to the site scale versus the respective surrounding landscape scale. Another way to consider the above concepts is through a matrix table developed by Diefenderfer et al. (2007) and presented below in Table 2.

The Shoreline Master Program Update for Pierce County (ESA Adolfson 2009) essentially defines strategies according to restoration versus protection action-strategies, similar to above concept strategies outlined by Johnson et al. (2003) and Diefenderfer et al. (2007). Our assessment approach detailed below in report section 2.0 inventories potential restoration areas and projects of importance to juvenile salmonids; we acknowledge that further work is needed in prioritizing restoration efforts according to strategies presented here in report section 1.3.3.

**Table 1. *An Ecosystem-Based Approach to Habitat Restoration in the Columbia River Estuary* Johnson et al. 2003, Table 2.3 (Page 15). Definitions of Restoration[1] Strategies.**

| Strategy | Definition | Comments |
|---|---|---|
| **Conservation** | Maintenance of biodiversity (Meffe etal. 1994). | Conservation biology is a synthetic field that applies the principles of ecology, biogeography, population genetics, economics, sociology, anthropology, philosophy and other theoretically based disciplines to the maintenance of biological diversity. Conservation can allow development to occur as long as biodiversity and the structure and processes to maintain it are not affected. Restricted development is an approach to conservation. |
| **Creation** | Bringing into being a new ecosystem that previously did not exist on the site (NRC 1992). | In contrast to restoration, creation involves the conversion of one habitat type or ecosystem into another. |
| **Enhancement** | Any improvement of a structural or functional ecosystem attribute (NRC 1992). | As noted by Lewis (1991), enhancement and restoration are often confused. The intentional alteration of an existing habitat to provide conditions that previously did not exist and which by consensus increase one or more attributes is enhancement. Shreffler and Thom (1993) found that, for estuarine systems, enhancement often meant enhancement of selected attributes of the ecosystem such as improving the quality or size of a tidal marsh or eelgrass meadow. |
| **Restoration** | Return of an ecosystem to a close approximation of its previously existing condition (e.g., Lewis 1991, NRC 1992). | Includes any form of restoration with the intent of improving habitat to a state closely approximating a historical or pre-disturbance condition. |
| **Protection** | Formal exclusion of activities that may negatively affect the structure and/or functioning of habitats or ecosystems. | Protection can also refer to protection of a species or group of species through management actions such as elimination of harm to a species directly or indirectly through damage of its habitat. Restricted development and land use ordinances can also be used to exclude unwanted activities as an approach to protection. |

**Strategy Definition Comments**

[1] The term "restoration" generally refers to any or all of the five fundamental restoration approaches commonly reported in the literature: creation, enhancement, *restoration*, conservation, and protection. When used to refer specifically to *restoration* as a particular strategy, we will italicize the word; otherwise, assume the usage in the general sense.

**Table 2. Possible restoration strategies indicated by disturbance at site and landscape scales (Diefenderfer et al. 2007 Table 11, adapted from Thom and others 2005a). Level of Disturbance where L = Low, M = Medium and H = High.**

| Site Scale: Level of Disturbance | Landscape Scale: L | Landscape Scale: M | Landscape Scale: H |
|---|---|---|---|
| H | Restore<br>Enhance | Enhance<br>Restore | Create<br>Enhance |
| M | Restore<br>Enhance<br>Conserve<br>Preserve | Enhance<br>Restore<br>Conserve | Enhance<br>Create |
| L | Conserve<br>Preserve | Conserve<br>Enhance<br>Restore<br>Preserve | Enhance<br>Conserve |

## 2.0 Methods: Assessment of the KGI Watershed for Identification of Salmon Habitat Nearshore Restoration, Year 2010

To assess the nearshore habitat throughout the KGI Watershed and ultimately identify project-areas for potential restoration with perceived benefits to salmon, we used a step-wise methodology. Our step-wise methodology entailed the use of:

- the NPST (2009) for identification of areas and attributes that are both of benefit and/or detriment to salmon life-history dynamics,
- aerial photo interpretation,
- pertinent available GIS databases,
- field reconnaissance for on-site verification of pre-identified project-areas deemed of merit,
- cross-referencing of our assessment results to the assessment by Pentec Environmental (2003), and,
- creation of electronic datasets and associated GIS-based assessment information to geo-reference nearshore restoration opportunities.

Results from our efforts were then synthesized in context of defined 'restoration' strategies dependent upon the degree of nearshore degradation at varying spatial scales. Ultimately, a list of potential restoration projects is provided from this assessment of which six projects were selected for 'project advancement' in the form of ~30% pre-project design plans.

### 2.1 Remote Assessment of Current Nearshore Conditions

Given that the KGI Watershed encompasses approximately 179 miles of shoreline, we first used remote-sensing methods to refine potential areas of interest for restoration of nearshore salmon habitat. To accomplish this, we first used the NPST to spatially define areas with relatively high habitat-benefit for juvenile salmonids using the NPST Benefits Model. Model-identified areas of benefit were then considered in relation to NPST assessment criteria for identifying associated attributes that limit salmon-habitat potential, the NPST Limiting Model. In all instances, we considered both the All Salmonids version of the NPST where the shoreline is rated equally versus the Chinook Fry model version that gives additional weighting to nearshore habitat attributes located more proximate to the Nisqually River confluence. The two model versions were considered equally, meaning areas of high benefit for salmonids were of the foremost interest for further investigations.

Defined 'priority' nearshore areas, according to the NPST methodology, were further examined using aerial photo interpretation. We first used aerial photos provided by the Washington Coastal Atlas archives (Washington State Department of Ecology 2008), that provide nearshore aerial photos as

recent as year 2006. Typically, aerial photos were cross-referenced with ortho photo imagery provided by the National Agricultural Imagery Program (2009) to compare best resolution and aid in image interpretation. Nearshore areas of interest and associated aerial images were then cross-referenced to the Fish Passage Barrier database provided by the Washington Department of Fish and Wildlife SalmonScape (2010); identified "suspected" barriers were noted for subsequent field inspection.

Ultimately, assessment methods involving the use of remote sensing techniques yielded a list of potential restoration projects within areas of relatively high benefit for salmonids (as identified by the NPST). The project list was categorized according to the following categories:

- Bulkhead
- Dock / Pier
- Culvert-Tide-Gate
- Estuary Protect
- Estuary Restore
- Feeder Bluff Protect
- Feeder Bluff Restore
- Beach Restore
- Blocked Stream

Project-areas of interest were then staged for subsequent field inspection to verify potential inclusion as a nearshore restoration project-area.

## 2.2 Field Reconnaissance and Verification

Field reconnaissance of 'pre-identified' potential projects within discrete shoreline areas were conducted by boat involving a crew of four people. Spatial co-ordinates were available for all pre-identified candidate project-areas of interest; co-ordinates were cross-referenced to real-time GPS tracking methods using a *Trimble Geo XM* while in the field to verify, and in some instances, correct project locations. At each project area of interest, a protocol was used to qualitatively infer feasibility for restoration actions. Projects deemed of low feasibility involved the following criteria considerations:

- Well maintained or obvious new improvement / creation,
- High risk from associated upland impacts due to desired nearshore restoration actions,
- High risk with respect to existing upland structures,
- High landowner value of existing structures,
- Marginal and/or questionable restoration value.

Project areas that were deemed 'feasible' based upon the above criteria and best professional judgment were cataloged. Such project areas were cataloged with a unique project identification number, respective of potential project type (see Report Section 2.1), field recorded GPS coordinate location, and digital photos capturing existing conditions (restoration opportunities) of interest. Throughout field excursions, we wanted to retain an opportunistic approach, meaning that we assumed we may have missed a restoration opportunity during the remote-sensing exercises. Thus, some projects were identified for the first time while in the field.

## 2.3 Projects Designated for Preliminary Restoration Design

Throughout the course of the project identification process, restoration opportunities at discrete locations were pursued for preliminary design and feasibility development. Projects given additional preliminary design and feasibility analysis were selected on two levels.

1. Priority/Feasibility Need: Projects deemed of high benefit based upon the remote sensing and field verification process in need of feasibility analysis to determine viability were analyzed to the greatest level possible regardless of landowner willingness.

2. Opportunity: As opportunities arose, such as landowner-initiated contact, individual opportunities were evaluated based upon previously identified projects and proximity to high benefit shorelines identified in both the remote sensing exercises and in the field.

## 2.4 Post-Processing of Potential Restoration Projects

One of our project objectives was to create living documents that could be modified and updated. To achieve this objective, data was stored electronically and ultimately retained within a file geodatabase; the NPST was used as our primary database framework. Geo-referenced locations of identified potential nearshore projects were then cross-referenced to project-areas identified in the 2003 assessment by Pentec Environmental. Identified potential projects were considered in context of associated habitat attributes, habitat condition, project type, and proximity to other identified projects from this exercise.

Last, we strived to interpret our efforts in the context of a larger long-term restoration vision, with some recommendations on approaches towards further development of a more robust scheme for prioritizing nearshore restoration efforts (Included in Section 4.0 of this report).

# 3.0 Results

The use of remote sensing methods, model approaches to identify beneficial habitat for salmon, and field reconnaissance/verification resulted in a suite of project-areas considered of highest importance for nearshore restoration efforts.

## 3.1 Remote Sensing of Potential Project Areas

We relied foremost upon the NPST to refine potential areas of interest for nearshore restoration. The NPST scored shoreline segments according to habitat attributes of perceived benefit for salmonids, particularly at the juvenile life-stage. We considered both benefit model versions of the NPST, being the All Salmonids version where the entire study area of interest uses a global scoring-weighting scheme, versus the Chinook Fry model version, where the scoring-weighting scheme favors areas and habitat attributes more proximate to the Nisqually River confluence. Considering the All Salmonids model version, areas of most interest were nearshore segment reaches (according to ShoreZone designations) with a model benefit score of 17 or higher (with a maximum possible model score of 35). Whereas in considering the Chinook Fry model version, segment reaches with a score of 28 or higher (with a maximum possible model score of 65) were selected for more intensive investigations. Shoreline segments of perceived highest importance based upon NPST results were further considered in cross-referencing such segments in relation to model scored areas with attributes limiting habitat potential for salmonids (Limiting Model, which considers marinas, docks, railroads, etc.).

Given nearshore segments of foremost interest based upon NPST model results, aerial photographs were referenced to further define potential restoration opportunities. Ultimately, prior to field investigations and validation efforts, we had a list of potential project areas with associated GPS coordinates, aerial photos, and particular on-the-ground issues of foremost interest.

## 3.2 Field Reconnaissance and Project Validation

We conducted on-the-water field reconnaissance missions on August 13$^{th}$ and November 11$^{th}$ of 2010. Although our foremost focus was pre-identified areas, we attempted to visually assess nearly all of the KGI nearshore shoreline while conducting field surveys. That stated, no field visits were conducted in the general Gig Harbor and Tacoma Narrows study area; in the instance of Gig Harbor, this general area was assessed by land, whereas in the Tacoma Narrows we relied upon the previous 2003 assessment (Pentec Environmental) which concluded the area was in relatively pristine condition and thus could be best considered for preservation/conservation.

During our field surveys, there were also instances in which we could not access the head of embayments given tide heights at time of surveys. In most instances we attempted to remedy this by subsequent visits by land; some of these areas were relatively pristine in which remote sensing methods did not identify any potential restoration issues/opportunities and thus we foremost relied upon remote assessment information.

## 3.3 Final Selection of Potential Nearshore Restoration Project-Areas

Ultimately, we identified a total of 67 project-areas suitable for nearshore restoration efforts throughout the KGI Watershed. Given our step-wise methodology in deriving these final project-areas, our results could be considered as priority areas most deserving of restoration actions. Metrics provided by the NPST can be used to 'rate' restoration project-areas according to both perceived benefits and also limitations to salmonids in terms of existing habitat attributes. Table 3 summarizes

NPST model results according to shoreline segments that encompass restoration project-areas identified of greatest importance according to our selection methodology.

**Table 3. Summary statistics based upon NPST results for nearshore segments containing identified final project-areas for potential nearshore restoration efforts throughout the KGI Watershed, WRIA 15, South Puget Sound, Washington. Summary model statistics are based upon 67 potential restoration projects located within 61 unique shoreline segments (based upon ShoreZone designations).**

| NPST Model Version | Observed Mean Model Score | Observed Minimum Model Score | Observed Maximum Model Score |
|---|---|---|---|
| All Salmonids Benefit | 15.1 | 2.0 | 29.0 |
| Fry Migrant Chinook Benefits | 21.3 | 4.0 | 45.0 |
| Limiting | 0.87 | 0.4 | 1.1 |

Model scores based upon the NPST can be considered in several ways. According to the NPST model results, certain projects have higher perceived benefits for Chinook Fry salmon based upon project proximity to the Nisqually River and life history needs. If we consider both the All Salmonids model version versus the Chinook Fry model version (Figure 3), these comparisons raise questions concerning the importance of areas most proximate to the Nisqually River confluence based upon NPST scoring criteria; an important question being if Chinook salmon and habitats proximate to the Nisqually River are of foremost importance in prioritizing nearshore restoration in South Puget Sound .

The benefits versions of the NPST essentially rate the amount and diversity of habitat attributes that are perceived to benefit production potential for salmonids, particularly at the juvenile stage within a given ShoreZone (2001) segment of interest. The NPST was also used to evaluate habitat attributes that are perceived to limit production potential for salmonids (Limiting model version, see Report Section 1.3.2). Figure 4 depicts the relationship between model benefits score (All Salmonids) versus respective Limiting model scores; this relationship shows the juxtaposition and amount of beneficial versus limiting habitat attributes within a given nearshore segment of interest. Limiting habitat attributes could be considered as existing stressors which limit or prevent process-function for creation and maintenance of habitat features preferred by salmon. Thus, interpretation of Figure 4 can be used to indicate nearshore areas comprised of desired beneficial habitat versus the degree of human-induced alterations which indicate restoration opportunities (i.e. removal of bulkheads, docks, etc.). Areas with high habitat benefits scores and little to no human-induced impairments (i.e. low Limiting model score) could be considered as more pristine areas, and potentially best suited for conservation/preservation measures.

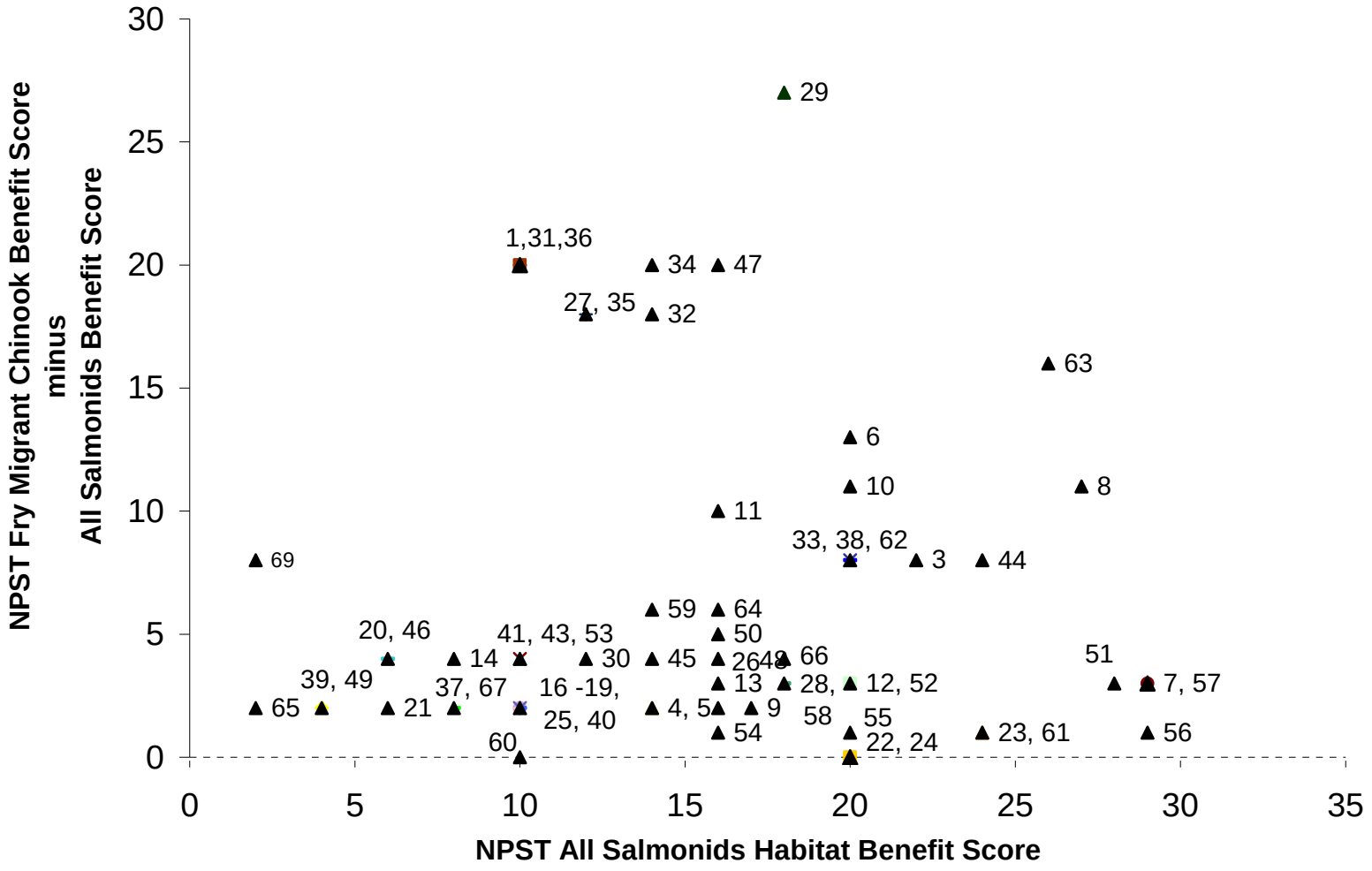


**Figure 3. Habitat benefits model scores based upon results using the Nearshore Project Selection Tool respective of unique, individual project identification numbers. Model scores depict the difference between the All Salmonids model version and respective habitat benefits scores using the Fry Migrant Chinook model version (i.e. benefits score Fry Migrant Chinook minus benefits score All Salmonids model version). Note: projects 26 and 70 are outside the boundary of the Nearshore Project Selection Toll and therefore do not have scores.**

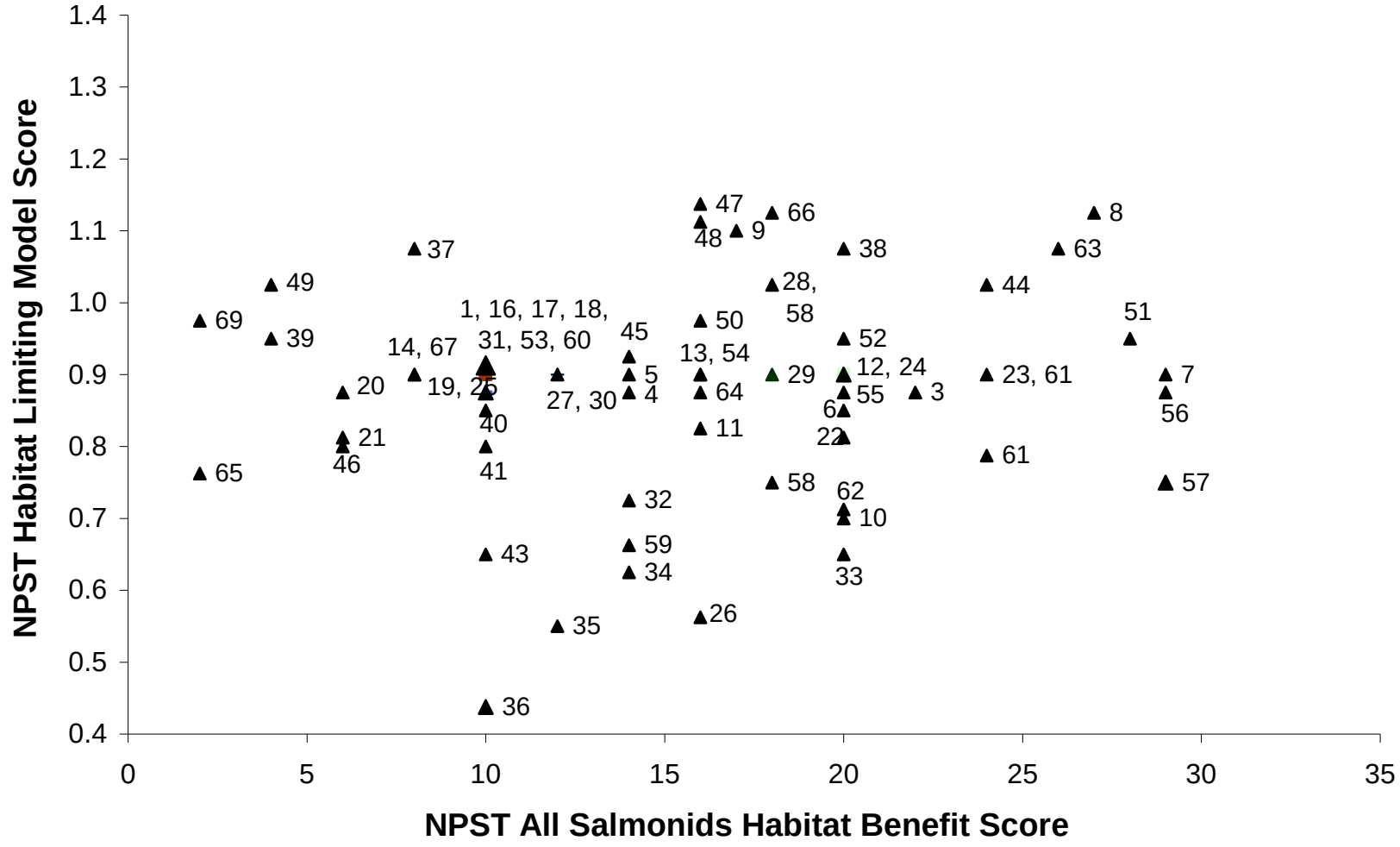


**Figure 4. Habitat benefits model scores based upon results using the Nearshore Project Selection Tool, All Salmonids version, versus respective habitat limiting model scores. Numbers associated with plotted points indicate unique, individual project identification numbers. Note: projects 26 and 70 are outside the boundary of the Nearshore Project Selection Toll and therefore do not have scores.**

The 67 projects we identified in this assessment as most important for restoration and protection efforts throughout the KGI watershed include, in-part, results from the previous 2003 assessment by Pentec Environmental. We cross-referenced our identified restoration projects to those identified in the 2003 assessment; this exercise identified 12 mutual projects using both our methodology and the methodology employed by Pentec Environmental (2003). There were an additional 26 projects identified in the prior nearshore assessment that we did not include in our list of 67 nearshore restoration projects; projects not included from the 2003 assessment largely entailed small project-types that we deemed largely aesthetic in value, such as removal of derelict boats, and in general, small clean-up projects.

We attempted to include additional assessment criteria to further refine and therein prioritize identified restoration projects. A total of 67 restoration projects were identified of which 27 were associated with shoreline beach habitat, 28 projects were located within nearshore embayments and a remaining 12 projects adjacent to feeder bluffs. In terms of general types of restoration projects we identified using our methodology, just over half (36 projects) were considered bulkhead removal projects, 17 as estuaries to protect (i.e. estuaries in relatively pristine condition), 4 projects were categorized as removal of docks or piers, 6 projects were classified as culverts or tide gates in need of removal and the remaining 4 projects were identified as intact feeder bluffs in need of protection. Of these projects, 6 were selected for preliminary project designs

The methodology used in this assessment included geo-spatial components to facilitate documentation and interpretation of assessment results. Using GIS methods, projects selected in this assessment effort can be referenced in terms of location, type and relationship to NPST model scores for habitat conditions. The use of the NPST allows for consideration of potential restoration projects in relation to existing habitat attributes of perceived importance for salmon (Figures 5 – 7, detailing NPST model scores for beneficial habitat versus limiting habitat feature scores). Assessment information was also used to develop data profiles for identified restoration projects throughout the KGI watershed (Appendix A, project profile summaries). The 67 projects in Appendix A are listed based upon a unique project ID number, which has no bearing on priority or identification status.

Based upon professional judgment, field reconnaissance of potential restoration opportunities included an assessment of restoration feasibility. In essence, this was an assessment of perceived value of human-made structures/alterations, and condition (intensive maintenance evident and/or absent) of existing structures. Feasibility criteria also deduced if desired restoration activities would pose a high risk to existing upland structures of value such as high-end retail homes, etc. Of the 67 projects selected in our assessment, 47 were deemed 'feasible', whereas 6 projects were considered important but of high risk and/or low feasibility for restoration, with the remaining 14 projects being classified as 'estuaries to protect' where we did not assign a 'feasibility' criteria. The designation of 'estuaries to protect,' was not vetted through a current ownership analysis, so some of these may already be protected.

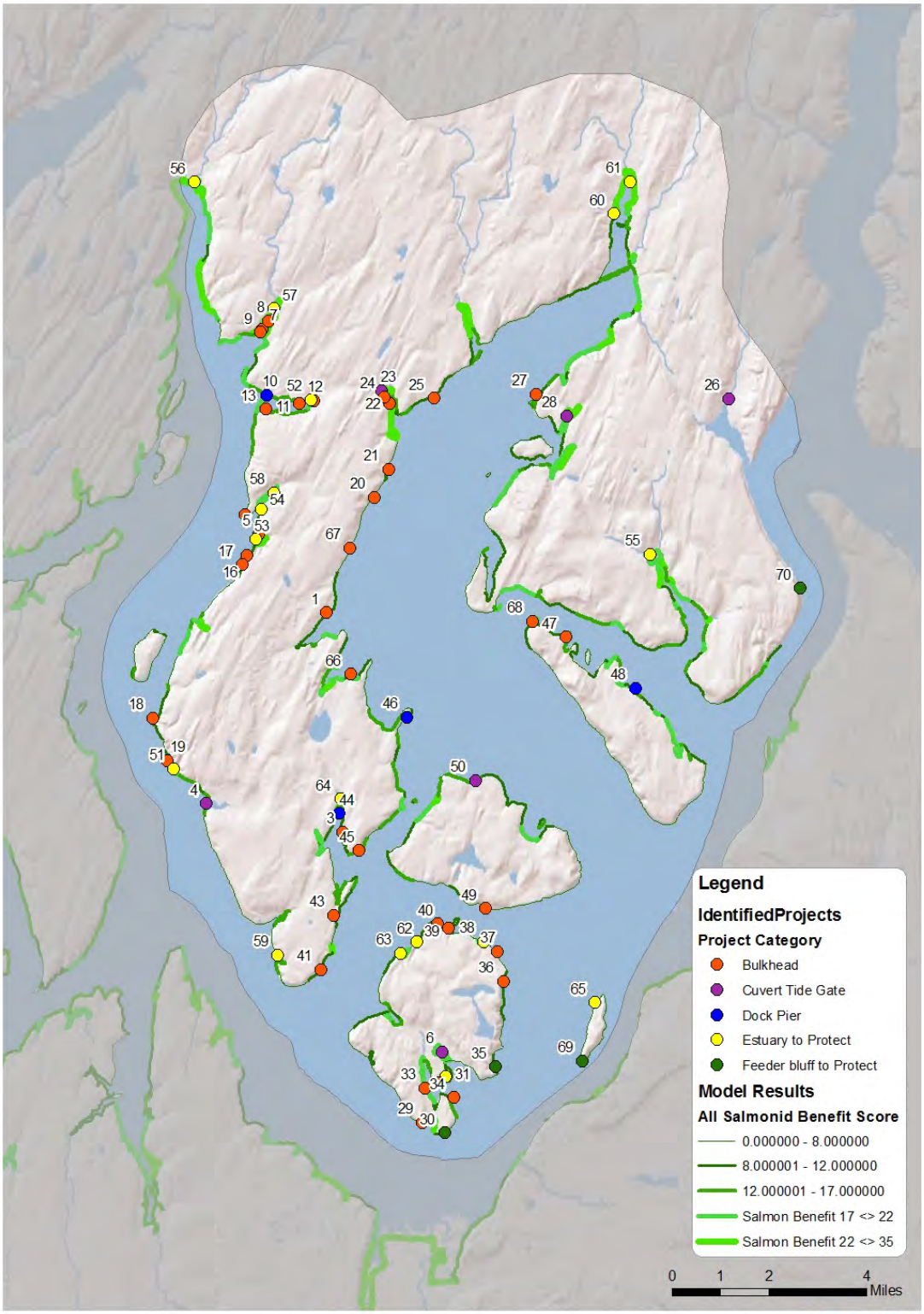


**Figure 5. Nearshore restoration project type and location throughout the greater Key Peninsula-Gig Harbor-Islands watershed in relation to model derived habitat benefits scores using the Nearshore Project Selection Tool (2009), All Salmonids model version.**

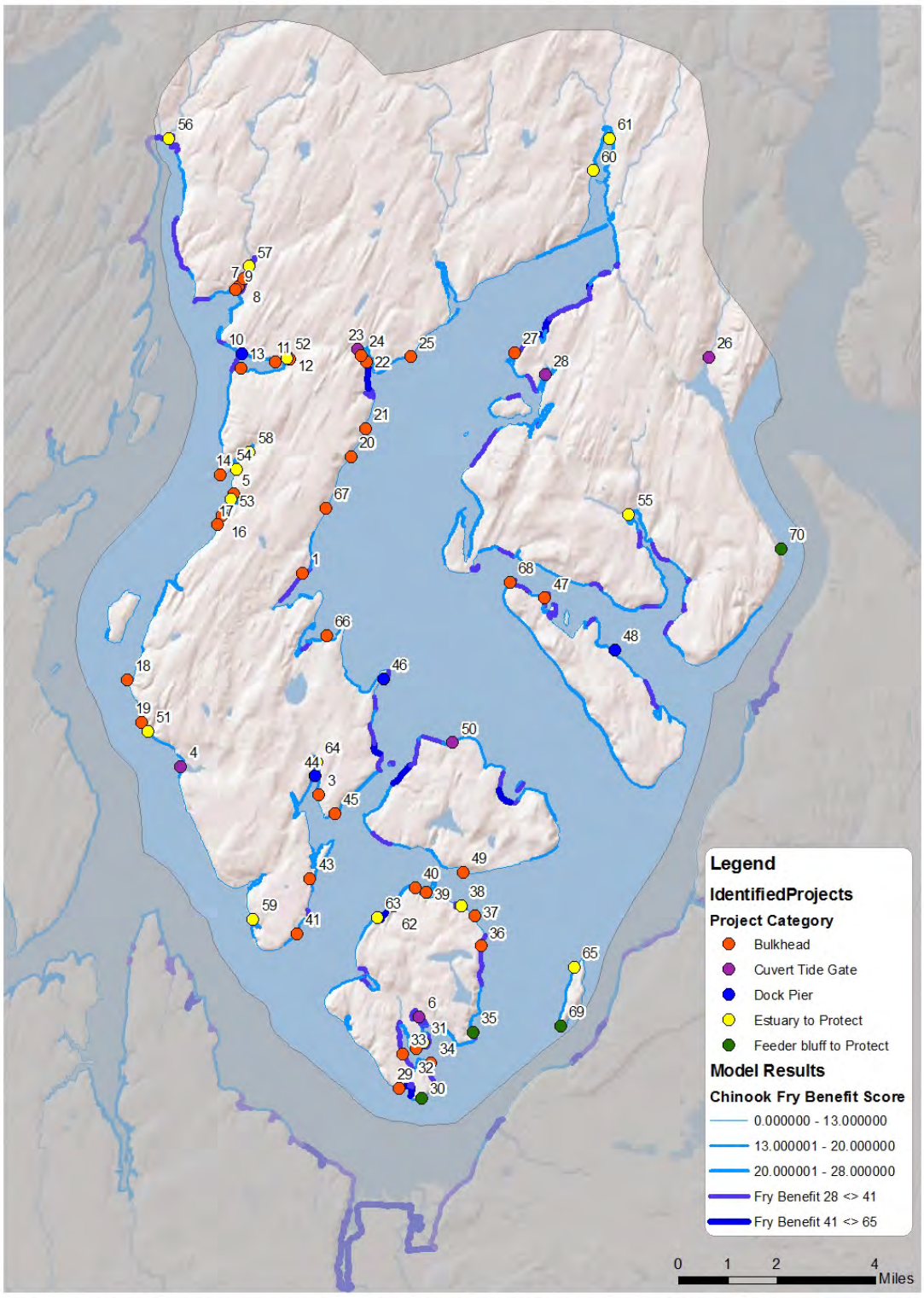


**Figure 6. Nearshore restoration projects by type and location throughout the Key Peninsula-Gig Harbor-Islands watershed in relation to model derived habitat benefits scores using the Nearshore Project Selection Tool (2009), Chinook Fry Benefit model version.**

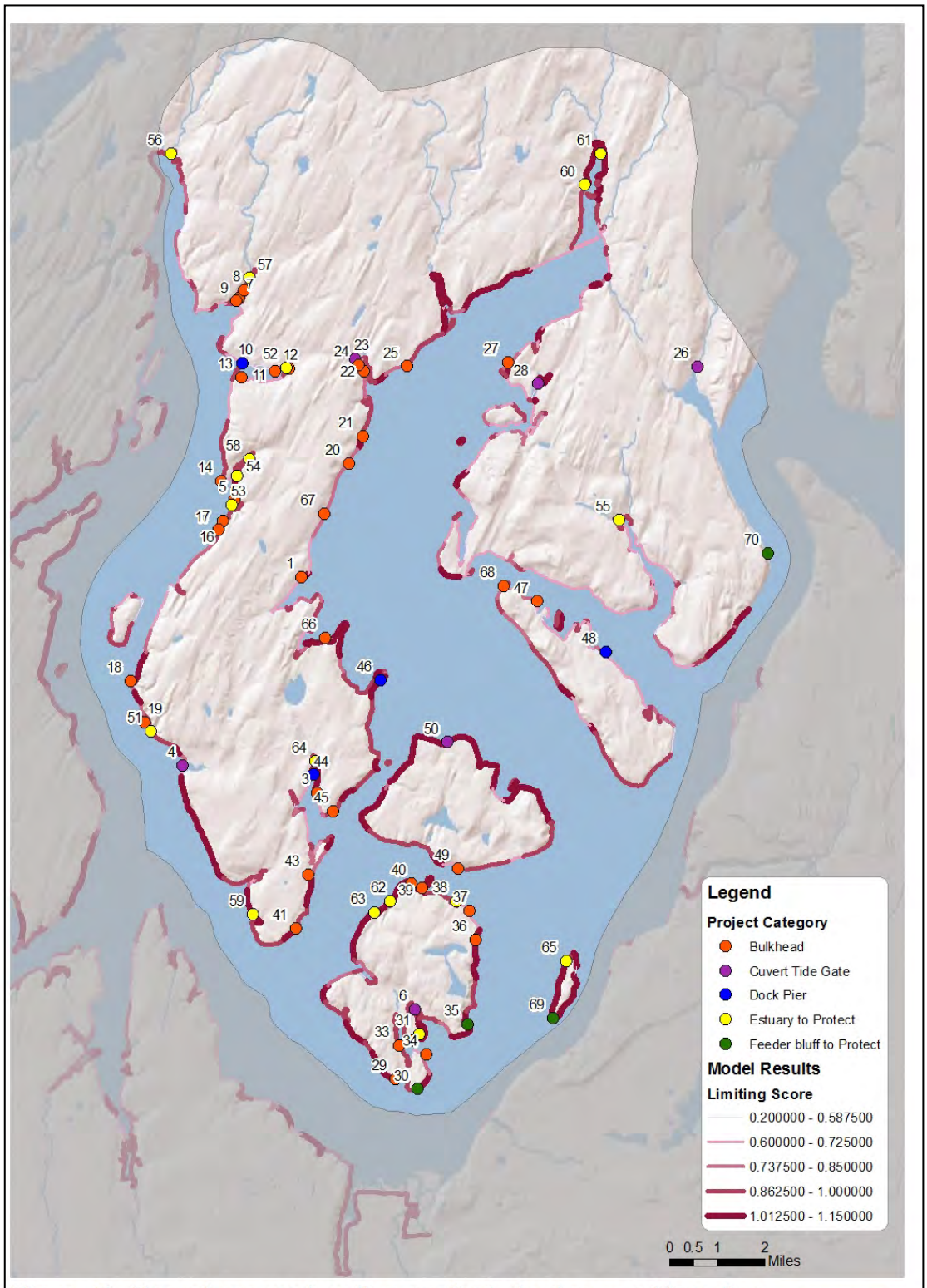


**Figure 7. Nearshore restoration projects by type and location throughout the Key Peninsula-Gig Harbor-Islands watershed in relation to model derived habitat limiting scores using the Nearshore Project Selection Tool (2009), Limiting Score model version.**

## 3.5 Preliminary Design Development of Nearshore Restoration Projects

Projects forwarded to preliminary design were selected both through a strategic identification process and as opportunity arose. Some of the projects selected for design that were more opportunistic in nature were initiated prior to completion of the remote sensing exercise. However, even the more opportunistic projects were vetted through the NPST analysis and compared against the results of the Pentec (2003) nearshore assessment before advancement to preliminary design.

The more opportunistic projects were Penrose Point Bulkhead Removal project (ID #66), Maple Hollow Restoration (ID #67) and VonGelern Cove Bulkhead Removal project (ID #1), which were initiated by the respective landowners. The other projects were identified through the remote sensing process and have varying degrees of landowner willingness: Filucy Bay Beach and Salt Marsh Enhancement (ID #3), Whiteman Cove Estuary Restoration (ID #4), and Haley Lagoon Shoreline Restoration (ID #5). Of the 6 projects developed for preliminary design, 3 are bulkhead removals on or near potential feeder bluffs, 2 are bulkhead removals in or near embayments, and 1 is a dam removal impounding an embayment. All of these projects seek to restore forage fish spawning habitat, sediment drift, salt marsh recolonization and estuarine function, or some combination thereof. Preliminary design reports for these 6 projects are included in Appendix B.

# 4.0 Discussion

The assessment methodology we developed and used to identify areas deserving of nearshore restoration efforts highlight the utility of remote sensing techniques, emerging GIS-based information and quantitative models. We feel that results from this assessment provide needed guidance and insight for advancing nearshore restoration efforts throughout the KGI watershed. In the process of this assessment effort we also recognize inherent limitations in being able to succinctly prioritize which restoration projects are of greatest importance. From our perspective, this limitation remains an overarching challenge in nearshore science, management and environmental restoration as a whole.

In this assessment we largely relied upon evaluation of existing habitat conditions throughout the nearshore environment, with a particular focus on habitat attributes and how they pertain to salmonid life-histories. In essence, this assessment catalogues existing habitat attributes respective of distinct ShoreZone segments (WDNR 2001), but is limited in specifying process-based dynamics that contribute to the form, function and persistence of such habitat attributes. Process-based restoration is becoming increasingly valued by the scientific community (Palmer 2009, Greiner 2010) and an overarching directive of the Puget Sound Nearshore Ecosystem Restoration Project ('PSNERP', Simenstad et al. 2006). As part of this, PSNERP has developed a suite of tools, among which is the "Change Analysis" assessment to evaluate historic versus current nearshore conditions from which to apply strategic approaches for prioritizing restoration. Given our assessment of the KGI Watershed, and its limitations, we strongly recommend a directed review and incorporation of PSNERP resources to further refine our assessment within WRIA 15.

Over half of the 65 potential restoration projects identified in our assessment of the KGI watershed were characterized as 'bulkhead removal' projects. Given that over half of the nearshore within Pierce County is considered 'modified' (WDNR 2001), it is not surprising that bulkheads are a prevalent focus for restoration efforts throughout this study area. Based upon our assessment, there is need for a more robust assessment protocol to identify and prioritize nearshore bulkheads most in need of modification/removal. Such an assessment would benefit from an analysis of current versus historic sediment sources which is not currently available for the KGI region. In part, this need is in conjunction with identifying 'priority' feeder bluffs as part of nearshore sediment budgets, net-shore drift dynamics and beach nourishment (Johannessen and MacLennan 2007). This aspect of nearshore restoration is an emerging science but warrants further consideration and development (see Puget Sound Shorelines and the Impacts of Armoring: State of the Science 2009).

A common theme in restoration science and strategies is consideration of dynamic relationships at the landscape versus the site scale. Spatial scales help guide restoration practitioners to determine appropriate strategies in relation to the likelihood of realizing restoration goals, and ideally, long-term restoration success (see Report Section 1.3.3). Our assessment of the KGI Watershed had a decided focus on the immediate marine nearshore interface where the NPST model-framework assessed nearshore segments according to ShoreZone delineations (WDNR 2001). Our framework thus considered projects (at the site scale) within a given ShoreZone segment (the landscape scale). Expansion of both site and landscape scales could incorporate consideration of adjacent ShoreZone segments respective of a given nearshore segment of interest. While this is certainly possible and our analysis approach could lend itself to such assessment considerations, we feel our approach would benefit from a more robust assessment of landscape influences. Given that process-based restoration is a desired and guiding strategy, we feel that our assessment suffers from limited consideration of upland terrestrial influences on nearshore forms and functions. Acknowledging the existing and ever-emerging datasets within the GIS framework, we feel that our assessment could be further developed by including such terrestrial upland information. This could be accomplished by considering watershed catchment areas in relation to nearshore environments; such considerations could include information to identify the degree(s) of upland impairments (i.e. impervious surface areas, land-use classifications, etc.) to be evaluated in relation to adjacent nearshore environments

Results from our assessment of the KGI watershed reiterate the need to identify restoration strategies (i.e. conservation, protection, restoration, enhancement, creation; Report Table 1). If we consider results from this assessment, particularly Figure 4 results (NPST Benefits Scores versus Limiting Scores) in context of the restoration strategy schematic provided in Figure 2 (Johnston et al. 2003), there is some inference towards identifying 'suitable' restoration strategies. Based upon our results, areas with high benefits scores and corresponding low 'limiting' scores could be considered more pristine areas best suited for conservation or preservation strategies; whereas areas with high limiting scores indicate increased prevalence of human-induced alterations in the nearshore and could suggest more appropriate strategies such as restoration, enhancement and/or creation. The corollary to this, and a cautionary note, associated model benefits scores do not necessarily reflect the degree of intact pristine habitat; rather, model benefits scores indicate a scaling of areas that encompass a suite of habitat

attributes presumably preferred by salmon (i.e. the degree of habitat diversity within a given ShoreZone unit). As an example, a given ShoreZone unit may only be comprised of saltmarsh habitat (no eelgrass, no forage fish spawning, etc.) and thus score relatively low according to the NPST benefits criteria. However, such areas should be considered in the context of larger landscape scales that address connectivity of ecosystem processes.

Appropriate restoration strategies in general concern the ability to establish natural ecosystem processes that are self-maintaining over time. If we consider the graphic representation of projects identified in this assessment of the KGI Watershed (Figures 5 – 7), restoration strategies need to consider large-scale restoration efforts, such as areas where projects are clustered, versus more small-scale restoration opportunities, where projects are more isolated from one another. These considerations should also be evaluated in relation to NPST model score results; one prioritization approach is to favor projects located within or most adjacent to nearshore areas scored as 'high benefit'.

Despite the limitations of our assessment, we feel results provide a transparent and repeatable methodology for identifying pertinent restoration opportunities/needs throughout the KGI Watershed. Furthermore, our assessment methodology easily lends itself to further development and refinements within the developed and contemporary GIS framework. From our perspective, the above discussion points and recommendations can be incorporated as an adaptive update to our assessment results, largely using GIS remote sensing approaches. Last, as restoration practitioners, we feel it is important to recognize and incorporate the sometimes 'opportunistic' nature of applied environmental restoration. Any developing strategies and frameworks should acknowledge this opportunistic aspect where landowner interests and cooperation towards restoration efforts is often a deciding factor regarding where and what type of restoration actions are possible. This last point is reflected in the six nearshore restoration projects advanced in this assessment for initial pre-project design and development, and ideally, near-term implementation.

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# 6.0 Appendix A. Assessment summary data profiles of selected nearshore restoration projects throughout the KGI watershed.

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# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **1** | Von Geldern | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Beach | 47.278386 | -122.756398 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1370** | 10 | 30 | 0.663 |
| **Description and Restoration Recommendation** | | | |
| **Remove series of soldier pile bulkheads (5+ homes) to improve beach and backshore connectivity** | | | |

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2009)

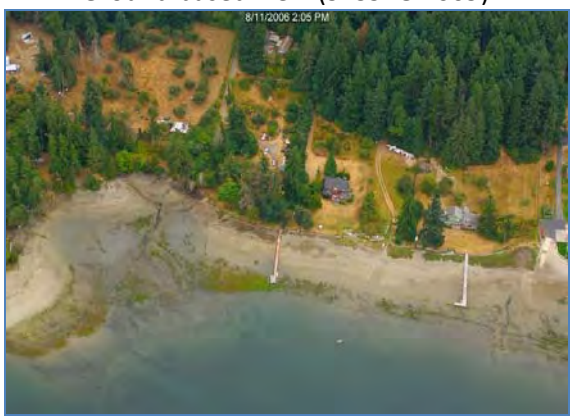
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **3** | Filucy Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Beach | 47.213353 | -122.746849 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1589** | 22 | 30 | 0.825 |
| **Description and Restoration Recommendation** | | | |
| **Remove soldier pile and tiered timber/rock bulkhead to improve salt marsh habitat and habitat connectivity in Filucy Bay** | | | |

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **4** | Whiteman Cove | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Embayment | 47.220568 | -122.806771 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2459** | 14 | 16 | 0.650 |
| **Description and Restoration Recommendation** | | | |
| **Remove sheet pile impoundment and two tide gates, restore spit and longshore drift, restore inlet to improve fish passage and tidal hydrology** | | | |

Aerial view (DOE 2006)

Aerial view (DOE 2006)

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **5** | Vaughn Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Beach | 47.301138 | -122.787404 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2418** | 14 | 16 | 0.800 |
| **Description and Restoration Recommendation** | | | |
| **Remove tire and rock bulkhead to improve beach and bluff connectivity and improve mouth of small embayment** | | | |

**2063**


Aerial view (DOE 2006)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **6** | Oro Bay | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.148704 | -122.700726 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1774** | 20 | 33 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove earthen dam impounding upper portion of finger estuary** | | | |

Aerial view (DOE 2006)

Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **7** | Rocky Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.362300 | -122.788080 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2389** | 29 | 32 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Remove pile bulkhead and concrete pillows, creosote platform and random creosote piles inside Rocky Bay to improve beach and salt marsh habitat** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

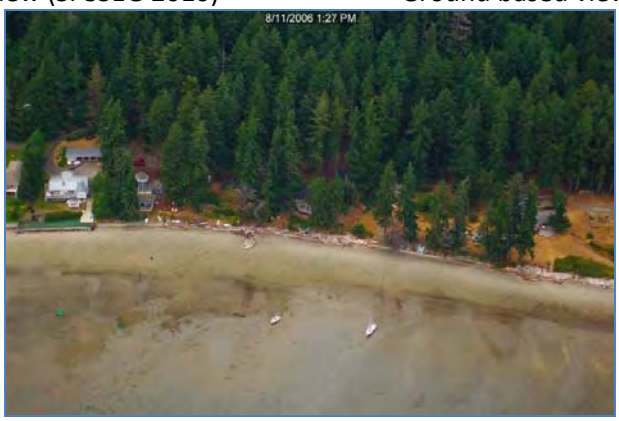
Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **8** | Rocky Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.364690 | -122.785600 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2392** | 27 | 38 | 0.850 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete bulkheads (3) and replace with soft armor to improve drift to estuarine spit and improve habitat connectivity to unarmored shorelines** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **9** | Rocky Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.361290 | -122.789110 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2387** | 17 | 19 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove tire and pile bulkhead from the toe of a forested bank** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **10** | Vaughn Bay | | Dock or Pier to Remove |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.342600 | -122.785400 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2404** | 20 | 31 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict piles from barrier spit** | | | |

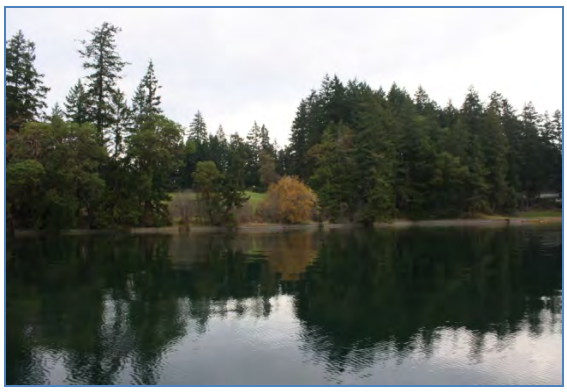
Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

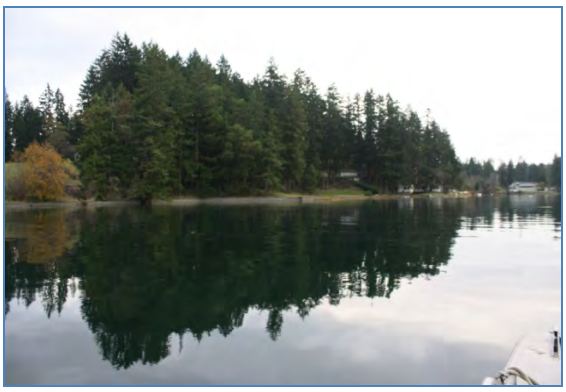

Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **11** | Vaughn Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.340540 | -122.771100 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2400** | 16 | 26 | 0.550 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete bulkhead to reconnect riparian and salt marsh** | | | |



Ground based view (SPSSEG 2010)



Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **12** | Vaughn Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.341410 | -122.764830 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2401** | 20 | 23 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete pillow bulkhead at head of Vaughn Bay to improve habitat connectivity** | | | |

Ground based view (SPSSEG 2010)

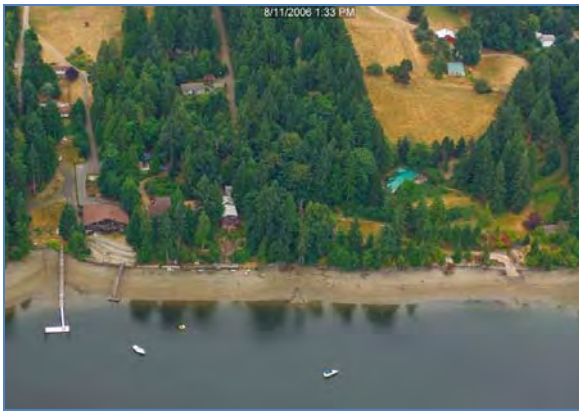
Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **13** | Vaughn Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.338420 | -122.785770 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2402** | 16 | 19 | 0.625 |
| **Description and Restoration Recommendation** | | | |
| **Remove rock bulkhead from toe of forested bluff** | | | |




Aerial view (DOE 2006)

Ground based view (SPSSEG 2010))

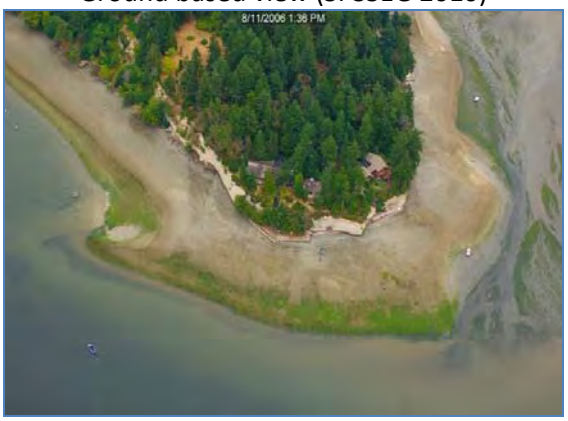
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **14** | Case Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.306800 | -122.793210 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2408** | 8 | 12 | 0.913 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete bulkheads (2) from toe of feeder bluff to restore sediment input and beach connectivity** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)



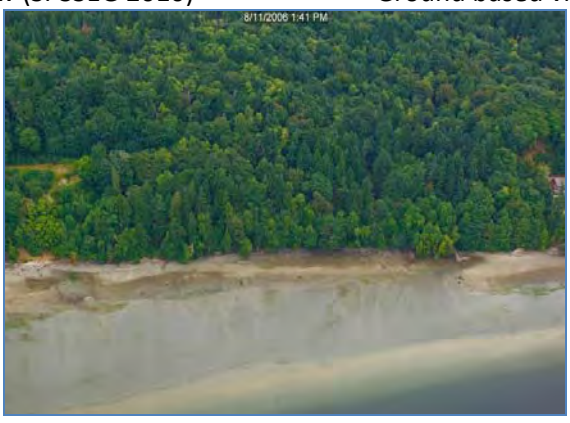
Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **16** | Case Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.294890 | -122.791930 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2422** | 10 | 12 | 0.950 |
| **Description and Restoration Recommendation** | | | |
| **Remove rock bulkhead from toe of forested bluff to restore sediment input** | | | |

Ground based view (SPSSEG 2010)

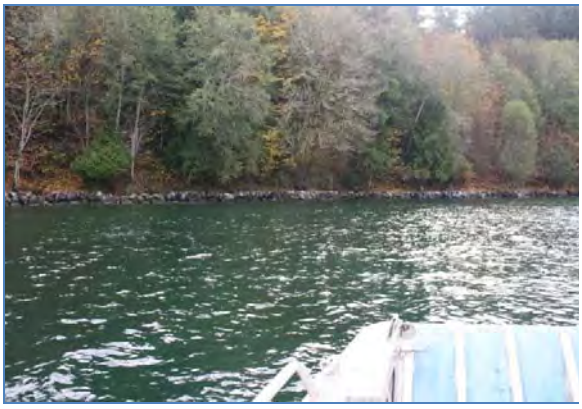
Ground based view (SPSSEG 2010)




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **17** | Case Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.291960 | -122.793970 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2422** | 10 | 12 | 0.950 |
| **Description and Restoration Recommendation** | | | |
| **Remove rock and concrete bulkhead from toe of forested bluff to restore sediment input** | | | |



Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **18** | Case Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.245620 | -122.83101 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2436** | 10 | 12 | 0.750 |
| **Description and Restoration Recommendation** | | | |
| **Remove rock and tire bulkhead and invasive plants from spit, remove concrete abuttments from creek channel** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **19** | Case Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.233130 | -122.824210 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2454** | 10 | 12 | 0.913 |
| **Description and Restoration Recommendation** | | | |
| **Remove failing concrete bulkhead and adjacent abandoned piles and concrete bulkhead** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **20** | Carr Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.313190 | -122.736910 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1374** | 6 | 10 | 0.763 |
| **Description and Restoration Recommendation** | | | |
| **Remove failing pile bulkhead from toe of feeder bluff** | | | |

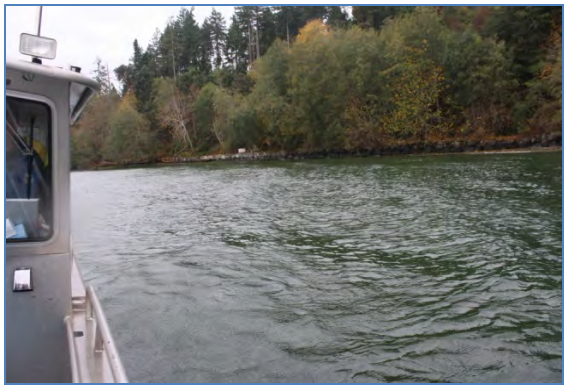
Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **21** | Carr Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.321640 | -122.731170 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1376** | 6 | 8 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Remove rock bulkhead from toe of feeder bluff** | | | |



Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

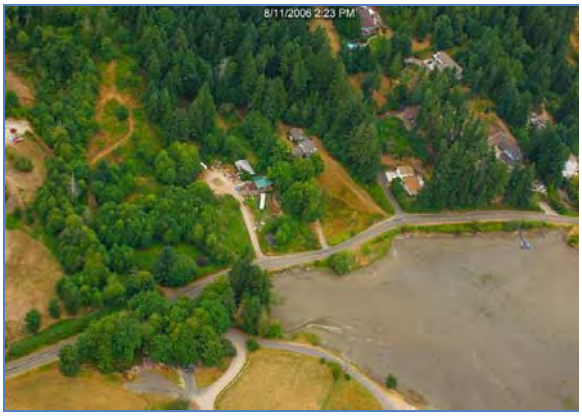
| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **22** | Glen Cove | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.341151 | -122.731310 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1381** | 20 | 16 | 0.813 |
| **Description and Restoration Recommendation** | | | |
| **Remove tire and gabion bulkhead** | | | |

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **23** | Glen Cove | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.344990 | -122.735290 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1382** | 24 | 25 | 0.700 |
| **Description and Restoration Recommendation** | | | |
| **Replace perched tidal culvert under road with larger structure to restore fish passage and tidal hyrdology** | | | |



Aerial view (DOE 2006)


Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **24** | Glen Cove | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.343118 | -122.734020 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1381** | 20 | 16 | 0.813 |
| **Description and Restoration Recommendation** | | | |
| **Remove failing bulkhead to restore beach structure and improve salt marsh** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **25** | Carr Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.343100 | -122.712300 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1390** | 10 | 12 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete (pipe section) encroached bulkhead to restore beach structure** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **26** | Gig Harbor | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.345426 | -122.583089 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1415** | 16 | 18 | 0.725 |
| **Description and Restoration Recommendation** | | | |
| **Replace tidal culvert in Crescent Creek with larger structure to restore tidal flow and fish passage** | | | |

Aerial view (DOE 2006)

Aerial view (DOE 2006)

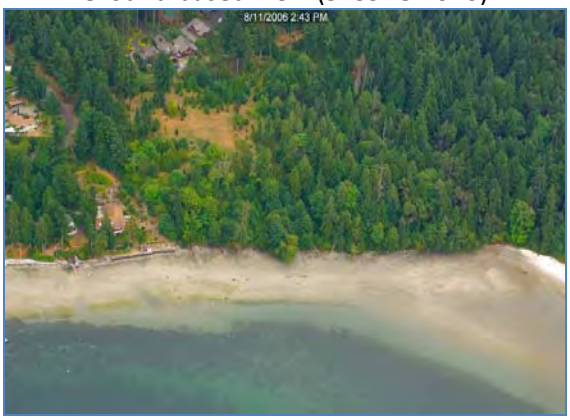
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **27** | Raft Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.345190 | -122.667490 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1436** | 12 | 30 | 0.800 |
| **Description and Restoration Recommendation** | | | |
| **Remove pile bulkhead from toe of forested bluff** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **28** | Lay Inlet | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.338890 | -122.653880 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1444** | 18 | 21 | 0.563 |
| **Description and Restoration Recommendation** | | | |
| **Replace buried tidal culvert under road with larger structure to restore fish passage and tidal hyrdology** | | | |

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **29** | Thompson Cove | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.127645 | -122.708391 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1756** | 18 | 45 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove ecoblock bulkhead and rock bulkhead adjacent to spit and stream to improve beach structure and longshore drift** | | | |

Aerial view (DOE 2006)

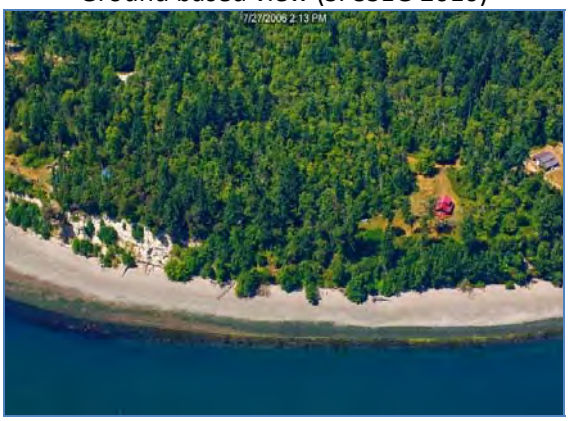

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **30** | Anderson Island | | Feeder Bluff to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.124722 | -122.698611 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1759** | 12 | 16 | 0.925 |
| **Description and Restoration Recommendation** | | | |
| **Protect feeder bluff** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)



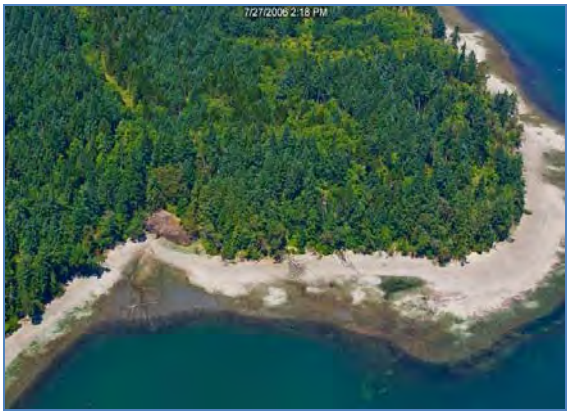

Aerial view (DOE 2006)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **31** | East Oro Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.141389 | -122.698611 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1772** | 10 | 30 | 1.138 |
| **Description and Restoration Recommendation** | | | |
| **Protect beach and estuarine embayment** | | | |


Aerial view (DOE 2006)




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **32** | Oro Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.139444 | -122.701667 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1771** | 14 | 32 | 1.075 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict structures in Oro Bay - 6 derelict boats on shore, and derelict boat ramp** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **33** | Oro Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.137786 | -122.707543 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1798** | 20 | 28 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove timber/crib bulkhead and ramp, remove invasives and replant with native vegetation to improve beach and riparian connectivity** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **34** | Oro Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.135278 | -122.695000 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1761** | 14 | 34 | 0.850 |
| **Description and Restoration Recommendation** | | | |
| **Remove pile and concrete bulkheads, old pier and boat house** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

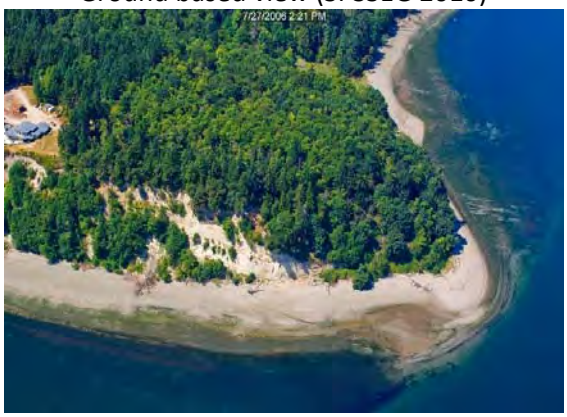
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **35** | Anderson Island | | Feeder Bluff to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.144722 | -122.677222 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1780** | 12 | 30 | 1.025 |
| **Description and Restoration Recommendation** | | | |
| **Protect feeder bluff with easement or acquisition** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)



Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **36** | Anderson Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.170220 | -122.674790 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1784** | 10 | 30 | 1.113 |
| **Description and Restoration Recommendation** | | | |
| **Remove bulkheads, derelict piles and corrugated plastic culvert diverting small creek to restore beach and freshwater input** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **37** | Anderson Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.179060 | -122.677700 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1785** | 8 | 10 | 0.713 |
| **Description and Restoration Recommendation** | | | |
| **Remove tire, timber and sheet pile bulkheads (3) to restore beach profile** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **38** | Anderson Island | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.181910 | -122.683790 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1787** | 20 | 28 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Protect sand spit and small embayment stream** | | | |

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **39** | Anderson Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.185560 | -122.699167 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1793** | 4 | 6 | 1.125 |
| **Description and Restoration Recommendation** | | | |
| **Remove tire & concrete bulkhead to improve beach and riparian connectivity** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

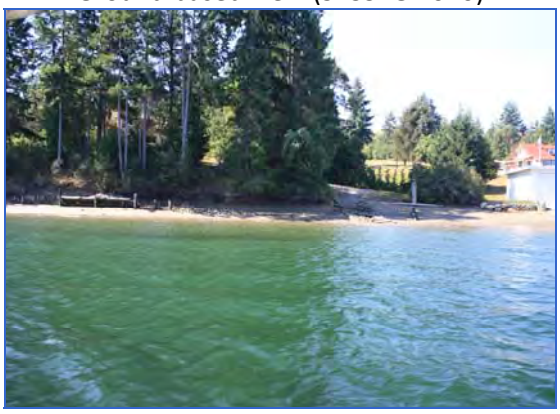
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **40** | Anderson Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.186776 | -122.704040 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1795** | 10 | 12 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict pilings and boat ramp to improve longshore drift** | | | |

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

Aerial view (DOE 2006)



Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **41** | Drayton Passage | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.172279 | -122.754460 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1564** | 10 | 14 | 1.025 |
| **Description and Restoration Recommendation** | | | |
| **Remove failed ecoblock bulkhead and improve beach and riparian connectivity** | | | |

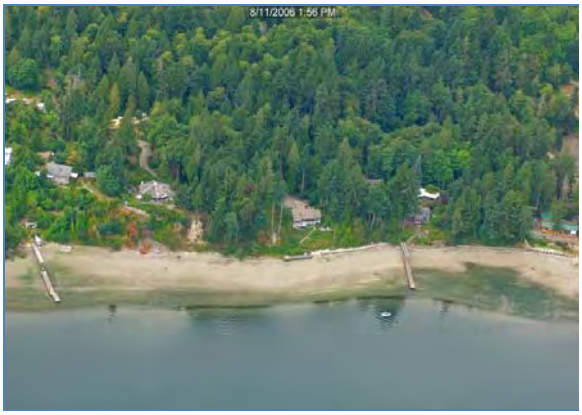
Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **43** | Drayton Passage | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.188500 | -122.749500 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1571** | 10 | 14 | 0.750 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete and pile bulkhead and groins to restore feeder bluff** | | | |




Aerial view (DOE 2006)

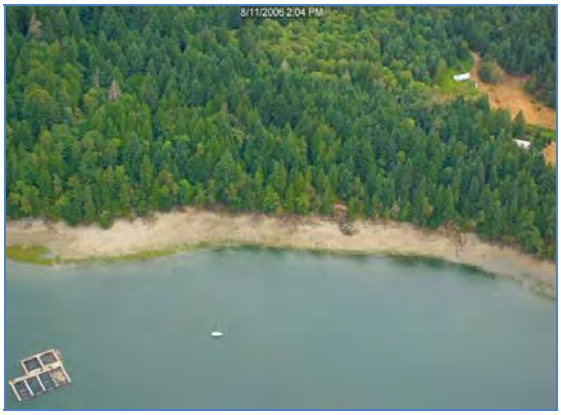
Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **44** | Filucy Bay | | Dock or Pier to Remove |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.218790 | -122.748600 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1586** | 24 | 32 | 1.125 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict fish pens** | | | |




Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **45** | Filucy Bay | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.207887 | -122.739480 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1592** | 14 | 18 | 0.950 |
| **Description and Restoration Recommendation** | | | |
| **Remove soldier pile bulkhead to restore feeder bluff** | | | |


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **46** | Filucy Bay | | Dock or Pier to Remove |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.248056 | -122.720000 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1604** | 6 | 10 | 1.075 |
| **Description and Restoration Recommendation** | | | |
| **Remove old pier on point to improve longshore drift** | | | |

Aerial view (DOE 2006)


Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **47** | Fox Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.273120 | -122.651350 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1659** | 16 | 36 | 0.650 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict culvert on beach to restore beach profile and improve longshore drift** | | | |

Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

Aerial view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **48** | Fox Island | | Dock or Pier to Remove |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.258410 | -122.620570 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1641** | 16 | 20 | 0.438 |
| **Description and Restoration Recommendation** | | | |
| **Remove derelict ferry dolphin to restore beach profile and improve longshore drift** | | | |

Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **49** | McNeil | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.191790 | -122.683380 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1678** | 4 | 6 | 0.725 |
| **Description and Restoration Recommendation** | | | |
| **Remove ecoblock bulkhead (2) to restore beach profile** | | | |


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)


Aerial view (DOE 2006)

Ground based view (SPSSEG 2010)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **50** | McNeil | | Culvert or Tide Gate Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.229815 | -122.689490 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1698** | 16 | 21 | 1.025 |
| **Description and Restoration Recommendation** | | | |
| **Remove/replace culvert with larger structure to restore fish passag and tidal hydrology to small embayment.** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **51** | Case Inlet | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.230618 | -122.821440 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2455** | 28 | 31 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **52** | Vaughn Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.341624 | -122.765835 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2401** | 20 | 23 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **53** | Haleys Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.299624 | -122.788399 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1602** | 10 | 14 | 0.975 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **54** | Dutcher Cove | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.308544 | -122.786297 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2415** | 16 | 17 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **55** | Wollochet Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.298422 | -122.615898 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1723** | 20 | 21 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary, at head of Wollochet Bay, with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **56** | North Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.405330 | -122.819810 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2375** | 29 | 30 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **57** | Rocky Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.368379 | -122.783389 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2389** | 29 | 32 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **58** | Dutcher Cove | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.313621 | -122.781022 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2412** | 18 | 21 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |

Aerial view (DOE 2006)

Aerial view (DOE 2006)

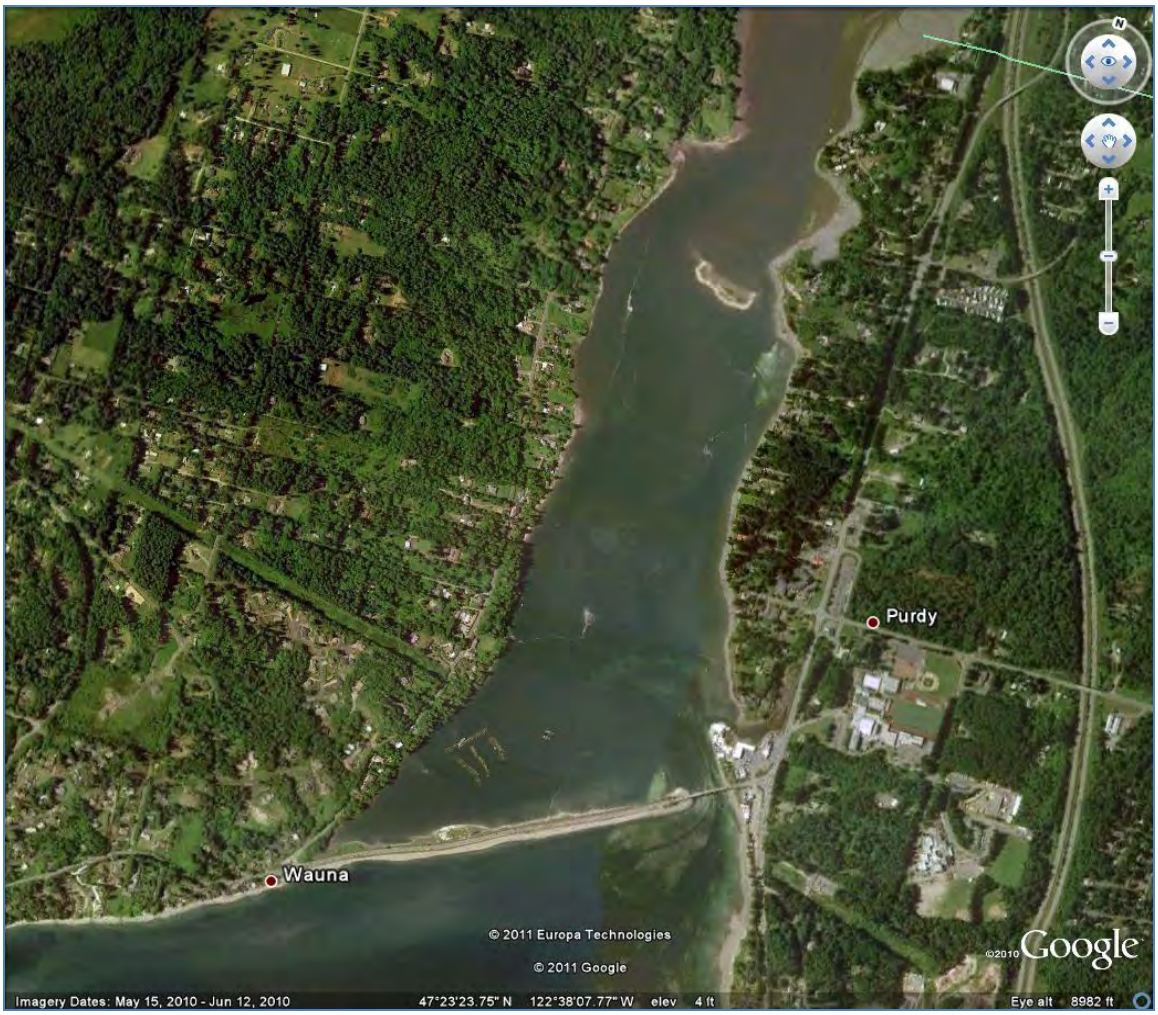
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **59** | Nisqually Reach | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.176129 | -122.773590 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **2469** | 14 | 20 | 1.075 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **60** | Burley Lagoon | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.399414 | -122.635538 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1408** | 10 | 10 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Large Estuary with some development impacts, assessment, protection efforts and restoration efforts should be undertaken.** | | | |



Aerial view (Google Earth 2011)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| 61 | Upper Burley Lagoon | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.409047 | -122.628629 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1410** | 24 | 25 | 1.100 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

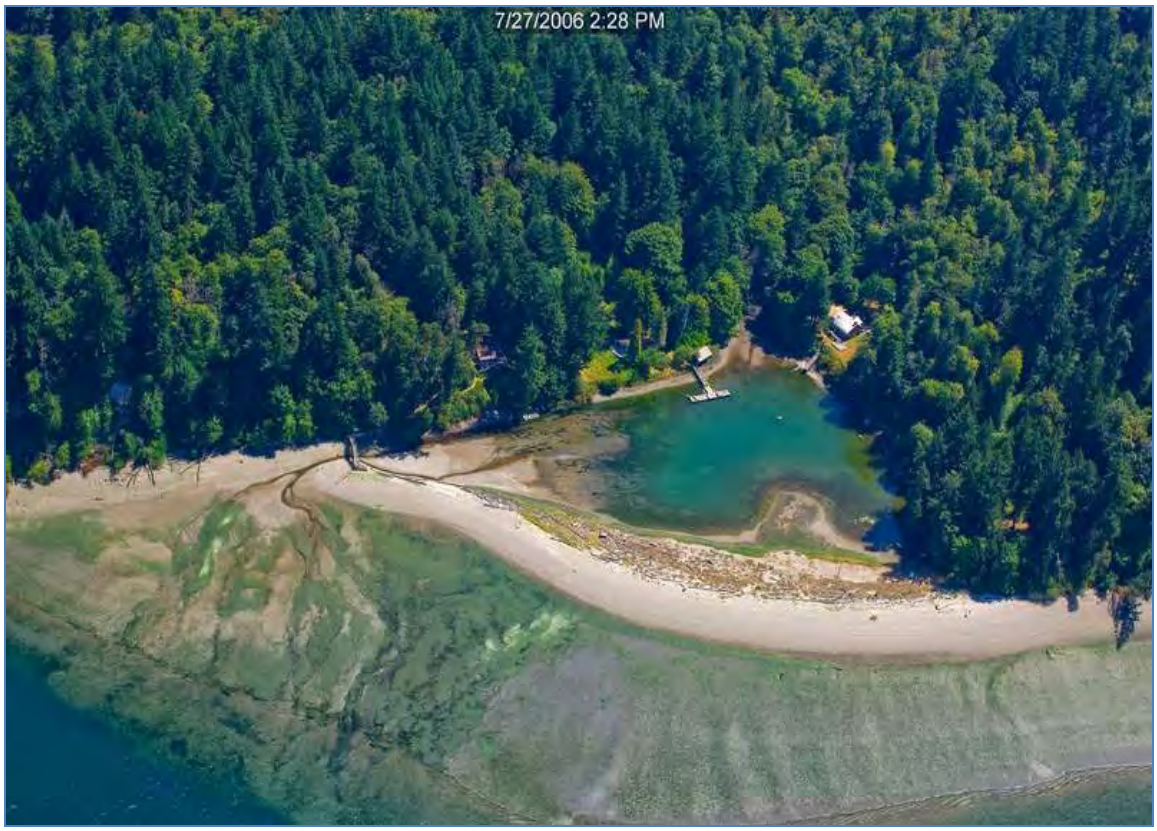
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **62** | Anderson Island | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.181213 | -122.713008 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1798** | 20 | 28 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **63** | Anderson Island | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.177771 | -122.719830 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1802** | 26 | 42 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development stuary with limited development impacts to protect from furture development** | | | |




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **64** | Filucy Bay | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.223056 | -122.748056 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1587** | 16 | 22 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |

Aerial view (DOE 2006)

Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **65** | Ketron Island | | Estuary to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Embayment | 47.164660 | -122.634401 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1531** | 2 | 4 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Estuary with limited development impacts to protect, or continue to protect, from future development** | | | |


Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **66** | Mayo Cove | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Beach | 47.260278 | -122.745295 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1351** | 18 | 22 | 0.875 |
| **Description and Restoration Recommendation** | | | |
| **Remove large creosote bulkhead with rip rap toe protection to restore beach profile and feeder bluff** | | | |

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)


Aerial view (DOE 2006)

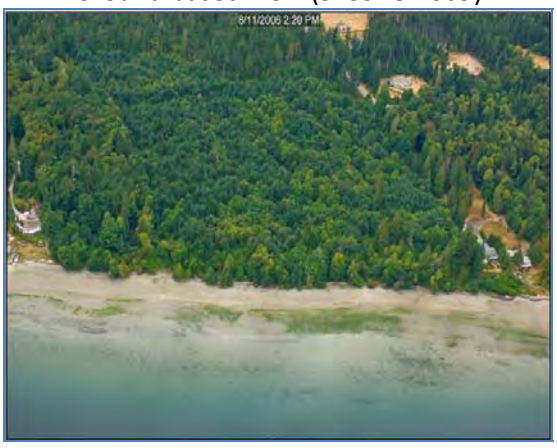
# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **67** | Carr Inlet | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **Y** | Beach | 47.297905 | -122.747135 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1373** | 8 | 10 | 0.788 |
| **Description and Restoration Recommendation** | | | |
| **Remove gabion bulkhead, and concrete/creosote timber stairchase to restore beach profile and feeder bluff** | | | |

Ground based view (SPSSEG 2009)

Ground based view (SPSSEG 2009)

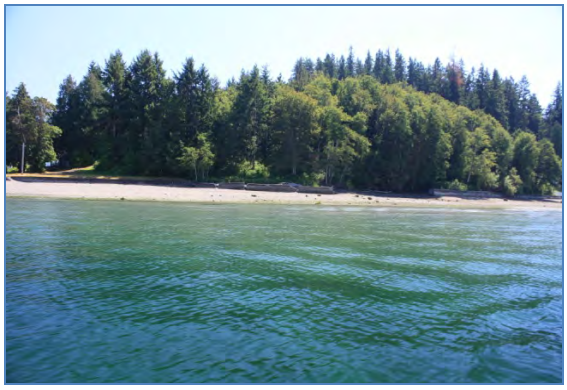
Ground based view (SPSSEG 2009)



Aerial view (DOE 2006)

# Project Data Sheet

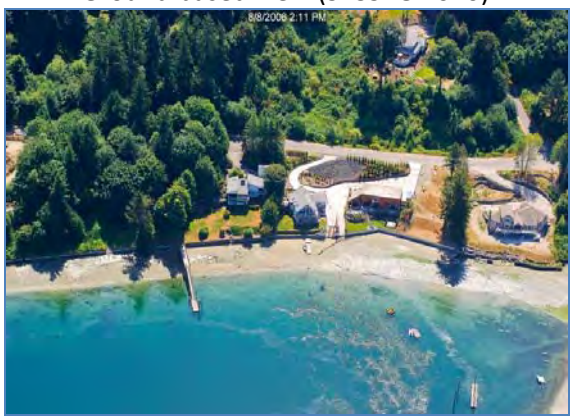
| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **68** | Fox Island | | Bulkhead Removal |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Beach | 47.277549 | -122.666438 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1663** | 16 | 20 | 0.900 |
| **Description and Restoration Recommendation** | | | |
| **Remove concrete bulkhead to restore beach and reconnect riparian** | | | |



Ground based view (SPSSEG 2010)

Ground based view (SPSSEG 2010)

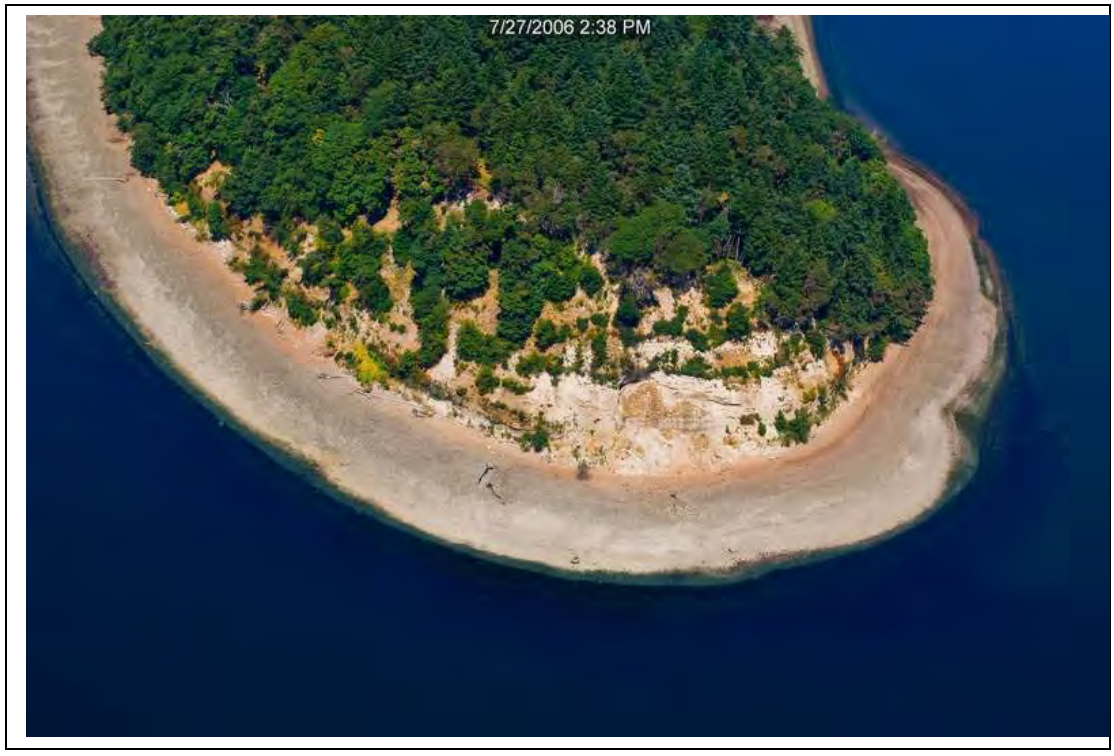
Aerial view (DOE 2006)



Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| 69 | Ketron Island | | Feeder Bluff Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.147583 | -122.369701 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **1526** | 2 | 10 | 0.975 |
| **Description and Restoration Recommendation** | | | |
| **Protect feeder bluff and adjacent shoreline.** | | | |




Aerial view (DOE 2006)

# Project Data Sheet

| Project ID | Geographic Location | | Project Category |
|---|---|---|---|
| **70** | Tacoma Narrows | | Feeder Bluff to Protect |
| **Preliminary Design** | **Primary Habitat Target** | **Latitude** | **Longitude** |
| **N** | Feeder Bluff | 47.279928 | -122.55157 |
| **Unit ID** | **All Species** | **Fry Migrant** | **Limiting Score** |
| **NA** | NA | NA | NA |
| **Description and Restoration Recommendation** | | | |
| **Protect feeder bluff and adjacent shoreline** | | | |


Aerial View (DOE 2006)

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# 7.0 Appendix B. Nearshore restoration projects selected and advanced to preliminary design development.

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## Appendix B.1: VonGeldern Cove Bulkhead Removal (Project ID # 1)

### Project Description

This bulkhead removal project is located on the northeast section of VonGeldern Cove. The following design report analyzed feasibility and design alternatives for removal of two adjacent bulkheads (210-feet) in VonGeldern Cove with the goal to restore natural processes and enhance nearshore habitat function on several (up to five) adjacent properties in the Cove (Coastal Geologic Services 2010). The site consists of a low bank beach with gently sloping uplands developed as single family homes. The site presents a good opportunity for restoration as shoreline armor appears to be unnecessary given the low wave energy and low erosion potential.

The toe of the existing bulkheads meet the beach approximately 1.5-feet below Mean Higher High Water, limiting the function of the active beach and back beach area. The conceptual approach for this project as detailed in the following design report would be to remove the vertical pile bulkhead(s) and grade the upper beach and upland area towards a more natural, gently sloping profile. The proposed toe of the slope would be moved 15-20 feet landward of the existing bulkhead toe to allow for colonization of saltmarsh vegetation and wave energy dissipation. The following report focused on two parcels with willing landowners, but the approach could be utilized at adjacent sites to expand the footprint and increase the benefit of the project, depending upon interest.


**Figure 7.1 Aerial photo (DOE 2006) location of bulkhead removals, project may include removal of one to five bulkheads.**

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# Conceptual Bulkhead Removal, Feasibility, and Conceptual Beach Enhancement Assessment at Von Geldern Cove Site, Pierce County, WA

Prepared for: South Puget Sound Salmon Enhancement Group

Prepared By: Jim Johannessen, Licensed Engineering Geologist and MS,
and Jonathan Wagoner
Coastal Geologic Services Inc.

November 30, 2010

## Introduction and Purpose

The objective of this bulkhead removal feasibility project was to provide coastal processes assessment, bulkhead removal feasibility, and conceptual designs for 2 different coastal sites on the Long Peninsula in the western portion of Pierce County, WA. This is the second of the 2 sites and the second of the 2 conceptual beach restoration memos. Based on the field visit and review of ground and air photos, it appeared that bulkhead removal should be generally feasible at the Von Geldern Cove site, which is composed of 2 adjacent, residential parcels. The larger goal of the project is to enhance nearshore habitats and natural processes through the removal of the bulkheads and implementation of coastal restoration management measures at the Von Geldern Cove site.

This memo summarizes the information for the Von Geldern Cove site visit conducted in March 2010. The memo covers both Task 1, which consisted of background information review, site assessment and coordination, as well as Task 2, which included the bulkhead removal/enhancement feasibility study and detailed conceptual designs, contained herein.
The Von Geldern Cove site under consideration is located at the northwestern shore Von Geldern Cove, in the village of Home on the Lower Peninsula in western Pierce County. The site is located 0.8 miles northeast of the Gig Harbor-Longbranch Road bridge near the head of bay. The site is accessed by private driveways off of B Street.

The site consisted of an undetermined number of adjacent parcels at the time of the project initiation. After discussion with K. Williamson of South Puget Sound Salmon Enhancement Group (SPSSEG), CGS was directed to focus on 2 adjacent parcels, and a 15-ft wide easement area (Sheet 1). The northeast parcel was the initial contact for SPSSEG, and is owned by Ted and Cathy Williams and located at 2305 B Street, Home, WA. The second parcel is owned by Clark and Cindy Johnson (parcel on the left of southwest side in Figure 1). A 15-ft-wide easement is located on the northeast side of the Williams parcel, which was reportedly owned by Katherine Judge, the owner of the parcel adjacent and further to the northeast. The 2 larger parcels and the easement have a total shore length of approximately 215 ft along Von Geldern Cove.

## Summary of Site Conditions

The site is pictured in oblique aerial photos from 2006 and 1977 in Figures 1 and 2. The site consists of low bank area with gently sloping upland areas that have been developed as single-family lots. There is a house on each of the 2 main parcels, with attached decks on the waterward side of the houses. The 1977 aerial photo appears to show that the Williams House was recently constructed, as the guard appears to have just been greeted at that time. This included re-creating all the way out to the bank crest area. Although it is not terribly clear, it appears that the soldier pile bulkhead wall was already in place in 1977 at the Williams site and several adjacent parcels to the northeast. The Johnson property was not developed in 1977 and contained a mixture of scrubby vegetation and immature trees. It appears that the bulkhead was not yet constructed on this property in 1977 (Figure 1).

The northeastern residence (Williams) was located approximately 100 ft landward of the top of bank, and the southern house was located approximately 80 ft from the top of bank. Sheet 1 shows approximate site conditions; note that this map and Sheet 2 were made using LiDAR elevation data and air photos for locating major features, and is therefore only approximate in nature. Access is from the landward side. The northeastern house has a septic drainfield located at least 60 ft landward of the bank crest, while the location of the drainfield at the other parcel is not known. The yards have a mix of lawn and small to moderate sized tress and shrubs. The bank elevation was measured at approximately 15 ft high, above the filled area just above the beach. The bank face and fill are landward of the bulkhead was heavily vegetated with English ivy, an invasive, exotic species.

Figure 3 show detailed site photos of the beach and bank areas. The beach at these study area properties was dominated by pebble, and was characteristic of typical mixed sand and gravel beaches of the greater central Puget Sound region. The upper intertidal beach near the bulkheads contained a greater percentage of sand, while the mid-intertidal beach contained pebble with sand and lesser amounts of cobble, and the lower intertidal contained pebble and cobble with sand.

The shore of the site is exposed to a maximum 6.5 mile fetch (open water distance over which wind waves are formed) from the east-southeast. The next largest fetch is from the northeast at approximately 3.2 miles. The fetch within Von Geldern Cove is limited to less than 0.7 miles from the southeast to southwest. Therefore the only fetch of significance is from the east-southeast, and winds from this direction are limited in occurrence. The smaller fetch from the southeast to southwest is the direction of both prevailing (most common) and predominant (strongest) winds. Since the area has such a low fetch from key directions, it can be characterized as “low” wave energy category (Cox et al. 1994). Although there is not a universally accepted definition of the term high wave energy in the Puget Sound region, one definition used for low wave energy is a fetch of 1 mile or less (Cox et al. 1994).

Net shore-drift, or the long-term effect of littoral drift was mapped at the study area in the 1980s for the WA Dept. of Ecology (Schwartz et al. 1991). A net shore-drift cell (also called a littoral cell of longshore drift cell) refers to a discreet sediment transport cell that generally includes erosional bluffs as sediment sources in the up-drift (and other) portions of the cell, zones(s) of sediment transport with limited input, and some amount of accretion shoreforms in the down-drift end

(Johannessen and MacLennan 2007). Net shore-drift is southeastward in Von Geldern Cove. Net shore-drift cell PI-16-2 originates at the minor point at the northeast end of the cove. The site is about one-third of the way along the drift cell and continues to the bridge where the sediment transport tapers off due to very low wave energy. The longer fetch from the northeast results in the southwestward net shore-drift. The rate of sediment transport is not known at this time within the drift cell or at the study area, however the rate is judged as being fairly low compared to other Puget Sound drift cells. Also, both the amount of shore change and the erosion potential at the site appear quite low.

The site was typed as a "bluff-backed beach" in the "Change Analysis" completed by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) in both historic and current conditions (Simonstad et al. 2009). This typology was fairly coarse in nature and did not include work at the site level. The presence of bulkheads and other typically-sized shore protection structures generally did not instigate a change in shoretypes from historic conditions in the Change Analysis.

The site was within the study area of a Nearshore Salmon Habitat Assessment completed in 2003 for Pierce County (Houghton et al. 2003). The site was part of "ecological management unit 9", which consisted of Von Geldern Cove, Mayo Cove and adjacent shores extending several miles south. The subject parcels were within shorter reach that was characterized of "low relative habitat quality", with a score that was among the lowest group in the much larger study area. The reach was also characterized greater than 50% armored, and with only 5010% of eelgrass present below the low tide line. The ecological management unit was described in terms of restoration potential as having "bulkheads were riprap does not appear to be needed for protection of structures or other maintained areas (e.g., gardens, etc.) instead, bioengineered alternatives could provide a similar degree of shoreline protection (if needed) without most of the delete serious effects potentially associated with vertical bulkheads and placement of riprap" (Houghton et al. 2003).

## Bulkhead Impacts and Benefits of Bulkhead Removal

The site presents a very good opportunity for coastal restoration. The bulkhead at the site appears unnecessary due to the low wave energy, relatively low rate of littoral sediment transport, and relatively low erosion potential. This is in the context of the existing setbacks of the homes and other key improvements being adequate to allow some amount of erosion and not pose a risk to these improvements. The shore modifications appear to have covered a substantial amount of upper beach and backshore habitat, and have altered natural bluff processes.

Many negative impacts have been associated with shore armoring, or "hard" shore protection structures, in the Puget Sound region and elsewhere. Impacts include direct and indirect changes to the nearshore environment. The impacts as understood by the scientific community in the Puget Sound region are summarized in MacDonald et al. (1994), Johannessen and MacLennan (2007), Clancy et al. (2009), Rice (2006), Brennan (2007), and Schlenger et al. (in review). In general the bulkhead-induced impacts include limiting the resiliency of the beach–bluff system by direct burial, reduction in natural sediment input, and altering hydraulic processes. Many researchers have associated vertical bulkheads with increased beach erosion. The above references detail these processes and discussion will not be fully explained, however, brief synopses are provided in the following paragraphs.

At the present location extending into the intertidal zone at the site, the bulkheads likely have significant impacts by covering nearshore habitats, impacting shoreline ecosystems. The impact of the physical size of the shoreline armor such as bulkheads covering portions of the beach is termed “direct burial” or “placement loss”. This represents the area covered, which appears to be on the order of 5-8 feet wide for the full length of the structures. This represents a moderate surface area of beach and backshore that is lost.

The bulkheads likely result in a number of biological impacts to the beach system. These include loss of upper beach area, sediment supply on and off-site to maintain habitats such as spawning areas for forage fish, loss of riparian vegetation, reduction in organic matter input, reduction in insect input, reduction in the amount of drift logs and associated loss of habitat complexity and microhabitats such as cooler areas where vegetation can become established. The details of these impacts are complicated, and are covered in other publications for shore armor similar to that found at the site.

One of the key impacts of the bulkheads is that, if functioning as intended, the walls prohibit sediment from a feeder bluff from entering the net shore-drift cell and being transported by littoral drift to the beach both within the property and in the remainder of the drift cell. The majority of the bluff at the site was very likely a historic feeder bluff in pre-development conditions (mapping of historic feeder bluffs has not been completed for this area) and the sediment supply to the drift cell that runs into Von Geldern Cove is reduced by the installation of the soldier pile walls. Feeder bluffs typically function to supply the large majority of sediment input to littoral or net shore-drift cells in the Puget Sound region, and this certainly appears true for this drift cell where there is limited sediment supplied to the beach in other areas and no streams our present. The reduction in beach sediment supply can also lead to an increase in wave-induced erosion of existing low elevation armoring structures and homes.

A recent study by Rice documented the effects of shoreline modifications on a Puget Sound beach on surf melt mortality. Results of the study show that anthropogenic alteration of the shoreline typically makes beaches less suitable for surf smelt embryo survival when compared with unmodified shores. The loss of shade caused by a vegetated riparian area exposed beaches to greater sun, increased temperature extremes and variation in the physical environment, all creating a harsher environment for egg survival (Rice 2006).

Loss of marine riparian areas is commonly associated with shoreline development and anthropogenically modified shores. Loss of these valuable areas has caused a loss of the ecosystem services and functions. Several functions were identified as taking place in a fully functioning marine riparian area in a recent document by Brennan (2007) including: water quality/pollution abatement, soil and slope stability, sediment control, wildlife habitat, microclimate control, shade, nutrient inputs, fish prey production, and habitat structure/LWD.

## General Recommendations

The toe of the soldier pile bulkhead walls where it meets the beach surface, as surveyed at the Williams site, was generally located approximately 1.5 ft vertically below mean higher high water (MHHW). This places the toe or base of the bulkhead at a tidal elevation where one or two high

tides will reach it on most days, and thus well within the active beach. Many days will have 1.5 to 2.5 ft of water against the bulkhead walls. On stormy days or other high water days, the toe of the wall would be within the reach of the waves for longer time periods. This has caused both a loss of upper beach and backshore area, loss of bank function and associated habitat loss, as explained in the above sections.

Removing the soldier pile bulkhead from the beach and restoring a gently sloped upper beach and exposed bank face is recommended for restoration of habitats and nearshore processes at this site. This proposed work would include removing the backfill landward of the bulkheads and regrading the bank face to a more gently sloped configuration. Portions of the bank face would also be revegetated with native vegetation suitable for this Marine riparian area. Completion of the proposed project would not cause significant future erosion as the site has a generally low erosion potential. As of now the proposed bulkhead removal is recommended for the 2-lot and adjacent easement area, extending over an alongshore distance of 210 ft, which is further described below.

## Conceptual Approach for Nearshore Habitat Enhancement

All restoration/enhancement recommendations provided in this memo are generally consistent with recommendations provided in the ”Management Measures” report created to provide guidance for conceptualizing and designing nearshore restoration projects in Puget Sound (Clancy at al. 2009). The proposed conceptual approach for the property involves removing the large majority of the length of the wooden bulkhead (soldier pile wall) and restoring upper intertidal and adjacent backshore and bank face areas. All of the existing soldier pile bulkhead would be removed within the approximately 210 foot long reach shown in the approximate site plan (Sheet 2). Bear in mind that the field investigation and additional research at this site was limited to an initial feasibility level and additional analysis and design work would need to be carried out to verify and refine the design approach for this site.

The ends of the bulkhead removal area would have to return walls installed near the property lines. These return walls would angle landward into the bank faced to prevent potential flanking erosion from reaching the property lines and adjacent parcels. Wood piles would be the logical choice for these short wall sections.

Pending further investigation, the backfill soils landward of the existing bulkheads appears suitable for upper beach sediment, and at least a portion of these soils appears to have been excavated from the beach. These soils would be used for beach nourishment at the site. The upper beach and bulkhead removal area would be regraded to have a more gradual slope that would greatly enlarge the land area at upper intertidal elevations suitable for restoration (Sheet 3). Soil cut while regarding the bank face to a more stable configuration would be used on the beach for the restoration/enhancement work. Even though this soil appears to be high in sand and silt content, the soil does contain a variety of grain sizes ranging up to pebble, and as it is the native material at the site and would likely provide a number of benefits at this site and down–drift, this material is recommended for use on the beach. Although this may result in a temporarily high elevation of the upper beach, this area would adjust over time and excess sediment would be redistributed, providing a benefit to down-drift beaches in the cove that have experienced an overall reduction of sediment input.

The bank toe would be moved to approximately 15-20 ft landward of the existing bulkhead toe, which is the position where the bank toe would likely have been in the absence of installation of the bulkhead at this point in time. This would result in the bank face position moving landward on the order of 6-12 ft (Sheets 2 and 3). A beach access trail would be constructed at each of the two primary properties that would run down the re-created bank face at an angle (Sheet 2)

The existing bulkhead and backfill area may displace fringing saltmarsh vegetation, which was located at some adjacent areas in the absence of bulkheads. Saltmarsh in the cove was dominated by *Salicornia viginica* (pickleweed) and *Disticulus spicata* (saltgrass). Saltmarsh vegetation has been determined to be a valuable habitat type in Puget Sound (Schlenger et al. in review). However, it is not recommended to replant saltmarsh vegetation as the beach profile will need to adjust over several years and also because it is very difficult to plant or transplant saltmarsh vegetation. Adjacent areas without bulkheads at the same elevation also had large woody debris and salt-tolerant backshore vegetation, both areas which have also been identified as important nearshore habitat components and which are missing from much of the Cove due toe he prevalence of shore armor.

Backshore habitat enhancement as outlined above will also provide a dry beach at all tides for recreational use of the site. This would generally seem to be a benefit for the users of the properties as at present, there is no beach exposed during many high tides and it is not possible to walk the beach without waiting through several feet of water.

## Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of specific individuals. No one other than the client and the client's direct project partners should apply this report for any purposes other than that originally contemplated without first conferring with the geologist who prepared this report. The findings and recommendations presented in this report were reached based on brief field visits. The report does not reflect detailed examination of sub-surface conditions present at the site. It is based on examination of surface features, bank exposures, soils characteristics, beach features, and geologic processes. In addition, conditions may change at the site due to human influences, floods, earthquakes, groundwater regime changes, or other factors. This report may not be all that is required by a construction contractor to carry out recommended actions. Great care must be exercised when working on unstable slopes or close to foundations.

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**Coastal Geologic Services Inc.**

Jim W. Johannessen,
Licensed Engineering Geologist and MS

Jonathan Waggoner
Environmental Scientist, BS

**ATTACHMENTS**

Figure 1. Oblique aerial photo from 8/11/06 (enlarged) by WA Dept. of Ecology.
Figure 2. Oblique aerial photo from 7/27/77 (enlarged) by WA Dept. of Ecology.
Figure 3. Photo page showing ground photos from spring 2010.

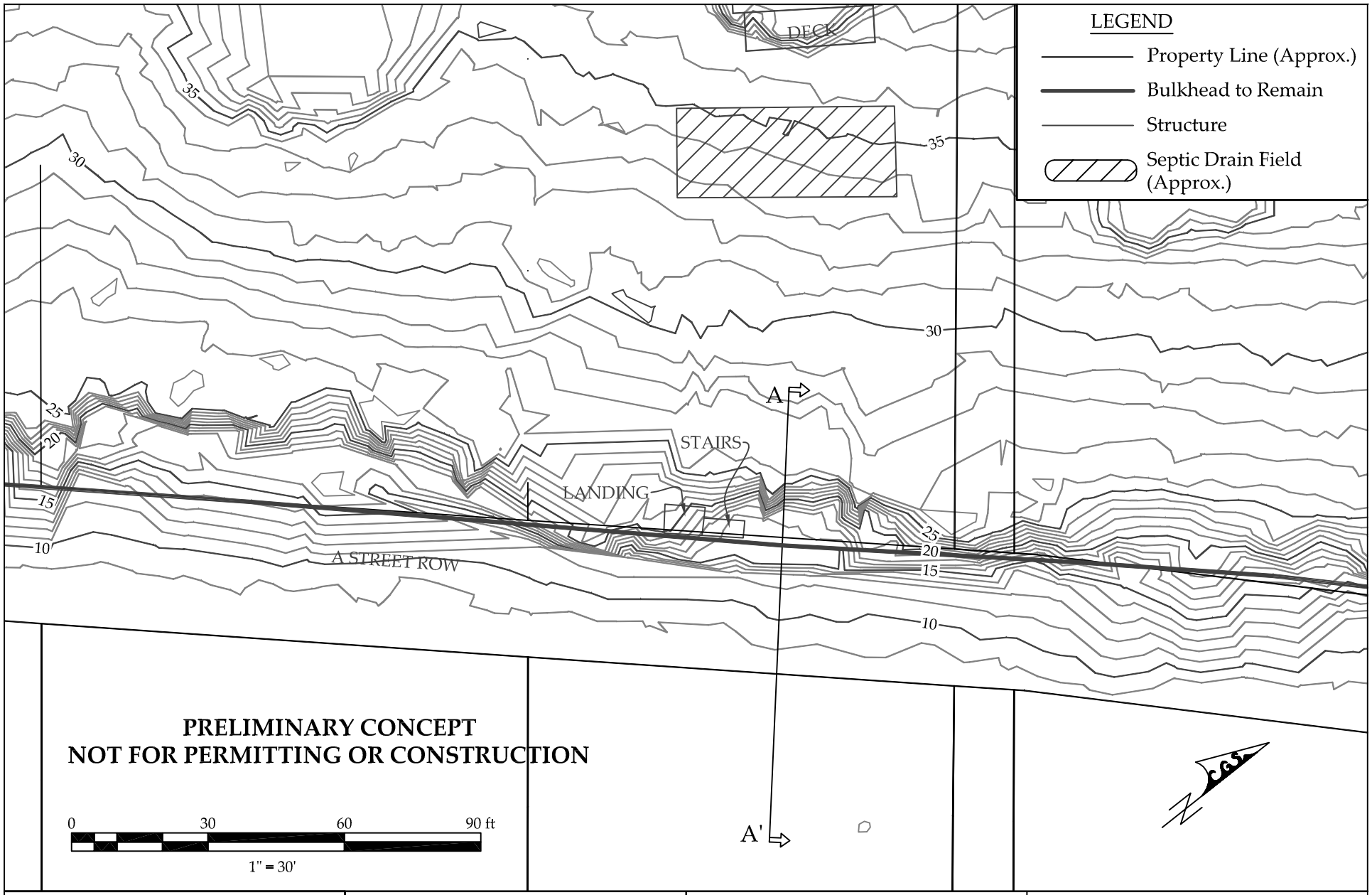
***Conceptual Drawing Set***

Sheet 1. Site Plan - Existing Conditions
Sheet 2. Site Plan – Conceptual Proposed Conditions
Sheet 3. Conceptual Cross Section

**Figure 1.** Von Geldern Cove site. Image enlarged from 8/11/06 shoreline oblique by WA Dept. of Ecology. Arrows show extent of potential project area.

**Figure 2.** Von Geldern Cove site. Image enlarged from 6/27/77 shoreline oblique by WA Dept. of Ecology. Williams house (red roof, near center) was recently constructed with cut visible in landward portion of yard and apparent fill near marine bank.

**Figure 3.** Photo page showing beach and bank, at lower and higher tides, on March 19, 2010. Fourth image shows upper beach substrate at Williams site. Last image shows bulkhead backfill.




**PRELIMINARY CONCEPT**
**NOT FOR PERMITTING OR CONSTRUCTION**

**PURPOSE:** Bulkhead Removal
**DATUM:** MLLW (MHHW = +13.5' MLLW)

**ADJACENT PROPERTY OWNERS:**

**Von Geldern Cove Bulkhead Removal**
**Site Plan - Existing Conditions**
1"=30'
**OWNER AND ADDRESS**

**PROPOSED:** Bulkhead Removal
**IN:** Von Geldern Cove
**COUNTY:** Pierce **STATE:** WA
**APPLICATION BY:** South Puget Sound Salmon Enhancement Group

**Sheet 1 of 3** **13MAY10**

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1711 Ellis St, suite 103
Bellingham, WA 98225
360-647-1845 - coastalgeo.com

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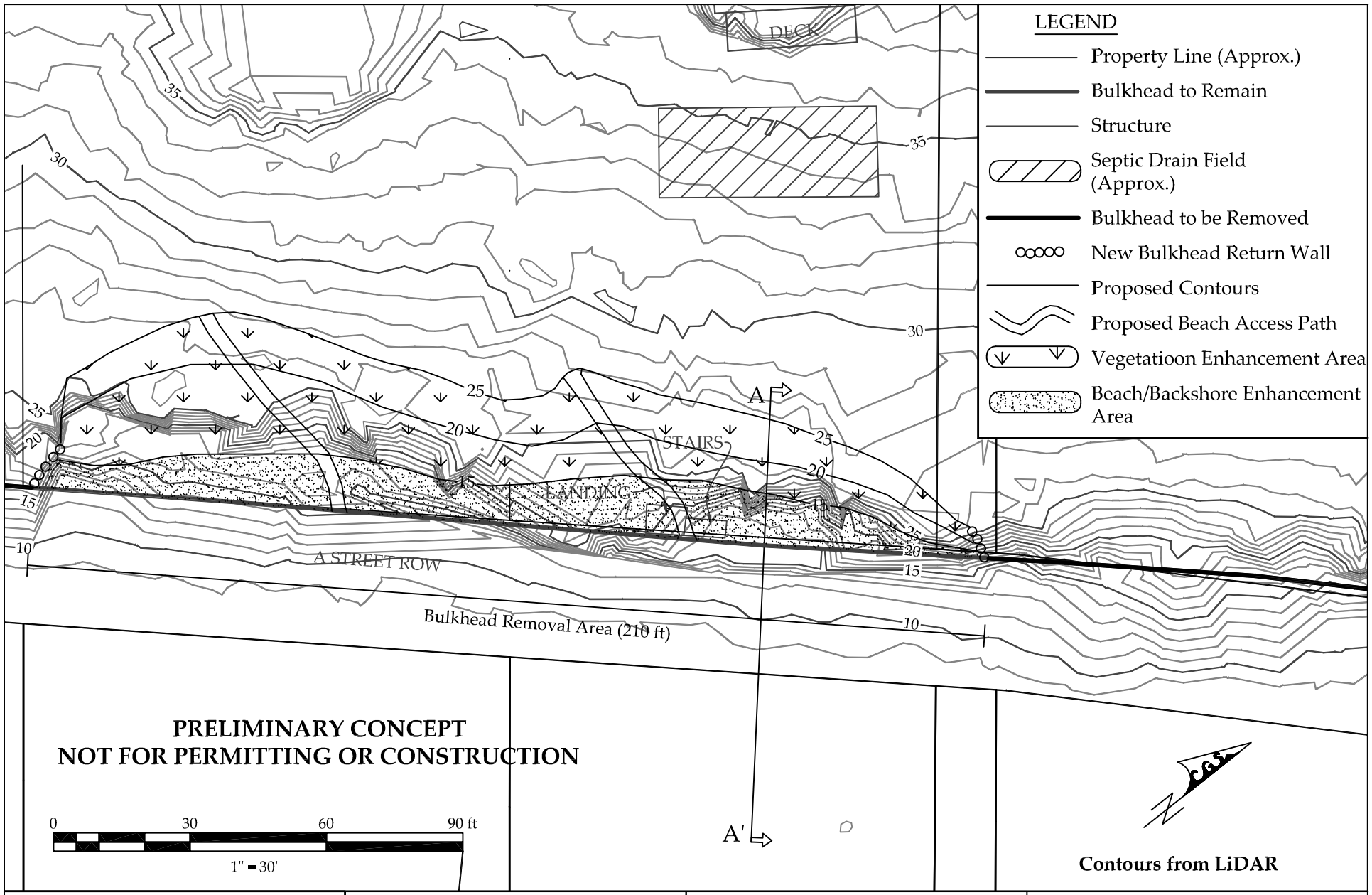


**PRELIMINARY CONCEPT**
**NOT FOR PERMITTING OR CONSTRUCTION**

0 30 60 90 ft

1" = 30'

**Contours from LiDAR**

**PURPOSE:** Bulkhead Removal
**DATUM:** MLLW (MHHW = +13.5' MLLW)

**ADJACENT PROPERTY OWNERS:**

**Von Geldern Cove Bulkhead Removal**
**Site Plan - Proposed Conditions**
1"=30'
**OWNER AND ADDRESS**

**PROPOSED:** Bulkhead Removal
**IN:** Von Geldern Cove
**COUNTY:** Pierce **STATE:** WA
**APPLICATION BY:** South Puget Sound Salmon Enhancement Group

**Sheet 2 of 3** **13MAY10**

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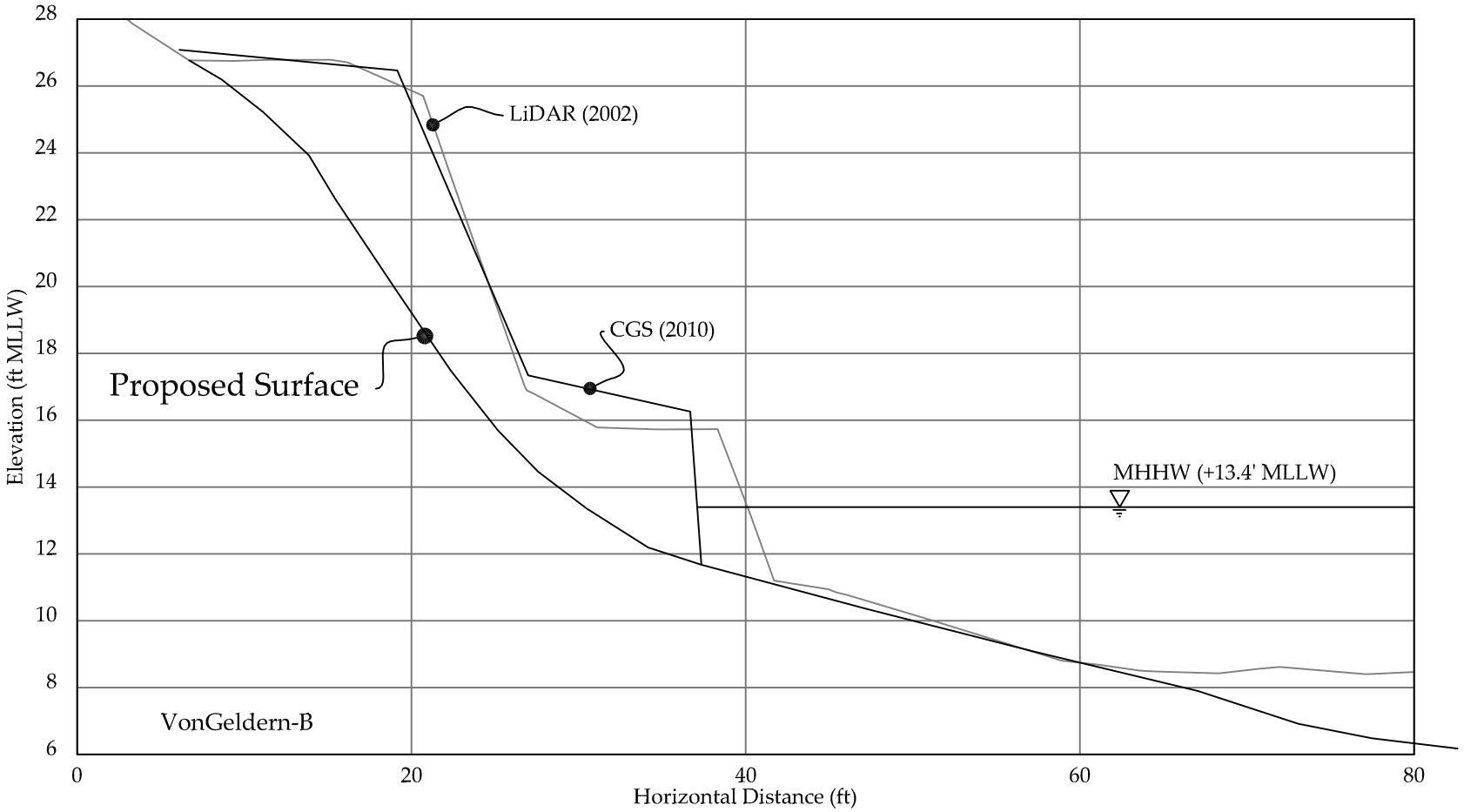


**PRELIMINARY CONCEPT**
**NOT FOR PERMITTING OR CONSTRUCTION**

| | | |
|---|---|---|
| **PURPOSE:** Bulkhead Removal<br>**DATUM:** MLLW (MHHW = +13.5' MLLW)<br><br>**ADJACENT PROPERTY OWNERS:** | **Von Geldern Cove Bulkhead Removal**<br>**Cross Section**<br>1"=10' (2X vert. exag.)<br>**OWNER AND ADDRESS** | **PROPOSED:** Bulkhead Removal<br>**IN:** Von Geldern Cove<br>**COUNTY:** Pierce **STATE:** WA<br>**APPLICATION BY:** South Puget Sound Salmon Enhancement Group<br><br>**Sheet 3 of 3** **13MAY10** |

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## Appendix B.2 Filucy Bay Beach and Salt Marsh Enhancement (Project ID#3)

### Project Description

This project is located on Northeast side of Filucy Bay. The proposed action area includes two bulkheads- one vertical pile bulkhead and one tiered rock and timber bulkhead. To the north of the site, a small freshwater tributary enters the bay along a natural, unarmored shoreline. Immediately to the south is patch of low gradient, high elevation salt marsh which then transitions again into more armored shoreline. Saltmarsh and forage fish spawning substrates are present along the project shoreline and adjacent shorelines. However the salt marsh in front of the two bulkheads is considerably thinner compared to adjacent, unamored shorelines, and the toe the bulkhead sits at approximately 9-foot elevation (MLLW) significantly impacting the extent of potential forage fish spawning and establishment of salt marsh.

The following feasibility and design analysis focused on removal of the bulkhead on the southern property, however a similar approach would be employed for replacement of both the timber pile and the rock and timber bulkheads (Coastal Geologic Services, 2010). The project has support from the landowners. The proposed enhancement approach would to remove the entire length of the two bulkheads (approximately 225ft in length) and fill material placed landward of the bulkhead. The upper beach and back beach profile would be restored using suitable material or import material to mitigate the effects of erosion on the beach face as a result of the bulkhead and to enlarge the existing area suitable for salt marsh re-colonization. Removal of bulkhead and re-contouring of the beach is expected to result in a three-fold increase in salt marsh surface area across the 225 ft project length.


**Figure 7.2. Aerial photo (DOE 2006) location of bulkhead removal in Filucy Bay. The project includes removal of two bulkheads.**

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# Conceptual Bulkhead Removal, Feasibility, and Conceptual Beach Enhancement Assessment at Willard Site Filucy Bay, Pierce County, WA

Prepared for: South Puget Sound Salmon Enhancement Group

Prepared By: Jim Johannessen,
Licensed Engineering Geologist and MS,
Coastal Geologic Services Inc.

June 21, 2010

## Introduction and Purpose

The objective of this bulkhead removal feasibility project was to provide coastal processes assessment, bulkhead removal feasibility, and conceptual designs for 2 different coastal sites on the Long Peninsula in the western portion of Pierce County, WA. Based on review of ground and air photos, it appeared that bulkhead removal should be generally feasible at these two sites. The larger goal is to enhance nearshore habitats and natural processes through the removal of the bulkheads at the Filucy Bay site that is the subject of this memo.

This memo summarizes the information for one of the two sites investigated the Filucy Bay site. The memo covers both Task 1, which consisted of background information review, site assessment and coordination, as well as Task 2, which included the bulkhead removal/enhancement feasibility study and detailed conceptual designs, contained herein.

The Filucy Bay site under consideration is located at 4918 Mancke Road, Longbranch, WA 98351-9556 and owned by the Willard family of Seattle. The site recommended for nearshore habitat enhancement (the subject of this memo) is located 0.5 miles north of the southern extent of the bay, and northeast of the village of Longbranch. The site is located a short distance west of Mahncke Road KPS, accessed by a private driveway.

## Summary of Site Conditions

The site consists of a relatively low elevation gently sloping parcel with a large low elevation and nearly flat yard waterward of the existing single-family residence. This was the southern of the 2 adjacent properties visited in Filucy Bay, and is pictured in oblique aerial photos from 2006 and 1977 in Figures 1 and 2. The residence was located approximately 95-100 ft landward of the existing shoreline bulkhead (Sheet 1). A small wooden deck was located on the waterward side of the house that extended approximately 10 ft from the house. The majority of the yard waterward of the house was covered with lawn, with the exception of several intermediate sized trees that were present in the northern third of the yard.

The southern approximately 25 feet of the shore area did not have a bulkhead present, and instead consisted of low elevation salt marsh log deposits (Figure 1). The bulkhead at the site consisted of a vertical, soldier-pile wall that extended between 3.2 and 4.3 feet above the beach surface as

measured on March 19, 2010. It appeared that some amount of fill was placed landward of the soldier pile wall, which was reportedly constructed in 1982. Moderately dense salt marsh vegetation was present in the southern portion of the shore, while patches of salt marsh vegetation were present in the 5-8 ft wide band waterward of the bulkhead. Salt marsh vegetation was much thinner and only present at higher elevations waterward of the bulkhead, relative to the southern unbulkheaded area. A shared dock was present generally straddling the property line and extended across the entire width of the high tide beach.

The shore of the site is exposed to 1.0 mile fetch (open water distance over which wind waves are formed) from the south-southwest, in Filucy Bay until the base of the point a short distance south. The area is exposed to only a 0.4 mile or less fetch from the northwest and west. Therefore, the shore is characterized as "low" wave energy category (Cox et al. 1994). Although there is not a universally accepted definition of the term high wave energy in the Puget Sound region, one definition used for low wave energy is a fetch of 1 mile or less (Cox et al. 1994).

Net shore-drift or the long-term effect of littoral drift was mapped at the study area in the 1980s for the WA Dept. of Ecology (Schwartz et al. 1991). A net shore-drift cell (also called a littoral cell) refers to a discreet sediment transport cell that generally includes erosional bluffs as sediment sources in the up-drift (and other) portions of the cell, zones(s) of sediment transport with limited input, and some amount of accretion shoreforms in the down-drift end (Johannessen and MacLennan 2007). Net shore-drift is northward in Filucy Bay in cell PI-19-3. The cell originates at Mahnckes Point at the south end of the bay. Net shore-drift continues about 1,600 ft north of the site where the sediment transport tapers off due to very low wave energy. The longer fetch from the south-southwest results in northward net shore-drift. The rate of sediment transport is not known at this time within the drift cell or at the study area, however the rate is judged as being fairly low compared to other Puget Sound drift cells. Also, both the amount of shore change and the erosion potential at the site appear quite low.

The site was typed as a "bluff-backed beach" in the "Change Analysis" completed by the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) in both historic and current conditions (Simonstad et al. 2009). This typology was fairly coarse in nature and did not include work at the site level.

The site was within the study area of a Nearshore Salmon Habitat Assessment completed in 2003 for Pierce County (Houghton et al. 2003). The site was part of "ecological management unit 10" in a reach that was characterized of "medium" habitat quality and 10-50% armored.

## General Recommendations

The site presents a very good opportunity for coastal restoration. The bulkhead at the site appears unnecessary due to the low wave energy, low rate of sediment transport, and low erosion potential. The shore modifications appear to have covered a substantial amount of salt marsh area and associated upper beach habitat, relative to this small parcel. Removing the soldier pile bulkhead from the beach and restoring a gently sloped upper beach and salt marsh is recommended for this site. The existing salt marsh at the southern end of the shore would be extended across the majority of the property, with a very short section of bulkhead relocated landward at the property

line where it meets the shared dock at the property line. More detail is provided in the following section.

Many negative impacts have been associated with shore armoring, or "hard" shore protection structures, in the Puget Sound region and elsewhere. Impacts include direct and indirect changes to the nearshore environment. The impacts as understood by the scientific community in the Puget Sound region are summarized in MacDonald et al. (1994), Johannessen and MacLennan (2007), Clancy et al. (2009), and Schlenger et al. (in review), and this general impact discussion will not be detailed here.

The existing bulkhead and filled yard area displace what could be saltmarsh, which has been determined to be a very valuable habitat type in Puget Sound (Schlenger et al. in review). The vertical face bulkhead may be causing beach erosion due to wave reflection and scour (MacDonald et al. 1994). The bulkhead has displaced salt marsh vegetation within the bulkhead footprint and it also largely prohibits salt marsh vegetation from becoming established waterward of the bulkhead toe. Adjacent areas without bulkheads at the same elevation have much more dense salt marsh vegetation, which was dominated by *Salicornia viginica* (pickleweed) and *Disticulus spicata* (saltgrass).

## Conceptual Approach for Nearshore Habitat Enhancement

The proposed approach for the property involves removing the majority of the length of the wooden bulkhead and restoring upper intertidal and adjacent supratidal salt marsh vegetation, and sandy backshore area. All of the existing soldier pile bulkhead would be removed with the exception of the Northern approximately 8 feet up the wall adjacent to the dock. And approximately 10-15 ft long stretch of new soldier pile return wall would be constructed adjacent to the end of the retained section of bulkhead (Sheets 2 and 3). The wood used for this would be selected from the piles during removal. This would leave room for habitat enhancement across almost the full width of the property.

Fill soil that had been placed immediately landward of the existing bulkhead would also be removed (Sheet 3). Suitable sandy soil removed from this area could be used closer to the house to raise low elevation areas distant from the shore in order to mitigate for potential longer-term sea level rise as well as to save money during enhancement work. The upper beach and bulkhead removal area would be recreated to have a more gradual slope that would greatly enlarge the land area at upper intertidal elevations suitable for salt marsh vegetation recolonization. The salt marsh area would be increased approximately three-fold as part of the enhancement project. A narrow path would be left through the central narrow portion of the salt marsh enhancement area for beach access.

The existing small willow tree would be relocated landward during construction, which would likely not cause the death of this single tree. The two existing 14-16" diameter shore pine trees would be left in place (Sheet 2). After bulkhead removal, a small soft shore protection installation would be constructed approximately 10 ft landward of the old bulkhead footprint fronting the two shore pines, to protect these trees from erosion of the root area during high water storms. This installation would be approximately 35-40 feet long and consist of on the order of 3 large, sound logs that would be

partially buried, weighted, and pinned in place by large granite or similar boulders (glacial erratics). This conceptual approach would need to be further refined in the final design stage.

A sandy backshore area would be established landward of the salt marsh enhancement area and waterward of the existing lawn. This area would be planted with clumps of appropriate herbaceous, backshore vegetation. All debris would be removed from the site and vegetation, to include the existing lawn would be established and cleaned up at the end of the construction phase.

## Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of specific individuals. No one other than the client and the client's direct project partners should apply this report for any purposes other than that originally contemplated without first conferring with the geologist who prepared this report. The findings and recommendations presented in this report were reached based on brief field visits. The report does not reflect detailed examination of sub-surface conditions present at the site. It is based on examination of surface features, bank exposures, soils characteristics, beach features, and geologic processes. In addition, conditions may change at the site due to human influences, floods, earthquakes, groundwater regime changes, or other factors. This report may not be all that is required by a construction contractor to carry out recommended actions. Great care must be exercised when working on unstable slopes or close to foundations.

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**Coastal Geologic Services Inc.**

Jim W. Johannessen,
Licensed Engineering Geologist and MS

Jonathan Waggoner
Environmental Scientist, BS

**ATTACHMENTS**

Figure 1. Oblique aerial photo from 8/11/06 (enlarged) by WA Dept. of Ecology.
Figure 2. Oblique aerial photo from 7/27/77 (enlarged) by WA Dept. of Ecology.

***Conceptual Drawing Set***

Sheet 1. Site Plan - Existing Conditions
Sheet 2. Site Plan – Conceptual Proposed Conditions
Sheet 3. Conceptual Cross Section

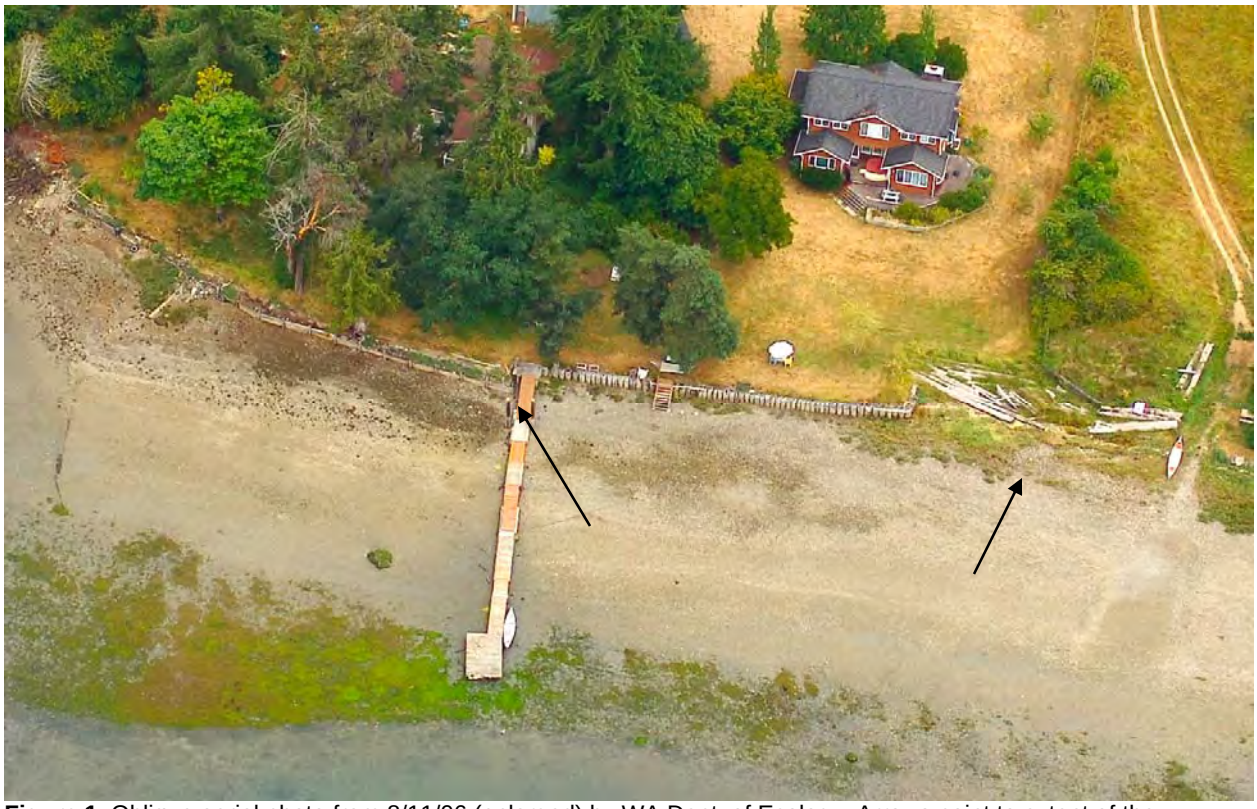

**Figure 1.** Oblique aerial photo from 8/11/06 (enlarged) by WA Dept. of Ecology. Arrows point to extent of the site.

**Figure 2.** Oblique aerial photo from 7/27/77 (enlarged) by WA Dept. of Ecology. Arrow points to site. Image appears to show an older bulkhead in place at the site, just to right of long dock. Owners reported that the current bulkhead was installed in 1982, and the new house was constructed in 1989.

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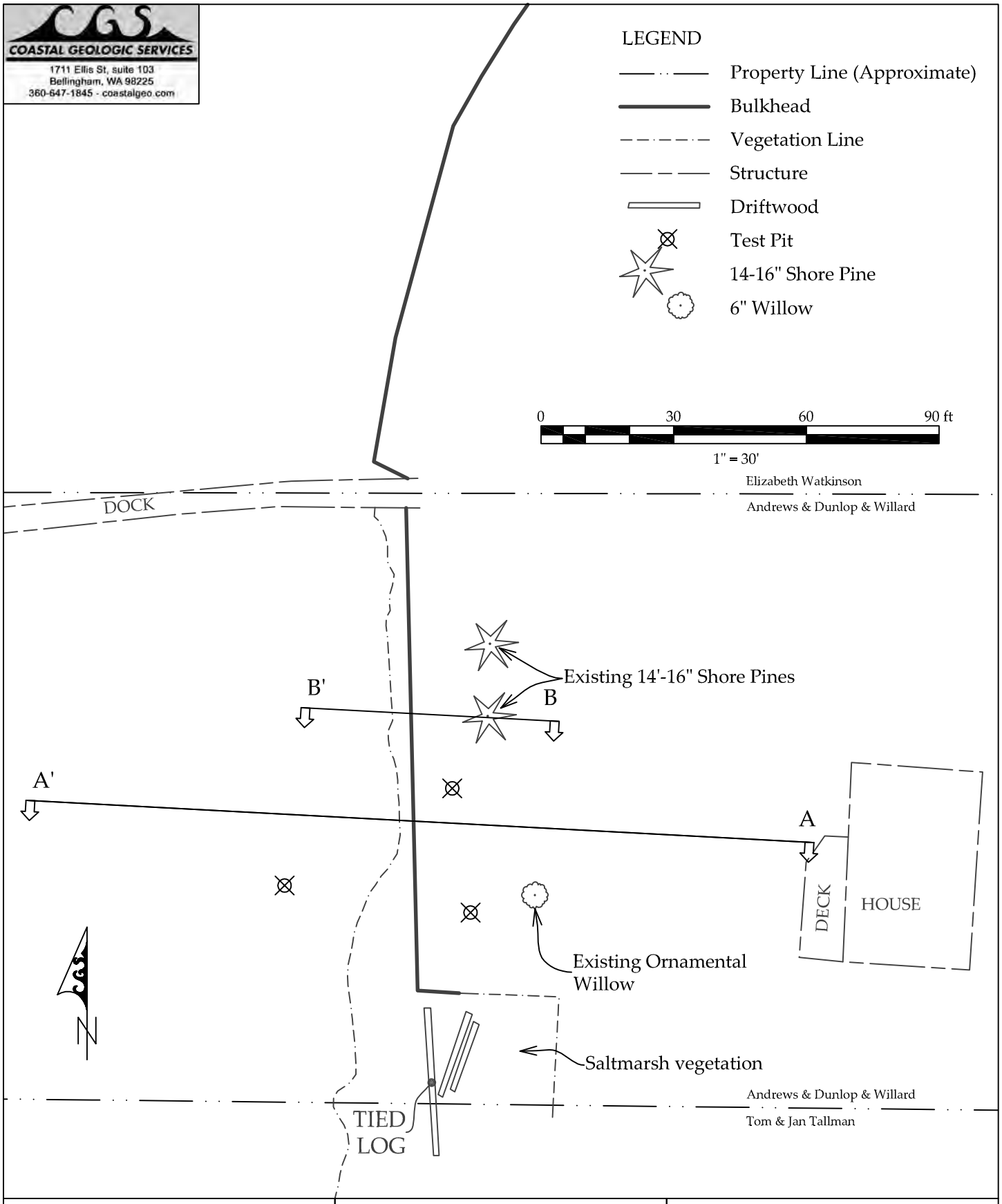


**PURPOSE:** Bulkhead Removal
**DATUM:** MLLW (MHHW = +13.5' MLLW)

**ADJACENT PROPERTY OWNERS:**
**Tom & Jan Tallman**
**Elizabeth Watkinson**

**Filucy Bay Bulkhead Removal**
**Site Plan - Existing Conditions**
1"=30'
**OWNER AND ADDRESS**
Andrews & Dunlop & Willard
1014 W Garfield St
Seattle, WA 98119-3249

**PROPOSED:** Bulkhead Removal
**IN:**Filucy Bay
**COUNTY:** Pierce **STATE:** WA
**APPLICATION BY:** South Puget Sound Salmon Enhancement Group

**Sheet 1 of 3** **10MAY10**

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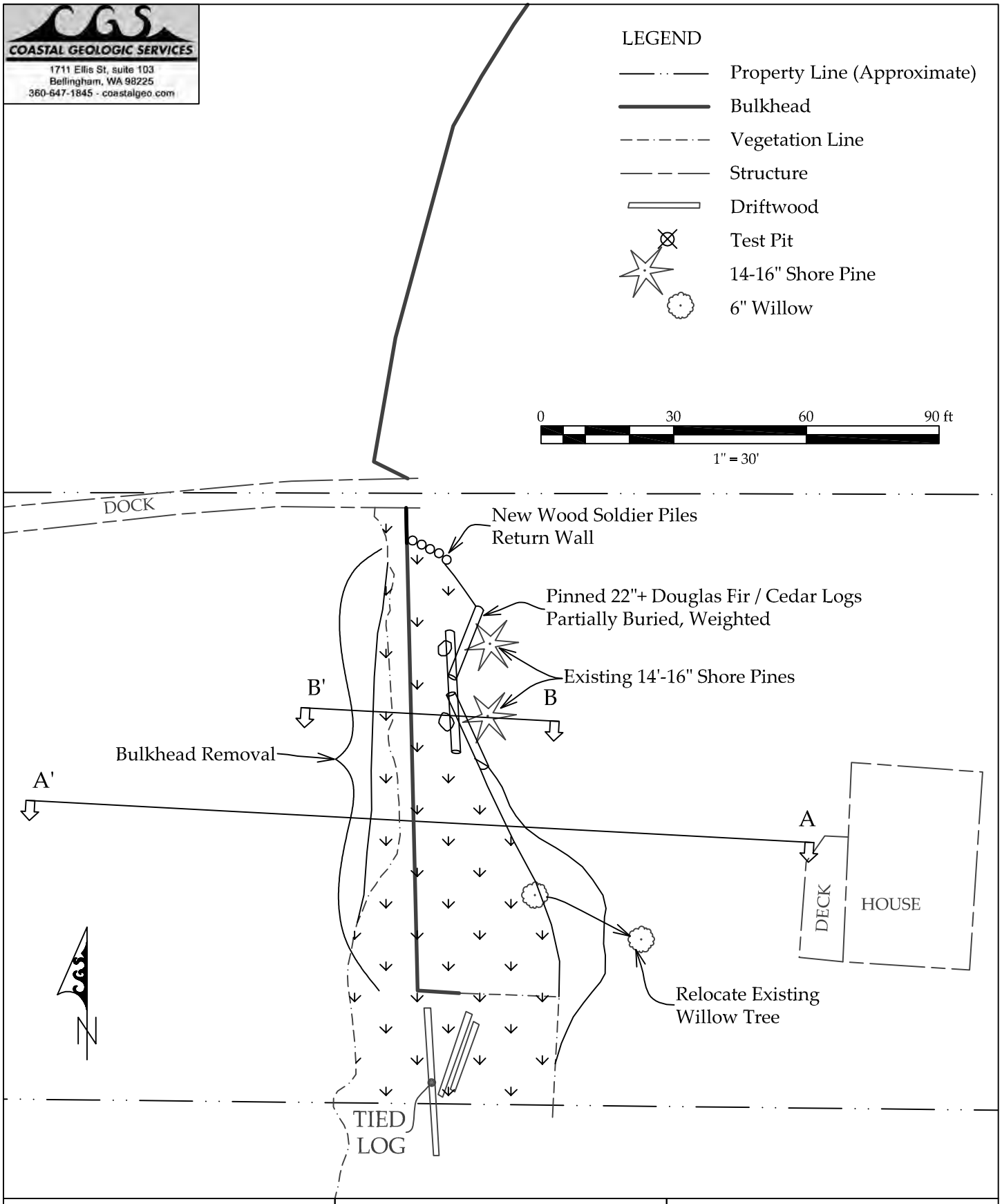
COASTAL GEOLOGIC SERVICES
1711 Ellis St, suite 103
Bellingham, WA 98225
360-647-1845 - coastalgeo.com




**PURPOSE:** Bulkhead Removal
**DATUM:** MLLW (MHHW = +13.5' MLLW)

**ADJACENT PROPERTY OWNERS:**
**Tom & Jan Tallman**
**Elizabeth Watkinson**

**Filucy Bay Bulkhead Removal**
**Site Plan - Existing Conditions**
1"=30'
**OWNER AND ADDRESS**
Andrews & Dunlop & Willard
1014 W Garfield St
Seattle, WA 98119-3249

**PROPOSED:** Bulkhead Removal
**IN:**Filucy Bay
**COUNTY:** Pierce **STATE:** WA
**APPLICATION BY:** South Puget Sound Salmon Enhancement Group

**Sheet 2 of 3** **10MAY10**

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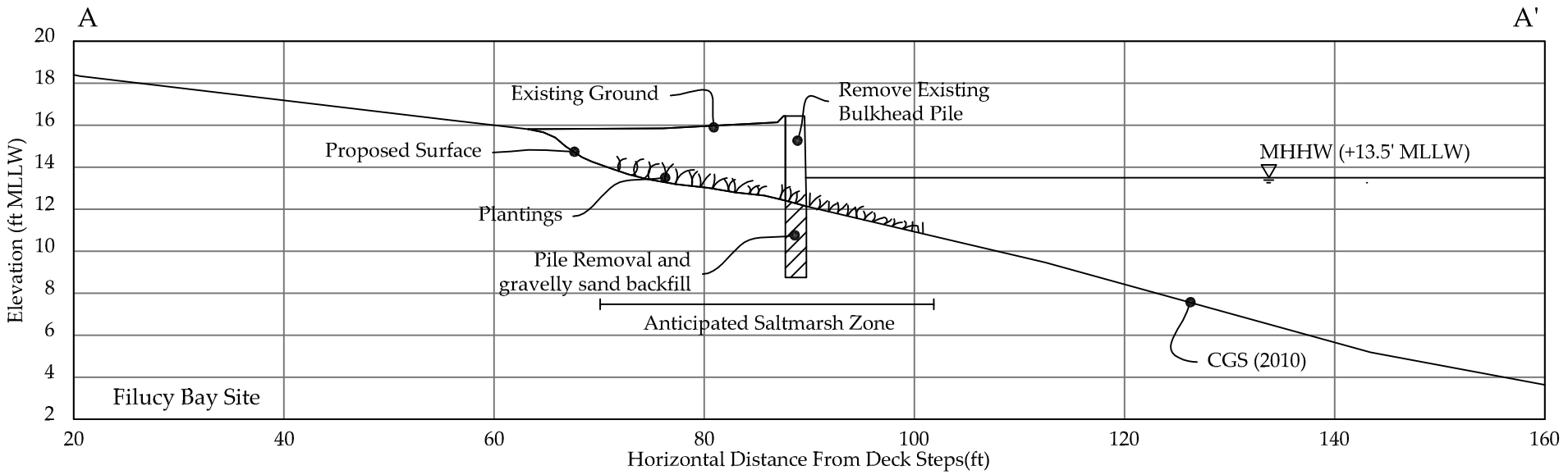


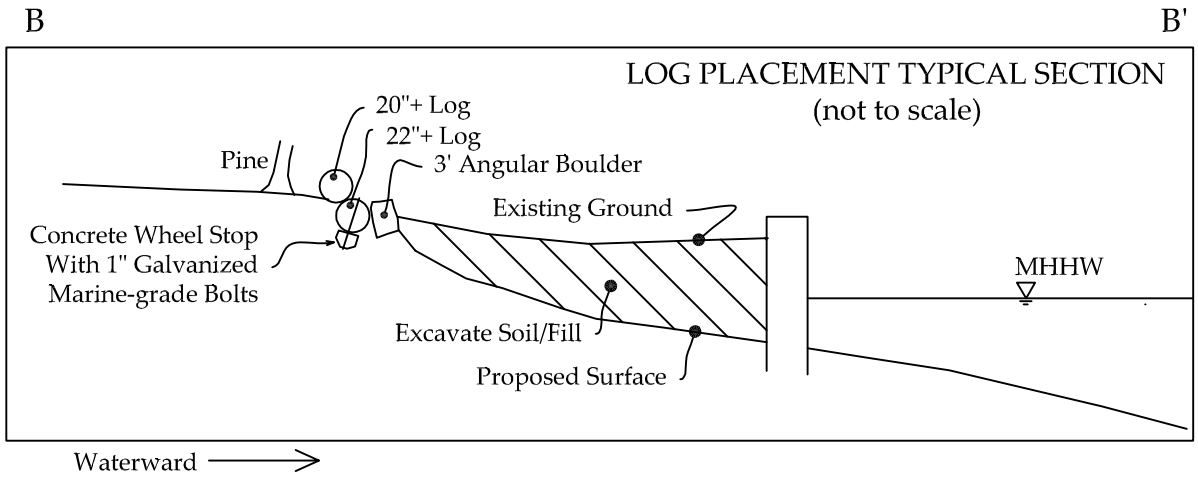


**PURPOSE:** Bulkhead Removal
**DATUM:** MLLW (MHHW = +13.5' MLLW)

**ADJACENT PROPERTY OWNERS:**
**Tom & Jan Tallman**
**Elizabeth Watkinson**

**Filucy Bay Bulkhead Removal**
**Cross Section**
Scale as Shown
**OWNER AND ADDRESS**
Andrews & Dunlop & Willard
1014 W Garfield St
Seattle, WA 98119-3249

**PROPOSED:** Bulkhead Removal
**IN:**Filucy Bay
**COUNTY:** Pierce **STATE:** WA
**APPLICATION BY:** South Puget Sound Salmon Enhancement Group

**Sheet 3 of 3** **10MAY10**

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## Appendix B.3: Whiteman Cove Estuary Restoration (Project ID # 4)

### Project Description

Whiteman Cove is a large (relative to South Puget Sound), historic, barrier estuary. The historic barrier spit was filled for maintenance of a roadway and the outlet to the estuary was dammed, allegedly for maintenance of the road and for use of the impoundment for Washington State Fisheries coho rearing programs. Two tide gates breach the spit and maintain surface water elevation of impounded water. Whiteman Cove presents a benefit restoration opportunity to increase estuarine rearing habitat, salt marsh recolonization and food production.

The impoundment is no longer operated for fisheries rearing purposes but the Cove is valued by the residents and the YMCA camp. All three landowner groups, WA State Parks, the YMCA Camp, and the Homeowners Association were solicited for interest in completing a ground-based feasibility and design assessment on their properties. The YMCA and WA State Parks met the opportunity with interest but the homeowners association declined participation in the project due to expressed concern with flooding. As such, the following feasibility and design report was developed (Anchor QEA 2010) to assess the feasibility and risk of a restoration project at this site with respect to flooding. The following report analyzed feasibility for restoring tidal connection to the Whiteman Cove through installation of a bridge at the historic outlet and decommissioning of the tidal gates. Generally, the report concludes that restoration of tidal hydrology to the Cove does not increase risk of flooding to shoreline structures, however additional evaluation would be required to further define risk to the homes.

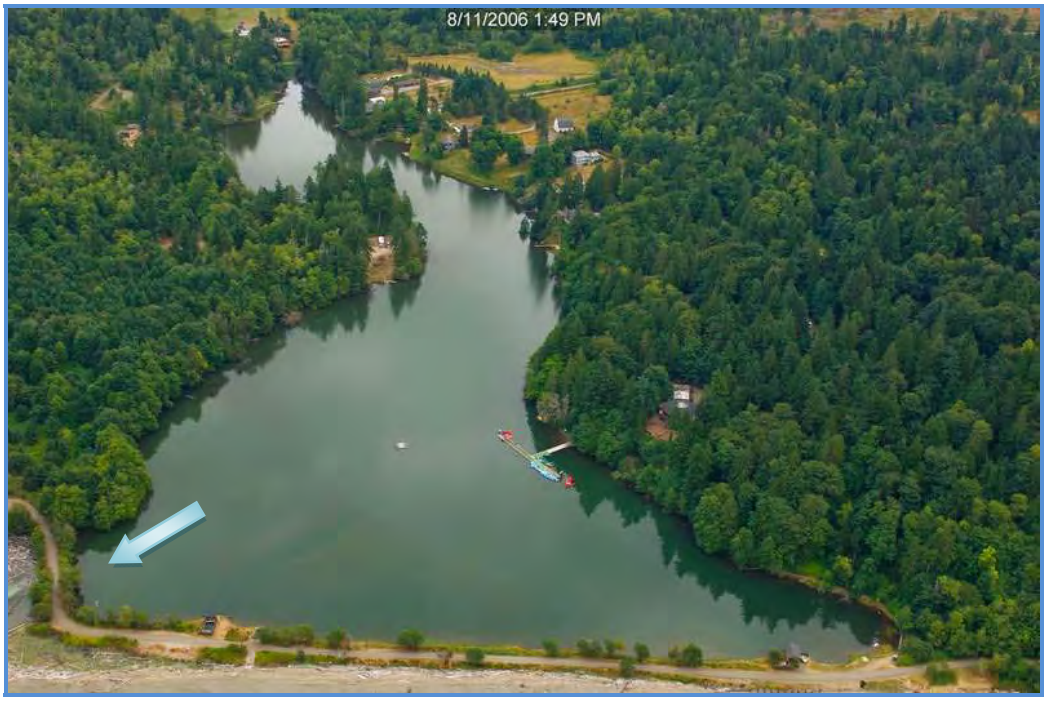


**Figure 7.3. Aerial photo (DOE 2006) showing roadway impoundment a historic barrier estuary, Whiteman Cove.**

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Seattle, Washington 98101
Phone 206.287.9130
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www.anchorqea.com

# MEMORANDUM

| | | | |
|---|---|---|---|
| **To:** | Kristin Williamson,<br>South Puget Sound Salmon Enhancement Group | **Date:** | November 18, 2010 |
| **From:** | Paul Schlenger and Kathy Ketteridge, Anchor QEA, LLC | | |
| **Re:** | Summary of Evaluation - Restoration Project Development Support at Whiteman Cove (DRAFT) | | |

This memorandum summarizes the results of a high level evaluation Anchor QEA, LLC (Anchor QEA) performed to support the South Puget Sound Salmon Enhancement Group's nearshore restoration project development at Whiteman Cove, which is along the eastern shoreline of Case Inlet (47°13.231'N, 122°48.294'W). The evaluation included a review of historical conditions and current topography at the site, overview of the proposed restoration design, discussion of potential flooding impacts due to the proposed restoration actions, and identification of data needs to move forward through 30% design. A rendering was also completed for Whiteman Cove to illustrate likely post-restoration conditions at the site at low tide (Figure 4).

## SITE DESCRIPTION

Whiteman Cove is a historic barrier estuary whose natural connection to Puget Sound has been closed by a roadway berm. Water levels in the cove are regulated by two tide gates. Properties adjacent to the cove include Joemma Beach State Park to the northwest, YMCA Camp Coleman along the southwest shore, and private properties inland along the remainder of the cove shore. The roadway berm, which separates Whiteman Cove from Puget Sound, is owned by Washington State Parks (Parks) to the north of the site (Bay Road KP South) and is a private access road to YMCA Camp Coleman to the west. Review of the LiDAR data shows that the elevation of the roadway varies from approximately 15 feet (ft) North American Vertical Datum (NAVD) 88 to 16 ft NAVD88. One tide gate is located on Parks property and one is located on YMCA property. Figure 1 provides a site map with parcel and property ownership information and Figure 2 shows historic shoreline conditions (T-Sheet) with a current aerial photograph.

Tidal datum information for the site was estimated from the tidal station at Olympia, Washington (# 9446969). This tidal station was chosen because it was the closest station to the site that includes a conversion to NAVD88. This estimate should be refined moving forward through 30% design. However, this provides a conservative estimate for this feasibility evaluation. Table 1 below provides the tidal datum information from the Olympia, Washington station.

**Table 1**
**Tidal Datums at Olympia, Washington (#9446969)**

| Tidal Datum | Value, feet relative to MLLW | Value, feet relative to NAVD88 |
|---|---|---|
| MHHW | 14.5 | 10.5 |
| MHW | 13.5 | 9.5 |
| MTL | 8.3 | 4.3 |
| NAVD88 | 4.0 | 0.0 |
| MLW | 3.0 | -1.0 |
| MLLW | 0.0 | -4.0 |

Notes:
MHHW = mean higher high water
MHW = mean high water
MTL = mean tide level
MLW = mean low water
MLLW = mean lower low water

Extreme high tide elevation at the site was taken from tidal predications from the National Oceanic and Atmospheric Administration (NOAA) tide station at McMicken Island in Case Inlet (#9446583). Elevations in MLLW were converted to NAVD88 for comparison with existing LiDAR data using the conversion show in Table 1 (0 ft MLLW= -4.0 ft NAVD88). Extreme high tide (not including the influence of storm surge) was found to be approximately 13.5 ft NAVD88.

## DESCRIPTION OF PROPOSED RESTORATION ACTION

Proposed restoration includes removing a portion of the road prism for Bay Road KP South on Parks property and replacing it with a bridge, as well as removal of both tide gates (including the outfall structures). The proposed location of the inlet between the cove and Puget Sound corresponds to the historic location of the inlet. Hydraulic evaluation to evaluate the size of the inlet opening is outside this scope of work. However, through

comparison of other sites (where hydraulic modeling was completed), the tidal opening (bridge span) will need to be approximately 50 feet to result in complete tidal inundation (and draw down) in Whiteman Cove over all tidal cycles. A hydraulic evaluation will need to be completed before completing 30% design to verify and optimize the proposed tidal opening. Existing condition and post-restoration images of the project site are show in Figures 3 and 4, respectively.

## POTENTIAL FOR FLOODING IMPACTS DUE TO TIDAL INUNDATION

Whiteman Cove and its shoreline are designated as "Zone A" by Federal Emergency Management Agency (FEMA) based on the current Flood Insurance Rate Map for the project area. This means that the project area is within the 100-year floodplain, but no flood elevations are available. Figure 5 provides an excerpt from the FEMA Flood Insurance Rate Map for the project area. As you can see from the map, the shoreline in Puget Sound does not currently have a different flood zone designation than Whiteman Cove and its shoreline. This implies that flood insurance requirements for homes along the shoreline of Puget Sound adjacent to Whiteman Cove and homes within Whiteman Cove itself should be the same. However, the proposed restoration activity may require a new FEMA study to update Flood Insurance Rate Maps for properties within Whiteman Cove.

LiDAR data for the project site (provided by Puget Sound LiDAR Consortium, 2002) was used to extract the 13.5 ft NAVD88 contour line from the project site topography. This elevation corresponds to approximate extreme high water at the project site. (Evaluation of impacts due to storm surge, localized increase in water level due to onshore wind and large waves, on the project site was outside the scope of this evaluation.) Figures 6A and 6B show the county parcel boundaries and the extent of tidal inundation (the 13.5 ft NAVD88 contour line) within Whiteman Cove post-restoration. Figure 6C provides a comparison between the 100-year FEMA Flood Zone and the estimated post-restoration tidal inundation. Observations from the evaluation of potential flooding impacts (and review of Figures 5 and 6A through 6C) are summarized below. In general, it appears that restoration of Whiteman Cove may not significantly increase risk of flooding to adjacent property owners.

- The FEMA Flood Zone designation for the shoreline along Puget Sound and within Whiteman Cove is currently the same (Zone A). However, the proposed restoration

activity may require a new FEMA study to update Flood Insurance Rate Maps for properties within Whiteman Cove.

- The extent of tidal inundation (post-restoration) appears to be within the extent of the 100-year floodplain in Whiteman Cove at most locations (see Figure 6C).
- Restoring tidal inundation to Whiteman Cove does not appear to flood any homes or other structures (not including docks or boathouses) that are visible in the aerial photograph (see Figures 6A and 6B).
- Tidal inundation may extend an additional 50 to 100 feet inland from the current edge of water shown in the aerial photograph.
- Existing dock and boat house structures would need to be modified to take into account a fluctuating water level, as well as the increase in water level due to tidal inundation. This includes the large YMCA dock fronting Camp Coleman.
- The Marine Center at Camp Coleman, which is located just south of the south tide gate, will be inundated by the tide post-restoration, and will need to be relocated.

## NEXT STEPS AND DATA GAPS

Proposed restoration actions will require additional evaluation and data collection to advance through 30% design and permitting, if desired. These data gaps and evaluation steps are summarized below:

- Targeted bathymetry data within Whiteman Cove.
- Water level data within Whiteman Cove (if available).
- Edge of water survey in Whiteman Cove.
- Survey of the tide gate and outfall structures. This information would be used to develop cost estimates for removal of those structures.
- Hydraulic evaluation of proposed inlet opening (bridge span). This evaluation will inform design of the tidal opening width, depth, and proposed bridge structure. The hydraulic evaluation should include a study of upstream flooding impacts along creek corridors which empty into Whiteman Cove.
- Evaluation of storm surge elevation at project site. This will inform an analysis of flood risk to properties within Whiteman Cove due to extreme storm events.
- Evaluation of impacts to littoral drift along the adjacent shoreline (within Puget Sound) due to the proposed restoration activities.


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ANCHOR QEA

Feet
0 200 400 600 800 1,000

**Figure 1**
Project Site Map
Whiteman Cove
South Puget Sound Salmon Enhancement Group


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**NOTES:**
T-Sheet, US Coast Survey, 1878

Feet
0 100 200 300 400 500

ANCHOR QEA

**Figure 2**
T-Sheet
Whiteman Cove
South Puget Sound Salmon Enhancement Group

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Not to Scale

Figure 3
Oblique Photograph of Existing Conditions
Whiteman Cove
SPSSEG SPS Site Feasibility

ANCHOR QEA

Not to Scale

Figure 4
Rendering of Post-Restoration Conditions (at Lower Low Tide)
Whiteman Cove
SPSSEG SPS Site Feasibility

ANCHOR QEA

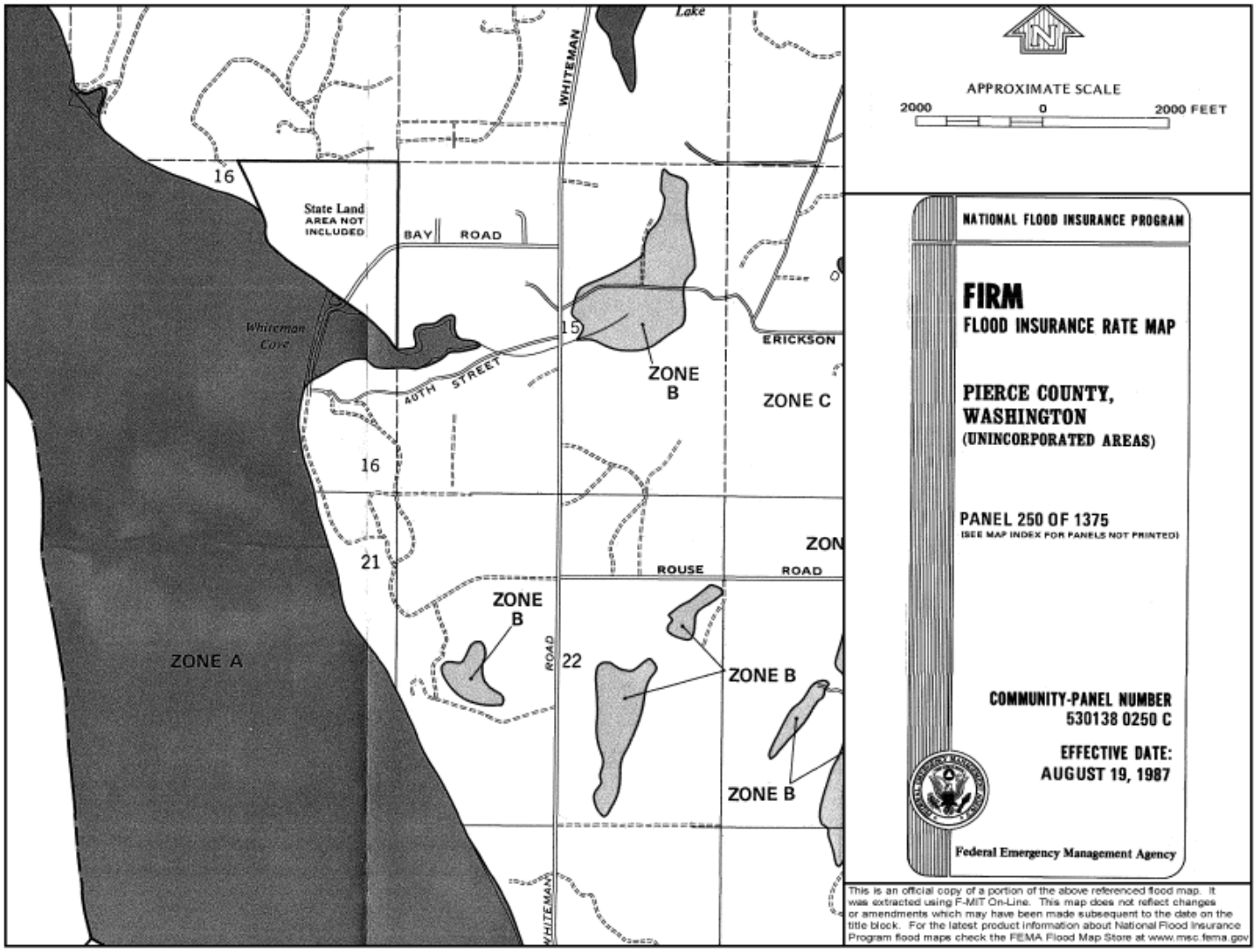


**Figure 5**
Excerpt from FEMA Flood Insurance Rate Map for Project Area
Whiteman Cove
South Puget Sound Salmon Enhancement Group

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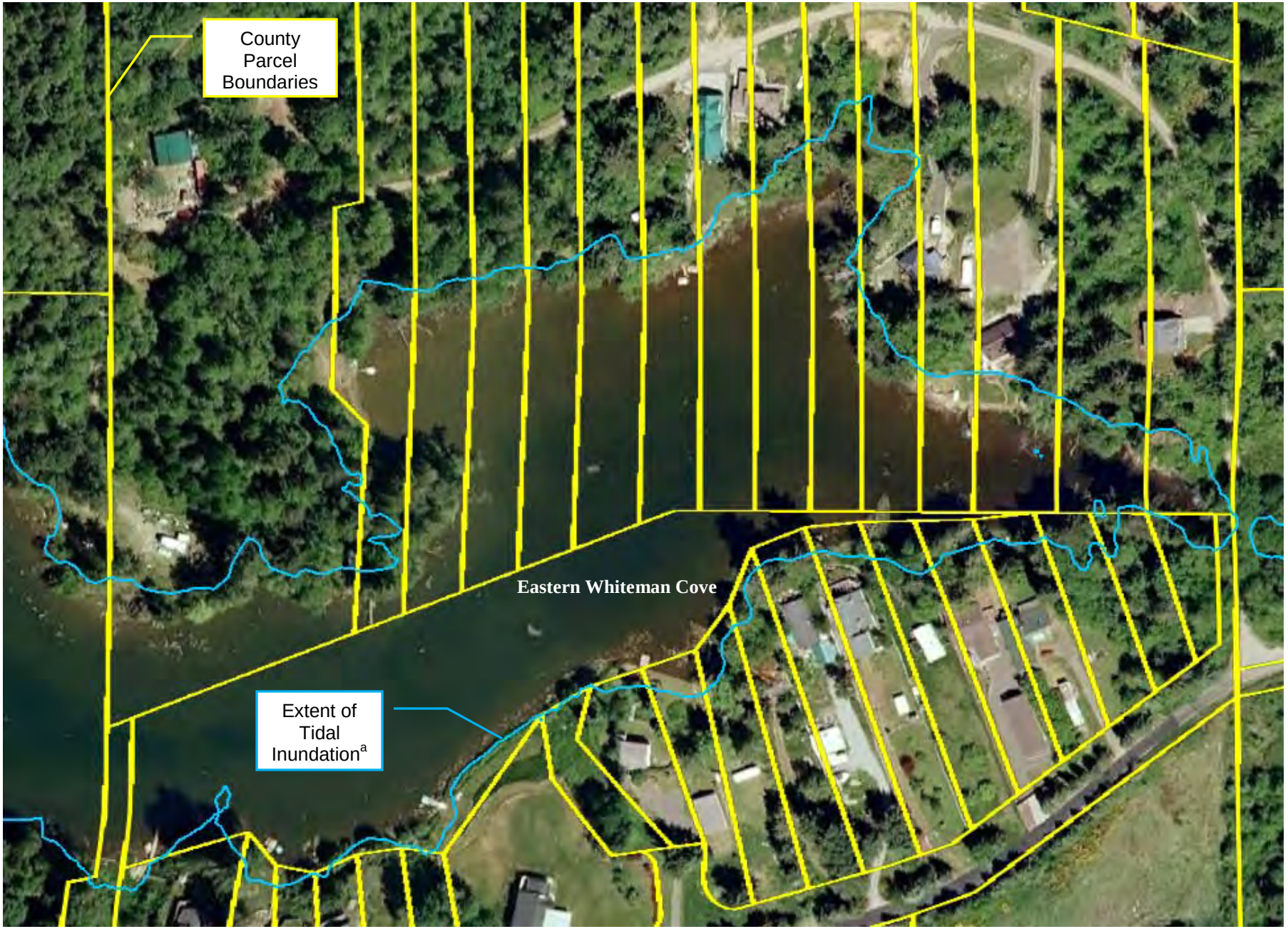
ANCHOR QEA

Notes:
a. Tidal inundation estimated at extreme high tide (excluding storm surge), +13.5 ft NAV88
Elevation based on Lidar and Tidal Datum Benchmarks.

**Figure 6A**
Predicted Tidal Inundation Post Restoration, YMCA and Parks Property
Whiteman Cove
South Puget Sound Salmon Enhancement Group

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Notes:
a. Tidal inundation estimated at extreme high tide (excluding storm surge), +13.5 ft NAV88
Elevation based on Lidar and Tidal Datum Benchmarks.

**Figure 6B**
Predicted Tidal Inundation Post Restoration, Private Residential Property
Whiteman Cove
South Puget Sound Salmon Enhancement Group


**NOTES:**
Elevation based on Lidar and Tidal Datum Benchmarks.
Tidal Inundation Estimated for Extreme High Tide (without storm surge) and is estimated as 13.5 ft NAVD88.

Feet
0 100 200 300 400 500

**Figure 6C**
Comparison of FEMA 100-yr Flood Extent and Predicted Tidal Inundation
Whiteman Cove
South Puget Sound Salmon Enhancement Group

## Appendix B.4: Haley Lagoon Shoreline Restoration (Project ID# 5)

### Project Description

Haley Lagoon, is a small barrier estuary fed by three freshwater streams, near Dutcher Cove in Case Inlet. The tidal channel has a history of lateral migration towards the bluff and bulkheads to the north of the tidal channel (Coast and Harbor Engineering 2010). Erosional forces from the tidal channel, coupled with wave energy from both the south and northwest, pose a threat to the cabins to the north of the Lagoon channel. As a result, the channel has been "rerouted" every 10 to 15 years by the landowners, with the most recent occurrence in Summer 2009 (pers. comm. P. Haley 2010).

While channel migration is a natural, dynamic process, the location of the cabins along the shoreline poses a structural dilemma. In order to eliminate the disturbance from rerouting of the stream channel at this ecologically sensitive site, and to alleviate the effects of an encroached tire/ filter fabric bulkhead and rock bulkhead, this project focuses on replacement of two bulkheads adjacent to the stream channel with subsequent beach nourishment to the eroded beach face and former stream channel to arrest some of the effects of channel migration. Two soft shore protection alternatives were developed to limit the disturbance to the nearshore ecosystem at this site and to provide a solution to the landowners that more closely replicates that natural form of the beach. The following report details the design analysis and development of the soft shore stabilization approaches.


**Figure 7.4. Aerial photo (DOE 2006) showing the bulkhead, lagoon, and tidal channel before channel reroute in 2009.**

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# HALEY LAGOON SHORELINE STABILIZATION – CASE INLET
# SOUTH PUGET SOUND SALMON ENHANCEMENT GROUP

## Technical Memorandum

COAST & HARBOR
ENGINEERING

110 Main Street, Suite 103, Edmonds, WA 98020 ✦ www.coastharboreng.com

COAST & HARBOR ENGINEERING

# Technical Memorandum
# Haley Lagoon Shoreline Stabilization – Case Inlet
# South Puget Sound Salmon Enhancement Group

## 1. Introduction and Background

A tidal channel that connects Haley Lagoon with Case Inlet has a history of lateral shifting and damaging a high bank and bluff that backs a portion of the shoreline. Erosion damage caused by the channel flows threatens houses and bluff stabilization structures at the shoreline. The property is owned by members of the Haley family who have owned the large parcel since the early part of the 20th century. Figure 1 is a location map of the Haley Lagoon project site.

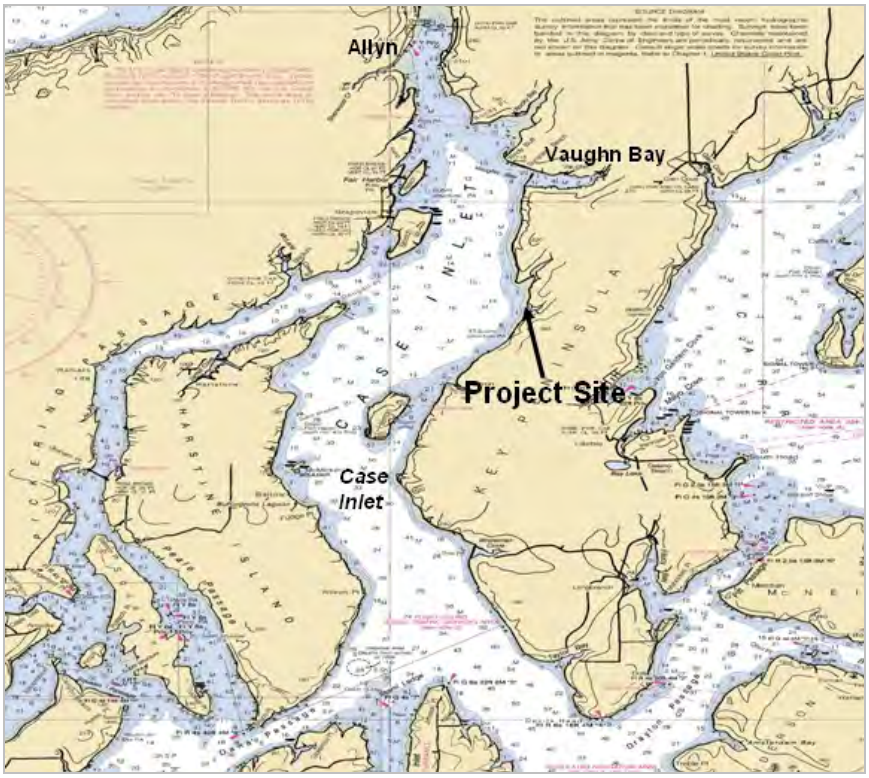


**Figure 1. Location map of Haley Lagoon project site**

Figure 2 is an aerial photograph showing the tidal channel confined between the northward trending sand spit at the Case Inlet shoreline and the channel's eastern bankline. A bulkhead composed of concrete filled scrap tires had been installed along one property as a response to

erosion risk, but it is undermined in places. Historically the property owners have repositioned the channel away from the bluff by shoveling a breach in the sand spit and allowing the channel to take a more direct route to Case Inlet. Outlet channel modification was conducted to prevent undermining and erosion of bulkheads and unprotected shoreline. Over time the channel would locate itself against the bluff again. The project reach is a length of bluff toe extending about 250 ft to the north and ending at the northern end of the tire bulkhead, and is indicated in Figure 3.


**Figure 2. Tidal channel location near bluff in September 2009**

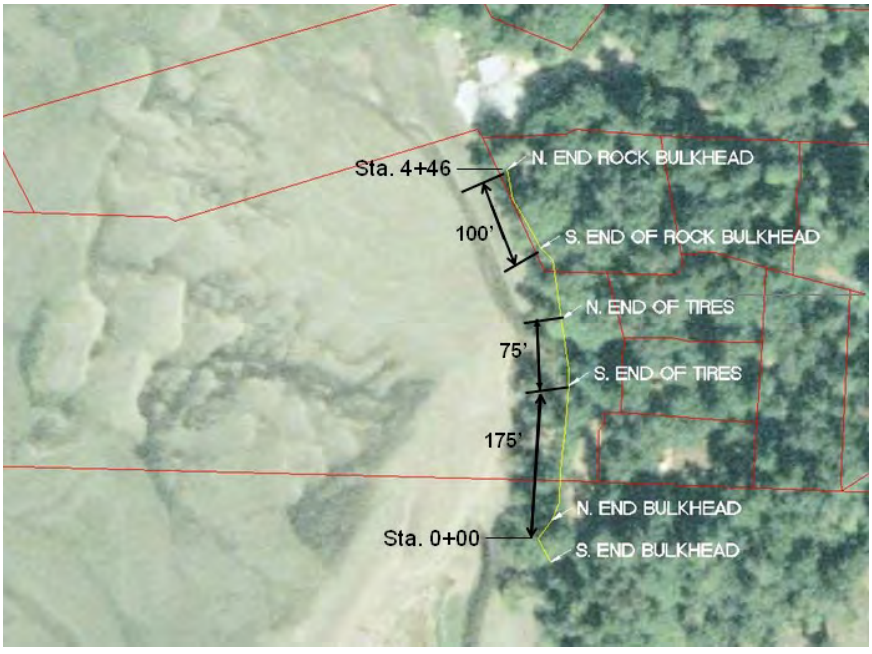


**Figure 3. Approximate project area and alongshore limits**

## 2. Project Objective

The project objective is to improve nearshore habitat structure and function as well as to protect the bankline where erosion could threaten houses or upland improvements. The property owners desire to have engineered bank protection that also conforms to goals of minimizing nearshore impacts and providing the opportunity for salmon habitat enhancement. Alteration of the sand spit will not be considered as part of any restoration or shore stabilization solution. The concept development, cost opinions, and concept-level drawings produced for this project phase are intended to be used to evaluate and determine project feasibility for securing funding for engineering design and construction, which comprise a separate project phase not scoped in the current work.

## 3. Data Collection

### 3.1. Site Recon

A site observation was made on September 7, 2010 to evaluate the physical processes operating at the site and qualitatively determine the intensity of those processes. The elongated spit that forms the left bank of the channel connects Haley Lagoon with Case Inlet. The progression of vegetation atop the spit indicates that the predominant direction of longshore transport is from south to north. The channel was rerouted (within the past 18 months) to a more direct path to Case Inlet by a minor amount of excavation. A portion of the former channel was plugged with excavated material, as illustrated in Figure 4.


**Figure 4. Recently excavated flow path and former channel location**

The beach profile shape northward from the end of the spit shows the typical high tide beach with coarse surface material and a low tide terrace composed of finer material. Formerly, the channel extended northward along the shore near the toe of the high tide terrace, as shown in Figure 5.


**Figure 5. Former creek location along toe of high tide beach near bluff toe**

A concrete bulkhead return wall marks the southern limit of the habitat enhancement project (Figure 6). The bulkhead made of concrete-filled tires was constructed at the water's edge to protect a house foundation. Figure 7 shows the bulkhead that is the primary subject of the bulkhead removal and shore protection project. North from the northern end of the tire bulkhead is a separate property where rock had been placed to control erosion at the bluff toe (Figure 8). Farther north the foundation of a house projects onto the high tide shoreline.

**Figure 6. Southern extent of shoreline reach targeted for soft shore protection**


**Figure 7. Scrap tire bulkhead constructed to protect upland from erosion**

## 3.2. Site Survey

Elevation data were collected at 150 locations using a total station to define critical details of the site configuration, document beach profiles, determine locations of existing shoreline structures, and form the basis for preliminary designs of shore protection concepts. Survey shot locations are shown with dots in Figure 9. Survey transects of the beach profile are shown as straight lines oriented perpendicular to the shoreline.

## 3.3. LIDAR Topography

Data collected from an aerial laser scanning system in 2002 and made available through the Puget Sound LIDAR Consortium were plotted to create a contour map (Figure 10) and a digital surface of the project area. Cross-sections were made through the surface at locations where sections were field surveyed. Cross-section profiles of the LIDAR and field surveys were compared to determine beach changes that might have occurred between 2002 and 2010.


**Figure 8. Rock revetment placed to control erosion of bluff toe**


**Figure 9. Locations of survey points collected in field survey of Sep 7, 2010**

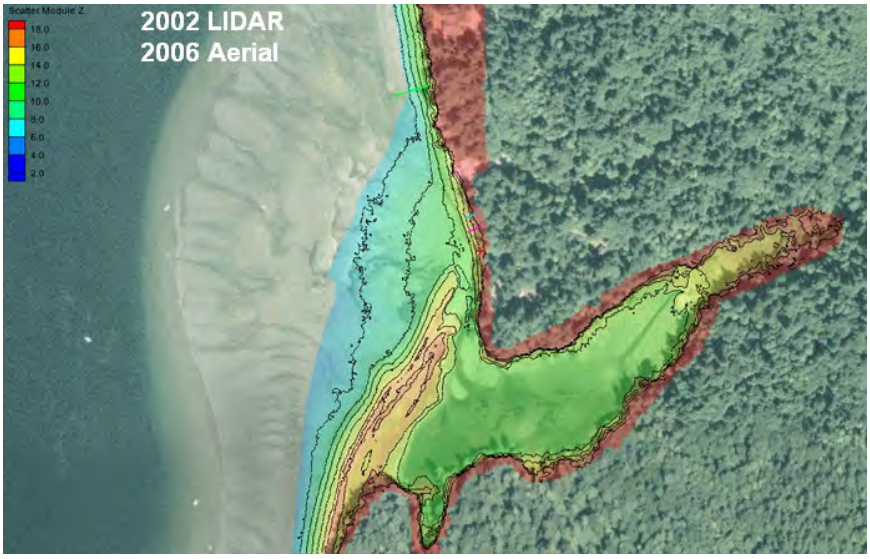


**Figure 10. Site topography created with LIDAR data**

## 3.4. Wind Records

Wind characteristics in the project wave generating area were developed using data of wind speed and direction recorded at West Point Lighthouse. That location was selected because although recording stations exist at more nearby locations, their statistical reliability in regards to length of record, representation of over-water wind speeds, and consistency of reporting format, is judged to be not as good as West Point data. Wind speeds corresponding to a range of return periods and directions were calculated for developing design wave parameters. Figure 11 shows a wind rose that represents the occurrence frequency and magnitude of wind speeds from directional sectors, and example wave height pattern in Case Inlet created by a strong south wind.

## 3.5. Tide Statistics and Datums

Tidal elevations relevant to the project site were adopted from the NOAA station at Ballow, WA without adjustment. Tidal datums are described graphically in Figure 12.

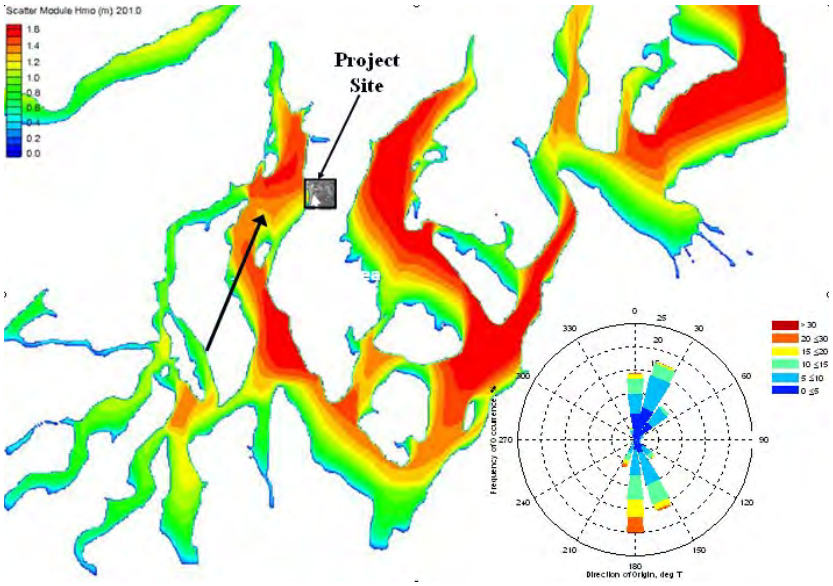


**Figure 11. Wind rose representing Case Inlet and wave heights generated from southwest wind**

**Ballow, WA, NOAA Station 9446583**

**Datums Applicable to Haley Lagoon**

| | MLLW | [1]NAVD88 |
|---|---|---|
| **Ordinary High Water (Est.)** | 15.5 | 11.18 |
| **Mean Higher High Water** | 13.94 | 9.62 |
| **Mean High Water** | 13.00 | 8.68 |
| **Mean Tide Level** | 8.00 | 3.68 |
| **Mean Sea Level** | 7.98 | 3.66 |
| **North American Vertical Datum** | 1.59 | 0.00 |
| **Mean Low Water** | 3.01 | -1.31 |
| **Mean Lower Low Water** | 0.00 | -4.32 |

Epoch 1983 - 2001

1. NAVD elevation based on relation between MSL and NAVD at Station 9446969, Budd Inlet.

**Figure 12. Relationship of tidal and geodetic datums at project site**

## 3.6. Sediment

Sediment size at the beach, channel, and spit top and below surface was noted and photographed. Samples were collected at locations where beach profiles were surveyed, and the sediment was stored for further analysis if necessary. General size characteristics were estimated from field sampling.

### 3.7. Site History

Site history was obtained through discussions with the Haley family during the site reconnaissance. A low dam was constructed across the Haley Lagoon outlet in the 1940's, and was removed in 1995. The dam was a simple barrier with no gates. At high tide water from Case Inlet entered the lagoon over the dam. The dam restricted lagoon outflow to water levels equal to that of the dam crest. These actions affected the sediment quantity delivered to the shoreline. First, sediment was impounded behind the dam and prevented continuous movement of sediment from the lagoon to the shore and along the shoreline. Later, with the dam removed, it is assumed that most of the impounded sediment was released in an uncontrolled manner.

The channel exiting the lagoon has a history of migrating toward the bluff toe in the distance from the concrete bulkhead northward for a distance of about 500 ft. At intervals of 10 to 15 years the channel was re-routed to a more direct path to Case Inlet by hand excavation, with excavated material placed to block flow from reentering the former channel. A cabin (the "association cabin") was built in the central portion of the study area. A tire bulkhead was constructed in front of the cabin after erosion threatened the cabin. The tire bulkhead has since been damaged by erosion (Figure 7).

## 4. Site Physical Processes

### 4.1. Waves and Currents

The site is exposed to waves generated by winds from the south and the northwest. The direction of spit growth indicates that the dominant wave transport is from south to north at the project shoreline, which is consistent with general wind patterns in Puget Sound. The wave energy environment of the site is expected to be low because the fetch is restricted. Wave hindcast for the site indicate that wave height of 2.3 ft from the south, and 1.3 ft from the north can be exceeded once in two years on average. Hindcast wave heights corresponding to other exceedance probabilities are listed in Table 1. These wave heights apply to a location offshore of the project site.

**Table 1. Hindcast wave heights and directions and corresponding return periods**

| Average Return Period (yr) | Wave Height From North (ft) | Wave Height From South (ft) |
|---|---|---|
| 2 | 1.34 | 2.34 |
| 5 | 1.57 | 2.72 |
| 10 | 1.73 | 3.09 |
| 25 | 2.17 | 3.43 |

Note: Wave height based on wind speeds measured at West Point. Wave height is at an offshore location.

Current speeds in self maintained tidal channels result from the adjustment of channel dimensions necessary to develop the velocity and velocity pattern to transport the

quantity and size of sediments delivered to the channel. Sediment is delivered to the channel by longshore transport at the shoreline and by transport from the lagoon. Peak tidal velocities of about 3 ft/sec, measured as section-averaged velocity, are necessary to maintain channels in sandy material (Bruun and Gerritsen, 1960). In gravelly material the necessary velocity must reach nearly 5 ft/sec (Simpson, 1976). The essential transporting characteristic of stable inlet channel is that the velocity develops a magnitude and duration to transport material out of the channel that would tend to restrict tidal exchange in the lagoon. Therefore, channel flows would erode sediment comprising the right bank or bluff toe when the channel is forced toward the bluff by infill from the left due to shore processes.

## 4.2. Sediment Supply

Aerial photographs dated 1990 to present, although taken at different tide levels, nevertheless document the lengthening of the spit and changing tidal channel position. A delta is located northward from the spit, formed by sediment supplied from the Haley Lagoon channel, longshore transport, and bluff erosion. The multiple branches within the channel exiting the lagoon indicate the channel must transport an abundance of sediment (Figure 13). The irregularity in the bluff line at the location of the delta indicates bluff retreat has been more rapid there than at locations north or south from there. Figure 10 shows the topography of the project area in 2002 created from LiDAR data, and the shoreline and channel locations, illustrating the northward orientation of the spit. A study by Schwartz and Wallace (1989) contained conclusions from their observations at Vaughn Bay that a drift cell extends from the north end of Dutcher Cove northward to the north end of the spit at Vaughn Bay. They estimate the net shore-drift rate at Vaughn Bay to be 2,013 cu meters per year (71,000 cu yd/yr).

**Figure 13. Channel bed sediment and channel form at lagoon outlet, indicating abundance of sediment that must be transported by the flow**

This project site is located about 2000 ft south of the southern limit of the Vaughn Bay drift cell, and littoral processes at the site are expected to be similar to those documented by Schwartz and Wallace. Sediment is supplied to this reach by the creek that exits Haley Lagoon, by longshore transport, and from bluff erosion. Sediment is transported away from the site mainly by longshore transport to the north. Spit growth and delta formation indicate there is a net gain in sediment volume in the project reach. Continuity of littoral drift in this shoreline reach does not depend on sediment supply from the bluff in the project reach.

## 4.3. Littoral Processes

Figure 14 shows the change in channel location from 1990 to 2009, and illustrates the threat posed by the natural dynamics of the channel. The channel migrates laterally to find the most hydraulically efficient path for water and the sediment it carries to reach Case Inlet. At times the channel has moved adjacent to the bluff toe. In such a location, creek current as well as waves at times of high water can erode the bluff toe and damage shore structures. Dominant processes vary by location, as shown in Figure 15. Stream hydraulics is the predominant mechanism for transporting sediment and forming the surface features in the south zone, the area sheltered by the high spit. Where the spit shelters the upper profile and bluff toe, smaller material does exist at the upper beach/bluff toe. The beach face is steepest in the lee of the spit because of the relatively low level of wave energy reaching the beach and channel side.


**Figure 14. Channel positions in 1990 and 2009**

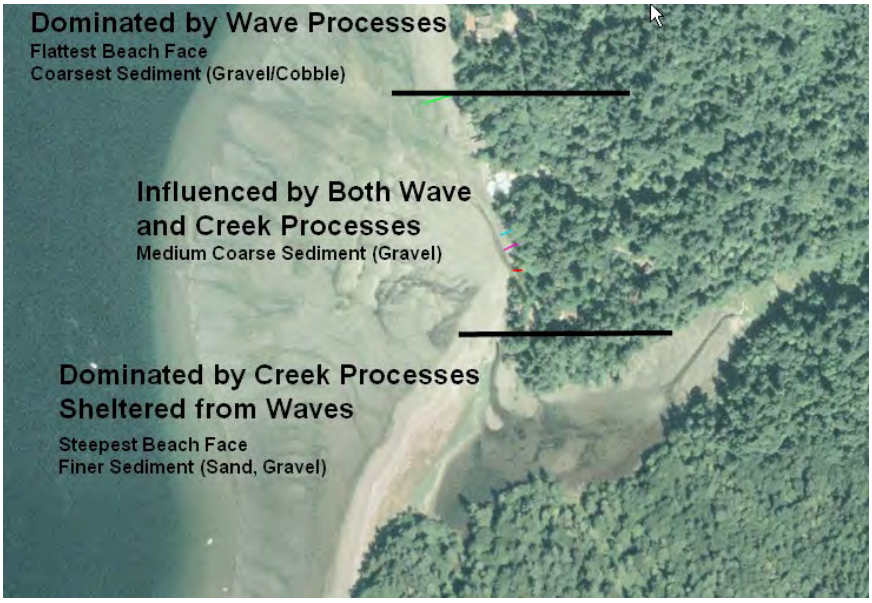


**Figure 15. Shoreline zones dominated by three combinations of processes**

A middle zone extends from the location where the spit is easily overtopped northward to the limit of the delta. Both wave and stream processes combine to form channels, and later fill them with sediment and relocate the channels, often endangering the bluff. Figure 16 shows a deposit of wave transported sediment at the western side of an abandoned channel. Had this been an active channel, the response would have been to erode the eastern channel side and translate eastward, toward the bluff. The bluff alignment in this region seen in aerial photographs results from the effect of combined forces of the stream and waves on long-term bluff recession.

**Figure 16. Evidence of wave transport of sediment into creek channel**

A third zone is north of the delta and out of the influence of the channel. A beach is visible there in aerial photographs and appears to have a wider, higher elevation high-tide beach than is present in the middle zone. Where the delta is fully exposed to waves, small size material is not found on the upper beach profile surface. Waves transport larger particle sizes to the higher elevation and remove smaller material from the surface layer. Smaller material is found at lower elevations on the beach where water is deeper and wave turbulence is less than in the wave swash zone. The relatively higher wave energy at this northern location creates a flatter beach face slope than at more sheltered locations to the south. An example of this morphology is shown in Figure 17.

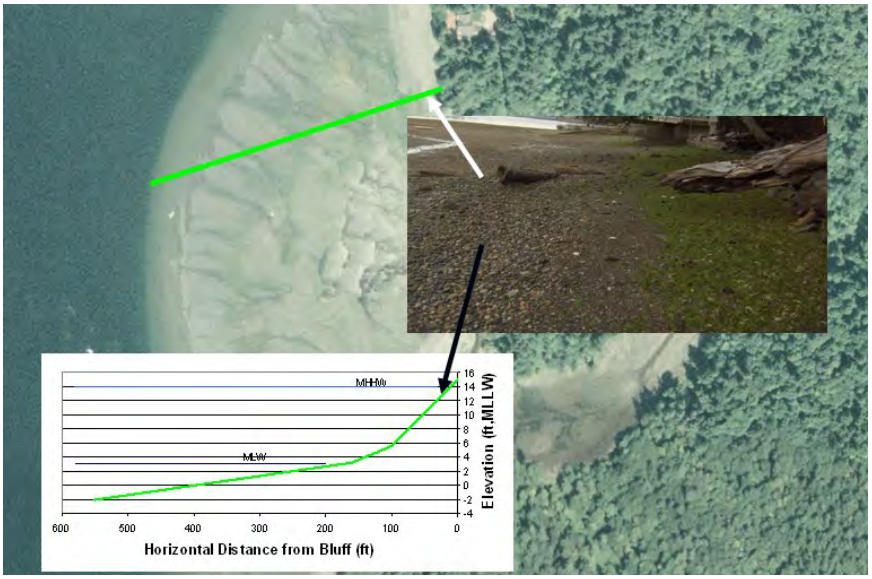


**Figure 17. Size and slope characteristics of beach fully exposed to Case Inlet waves**

## 5. Condition Assessment

### 5.1. Historical Dredging and Channel Remnants

Limited records show that the channel was last rerouted in the summer of 2009. The beach material dug for the channel was used to plug the channel that had migrated toward the bluff toe. Previous actions occurred on a roughly 10- to 15-year interval. Only hand digging was permitted by the Regulatory Agencies. Channel relocation represents significant work by a large number of individuals with shovels. Continued channel migration and corresponding effects from the adjacent shoreline will occur as a result of ongoing natural nearshore processes. Any new shore protection shall consider the need for continued channel relocation and/or undercutting and toe scour.

## 5.2. Existing Shoreline Structures

Construction at the shoreline to control damage to the bluff and to property includes a formed concrete bulkhead at the south edge of the project area, the scrap tire bulkhead protecting the "association cabin," and a rock bulkhead. House foundations north of the project area show signs of sediment scour at the footings. The rock bulkhead shows signs of failing. The tire bulkhead shows that it has been both undercut at the toe and overtopped, with storm debris tossed onto the upper surface. The rock and tire bulkheads are in a state of medium to severe deterioration, providing limited shore protection function. Replacement is needed for protection of uplands and infrastructure.

## 5.3. Bluff and Upper Beach

Undercutting the bluff toe and eroding the bluff face are processes currently active in the project reach. Trees lean toward the water due to lack of soil support. Footings of concrete walls are visible, indicating the sediment surface has lowered from previous times. Figure 18 shows an abandoned channel located near the bluff toe and illustrates the depth to which undercutting can occur and the depth to which erosion protection must extend. Wood drift debris is not abundant and is found only at the highest elevation at the back beach. At some locations wood may be responsible for damage to the bluff toe. Groundwater processes were not investigated, but seeps from the bluff face were not evident in the site visit although freshly eroded surfaces on the bluff were noted.

**Figure 18. Depth of abandoned channel near tire bulkhead**

Surface sediment size varies alongshore in the project reach. At the southern end of the project area an abundant supply of sand and small gravel nourishes the spit. At the northern end of the project area the beach profile is fully exposed to waves, and sediment has formed a broad delta on the lower profile. The higher-elevation beach

surface sediment is cobbly (Figure 5). During occasions of high waves at times of high water level, coarse material is moved to the upper beach, above the break in slope. This material is thought to be stable most of the time, as evidenced by the presence of marine growth on the particles.

### 5.4. Site Condition Summary

The overall assessment of the project site as it relates to shore protection is summarized in the following.

- Sediment transport continuity in the littoral zone is not dependent on erosion of the bluff within the project area. The lagoon mouth and tidal channel are not a sediment sink, and may be a sediment source, supplying small gravel size material to the littoral zone.
- Channel migration will continue to impact any shore protection unless specific measures are taken to control the extent of migration.
- Continued spit growth will have the effect of extending northward the zone in which channel migration causes impacts to the bluff toe and shore structures.
- The size of naturally occurring material comprising the upper beach indicates the type of material that could be used in a soft shore protection concept, provided the imported material size distribution and the constructed slope are properly engineered.
- Grounded woody debris is not abundant on the beach because the beach profile is generally too low for this wave and tide environment. Woody debris incorporated in any solution for shore protection would need to be placed at a higher elevation than the current level of the back beach. The back beach would need to be wide enough to minimize movement of the wood against the bluff face.

## 6. Shore Protection Alternatives

Based on the site condition evaluation, data review, and qualitative analysis of physical processes, a range of shore protection concepts were considered. Two approaches that could be effective are a type of soft shore protection and a standard rock revetment. Effectiveness is a quality that is measured against criteria. Performance criteria are presented and the selected alternatives are described and evaluated in the following:

- A berm composed of coarse gravel of the size seen in Figure 5 at the bluff toe could be a long-term erosion control measure. Supplementing the shoreline with the type of material that exists on site and formed in a feature that is natural to the site could both protect the bluff toe and improve habitat in the project reach.
- Stabilizing the bluff toe with a rock revetment and with the tidal channel left unconstrained would require the revetment toe to extend at least to the depth of the maximum channel depth to prevent undermining in the design life. The height of the revetment should be designed to account for increased wave runup due to water depth at the toe.

- The wave exposure of the northern part of the project length would probably preclude use of anchored woody debris as a primary shore protection system, because wave forces and water surface elevation in the design event will likely require an anchoring system that is impractical for the site. Installing such an anchoring system would result in substantial disturbance of the shore environment.

## 6.1. Performance Criteria

Criteria for shore protection performance are developed from project objectives and detailed understanding of site processes. Criteria are listed below:

- Replace tire bulkhead with effective shore protection that also improves substrate.
- Control channel migration to prevent undermining of installed shore protection.
- Depth of scour possible at toe of shore protection is approximately +7 ft MLLW, the current bottom elevation of the channel.
- Ends of constructed shore protection must be protected from flanking by either tying into existing structure or feature, or by an effective transition.
- Constructed beach alternative for shore protection should have equilibrium slope and material size designed to 2-year wave conditions, and material of this size should remain on the profile up to the energy level of the 25-year return period wave storm.
- Reduce frequency for ongoing channel relocation activities for the purpose of shoreline stabilization and protection.

## 6.2. Soft Shore Protection

The rationale for designing soft shore protection is that the solution diminishes wave reflection and the associated substrate impacts. Because the soft solution approach more closely duplicates the form of natural beaches, wave and sediment processes would likely be more natural to the setting and less disruptive to nearshore habitat. Based on the site processes described above, soft shore protection could be a constructed high tide beach composed of coarse gravel, with toe protection to prevent future movement of the creek into the constructed beach.

The conceptual beach configuration is shown in Figure 19. Beach crest elevation will be designed to match the elevation formed by waves shoaling on a gravelly slope, which at this location is about 15.5 ft above MLLW. Beach material composed of a broad distribution of fine to coarse gravel, with the largest size of 2 ½ inches, would form a beach face slope of 7 horizontal to 1 vertical in the wave environment at this site. The recommended minimum beach crest width is 10 ft, to allow dissipation of overtopping waves and grounding of drift logs. A small revetment buried behind the beach is recommended as bluff protection in the case of an extremely erosive event. The toe of this revetment should be buried below beach crest elevation, and the crest exposed above the beach up to elevation 17.5 ft. The toe of the beach would be protected with buried cobbles extending down to the level of the bottom of the

channel, to protect the beach in the case of lateral movement of the channel. The cobbles would be sized for stability if exposed to current erosion or to waves.

Longer constructed beaches have longer periods between maintenance events, all else being similar. A way of reducing the loss of beach material from the southern end of the constructed beach is to tie the beach into the northern end of the existing concrete bulkhead. The northern end of the constructed beach will require a designed transition into the unprotected reach of shoreline.

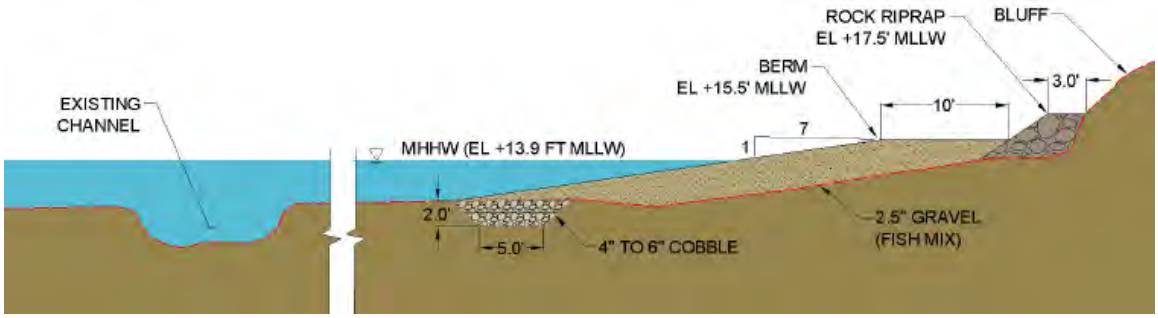


**Figure 19. Soft shore protection concept**

## 6.3. Rock Revetment

The rationale for designing a rock revetment as shore protection is that stability and performance of the engineered structure is well known. The design will require a smaller overall volume per foot of length of revetment than the soft shore solution, but more excavation would be required. The crest elevation of the revetment would need to be higher than for a constructed beach to protect against the higher wave runup, owing to the steeper slope of the revetment face.

The conceptual revetment configuration is shown in Figure 20. The median size of the riprap rock is estimated to be 2 to 3 ft along the intermediate axis. The toe elevation of the revetment is expected to be +7 ft, to prevent being undercut by the channel when it moves against the revetment.

Transition of the rock revetment into the unprotected shoreline reach is required, to minimize the "end effect" of terminating a hard structure at an erodible shoreline. Similar to the soft shore protection description above, one option could be to tie the southern end of the revetment into the northern end of the existing concrete bulkhead.

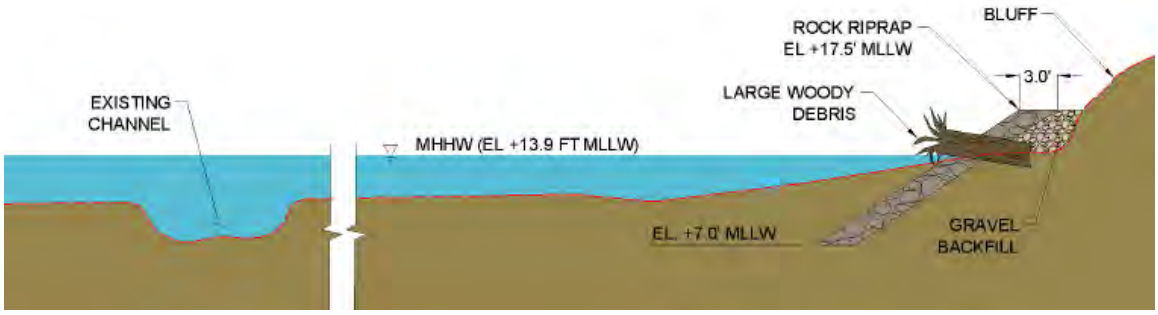


**Figure 20. Rock revetment shore protection concept**

## 6.4. Project Lengths

Two lengths of each alternative concept were considered, for shore protection performance and costs. For Alternative 1 soft shore protection, Option A is assumed to extend from the concrete bulkhead on the south to the northern limit of the existing tire bulkhead, a distance of 325 ft. See Figure 21. For Alternative 1, Option B, the soft shore protection is assumed to extend farther northward to the southern foundation wall of the Ted Haley house, a distance of 450 ft, indicated in Figure 22. For Alternative 1B no transition would be needed; terminating the constructed beach at the house foundation would be an effective way to limit longshore loss.

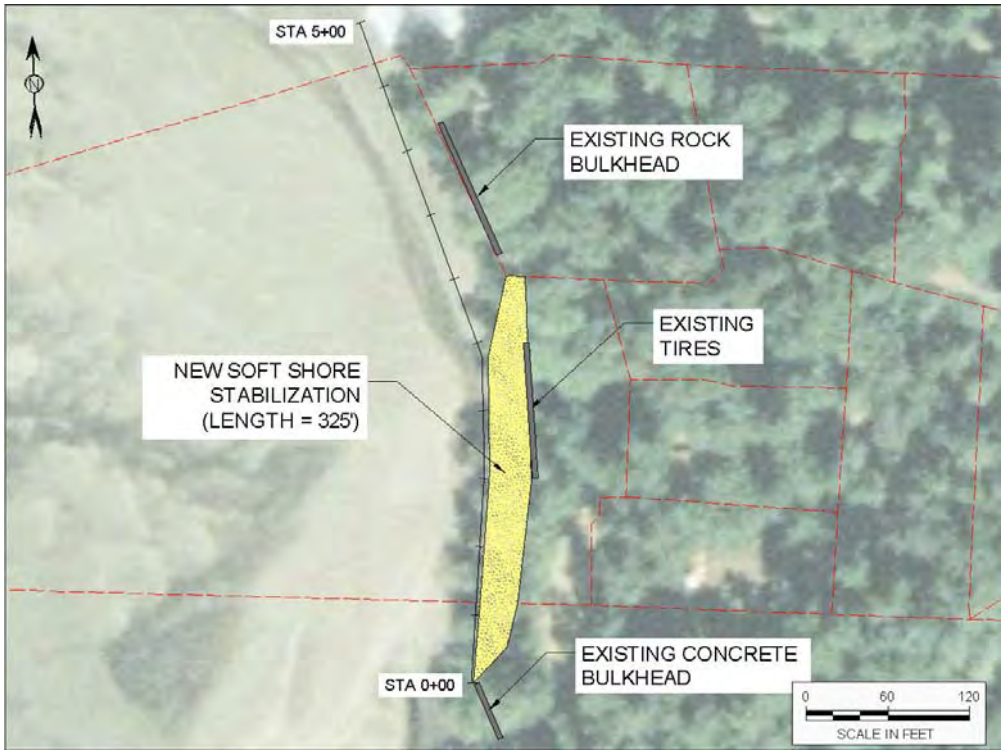


**Figure 21. Alternative 1A project limits for soft shore protection concept of length 325 ft**

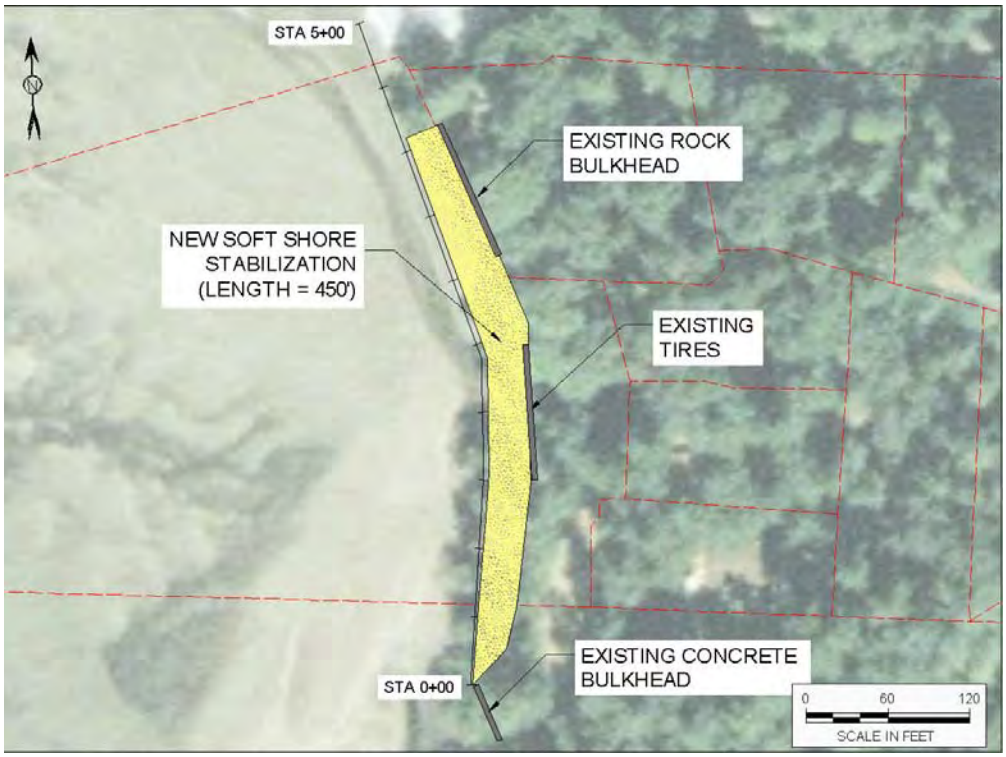


**Figure 22. Alternative 1B project limits for soft shore protection concept of length 450 ft**

For Alternative 2 rock revetment, Option A, the construction is assumed to equal the extent and location of the soft shoreline solution Alternative A (325 ft). See Figure 23. Alternative 2A would protect the bluff for the full distance from the concrete bulkhead to the "association cabin," and benefit the road atop the bluff. For Alternative 2, Option B, the rock revetment is assumed to simply replace the existing tire bulkhead and extend slightly farther for the transition sections, a total length of 100 ft (Figure 24). Alternative 2B would protect the cabin, but would not diminish the risk of future instability of the road atop the bluff.

## 6.5. Initial Construction Costs

A preliminary-level estimate of construction costs was developed for each alternative. Costs were developed from material supplier quotes, previously bid projects, and communications with contractors. All costs include sales tax but do not include any regulatory permitting, environmental studies, or engineering costs. Construction costs are listed in Table 1.

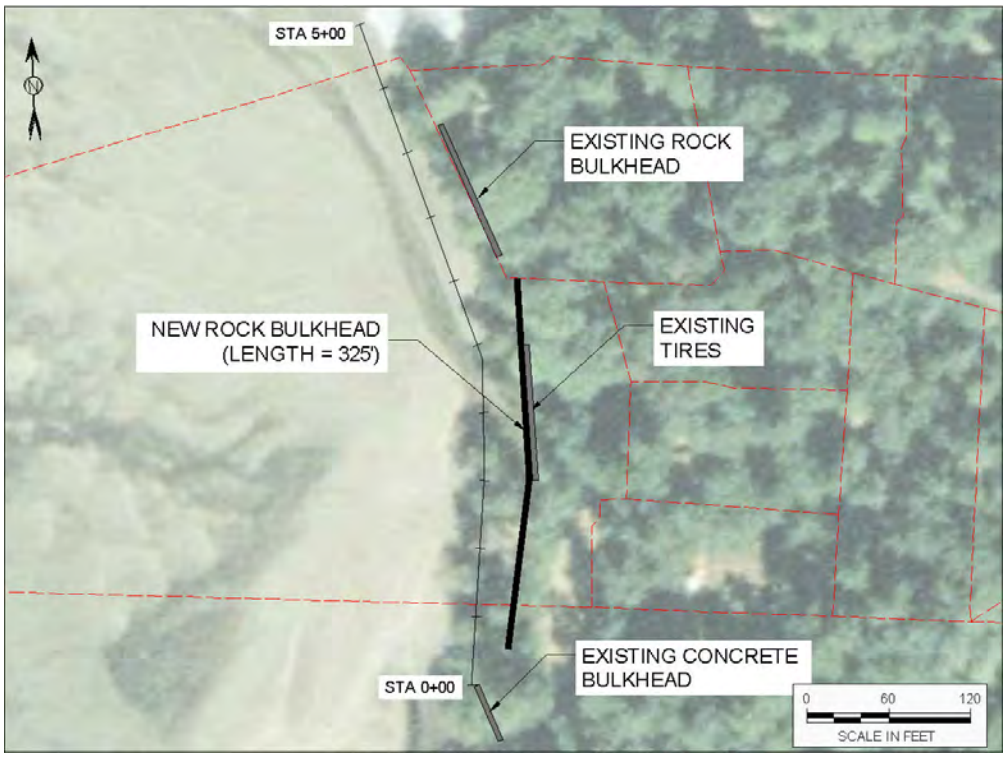


**Figure 23. Alternative 2A project limits for rock revetment concept of length 325 ft**

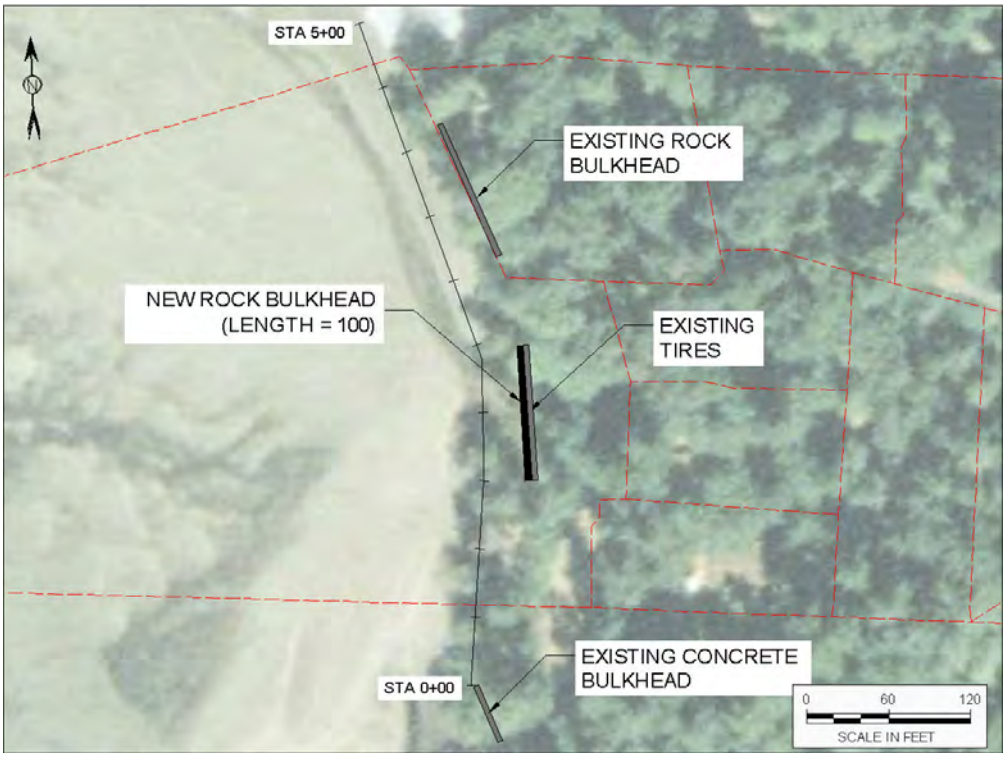


**Figure 24. Alternative 2B project limits for rock revetment concept of length 100 ft**

## 6.6. Other Considerations

The soft shore protection structure is by design compliant with extreme natural forces, and is therefore dynamic. Some placed beach material is expected to be lost alongshore during times when waves would move that material. Loss is minimized by designing the cross-sectional shape and dimensions to imitate those of a beach that would naturally form in this environment, given adequate supply of coarse material. Loss of material to the offshore is expected to occur if the project experiences a wave storm more energetic than the 25-year return period storm. Maintenance in the form of replacing material lost to the littoral zone is expected to be required approximately on a 15- to 20-year cycle. The longer constructed beach, Alternative 1B, would have a lower rate of longshore loss because of a better termination of the northern end than would Alternative 1A. The incremental cost of extending the project length to the terminus of Alternative 1B is relatively low because the volume of imported material per foot of beach is less than in the rest of the project.

The design life of the rock revetment is typically 35 to 50 years depending on rock quality. Minor maintenance may be required to repair damage from extreme storms. Wood incorporated in the rock structure will deteriorate in time, with the result of disrupting the rock stability in the vicinity of the wood.

# 7. Summary

The foregoing alternatives analysis is summarized below.

**Table 1. Alternatives Summary Table**

| Alternative | Pros | Cons | Cost |
|---|---|---|---|
| 1-Soft Shore Solution | -Enhances natural processes and habitat<br>-Recruits large wood<br>-Requires least excavation per ft of length<br>-Protects access road on bluff top<br>-Protects against channel migration | -Requires more maintenance than Alt 2.<br>-Initially covers substrate<br>-Risk of damage to constructed beach in very large storm | 1A: $135,000 to $170,000<br>1B: $160,000 to $200,000 |
| 2-Rock Revetment | -Well-tested design procedure<br>-Provides protection in very large storm<br>-Low maintenance<br>-Only 2A protects access road on bluff top | -Requires most excavation per ft<br>-Possible negative impact to substrate<br>-Does not meet soft stabilization and salmon enhancement goal<br>-Potential continual channel dredging and maintenance<br>-Alt 2B only protects 1 structure; access road at risk | 2A: $135,000 to $170,000<br>2B: $65,000 to $75,000 |

## 8. References

Bruun, P. and F. Gerritsen. 1960. Stability of Coastal Inlets. North-Holland Publishing Co., Amsterdam, 123 p.

Schwartz, Maurice L., R. Scott Wallace, and Edmund E. Jacobsen 1989. Net Shore-Drift in Puget Sound. Engineering Geology in Washington, Volume II, Washington Division of Geology and Earth Resources Bulletin 78, pp. 1137 - 1146

Simpson, D. 1976. Hydraulics of Two Small Gravelly Tidal Inlets. Thesis submitted in partial fulfillment of requirements for M.S. degree. University of Washington, Seattle, WA. 142 p.

This document is being released for the purpose of review and alternative analysis, under the authority of R. Shane Phillips, P.E. This document is not to be used for purposes of permitting, final engineering design, or for construction documents.


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## Appendix B-5: Penrose Point Bulkhead Removal (Project ID # 66)

### Project Description

This project is located in Penrose Point State Park in Case Inlet. Nearshore habitats present within the park are generally in really good condition; however, habitat and habitat forming processes in the project reach have been impaired by a 700-foot long creosote bulkhead with rip rap toe protection that sits at approximately 10-feet (MLLW). The bulkhead limits shallow water habitat at high tide, sits on top of potential surf smelt spawning habitat, impairs water quality through input of toxic creosote residue, impounds bluff sediment and has eliminated riparian fringe habitat for input of nutrients and wood.

Removal of the bulkhead will reconnect bluff and riparian processes , restore sediment transport, improve the beach profile for rearing and foraging salmonids, and enhance forage fish spawning habitat. The bulkhead sits between a divergence zone at the head of a long, natural low tide spit, at the end of two drift cells, approximately ½ mile in length.

In working with WA State Parks through the design and feasibility process, Anchor QEA developed a feasibility study detailing four alternatives for removal of the bulkhead that maintained some of the recreational opportunity currently provided by the bulkhead (Anchor QEA 2009). Through this exercise the stakeholders determined the most beneficial, most cost effective, and most viable alternative was full removal of the bulkhead (Figure B-2a and B-2b).


**Figure 7.5. Aerial photo (DOE 2006) showing location of bulkhead along the shoreline.**

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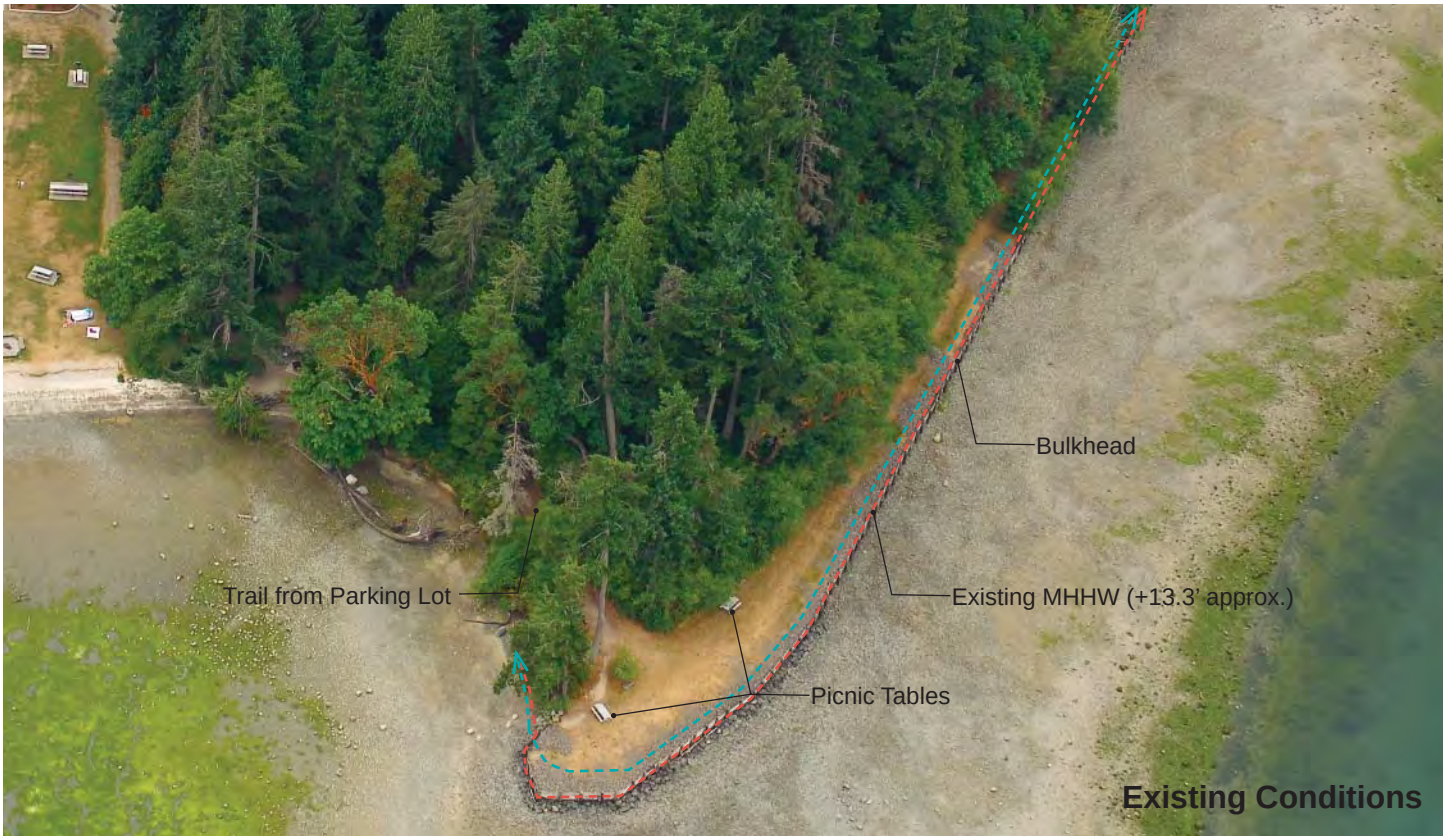
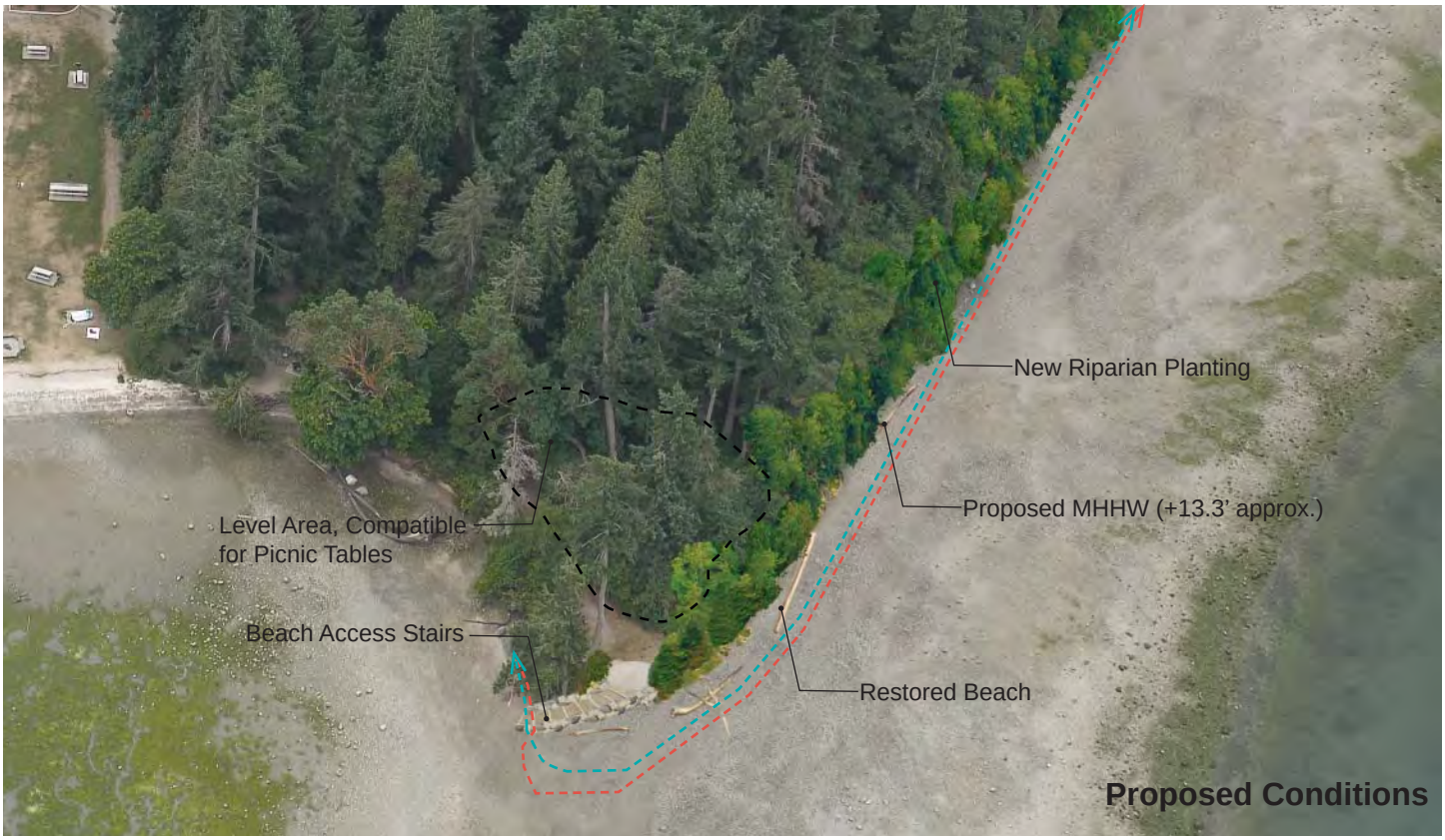
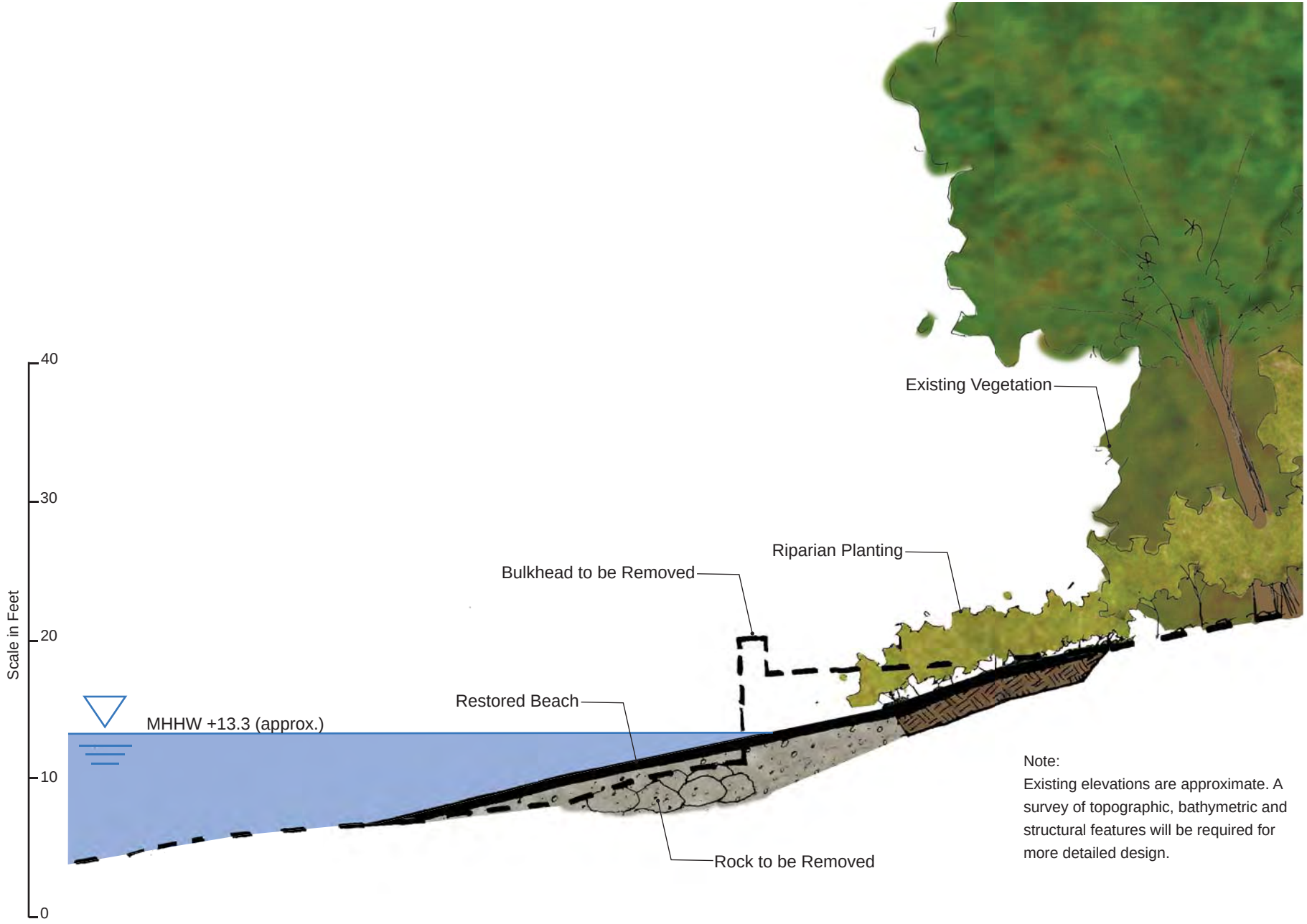



ANCHOR QEA

Existing MHHW (approximate)
Proposed MHHW (approximate)

**Figure 1**
Full Bulkhead Removal and Beach Access
Penrose Point State Park




ANCHOR QEA

0 5 10
Scale in Feet

**Figure 2**
Full Bulkhead Removal Typical Section
Penrose Point State Park

# DRAFT FEASIBILITY REPORT

# PENROSE POINT STATE PARK SHORELINE RESTORATION

**Prepared for**

South Puget Sound Salmon Enhancement Group

**Prepared by**

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Suite 300

Seattle, WA 98101

**May 2009**

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# 1 INTRODUCTION

This report presents the results of a preliminary, focused feasibility study of shoreline habitat restoration options for the Penrose Point State Park (Park), located 16 miles southwest of Purdy, Washington, in western Pierce County. Figure 1 is a Vicinity Map showing the Park site.

The study was performed by Anchor QEA (Anchor QEA), LLC on behalf of the South Puget Sound Salmon Enhancement Group (SPSSEG). Anchor QEA's work was based on a site visit at the Park on February 12, 2009, and a meeting with Park and SPSSEG representatives during that site visit. The study was also based on site drawings provided by the Park and SPSSEG and the following additional sources of information:

- Bare Earth LIDAR of the Pierce County Lowlands (Puget Sound LiDAR Consortium 2004) provided topography for the site
- Historic oblique aerial photography (Ecology 1977, 1992, 2000, 2002, 2006)
- Recent aerial photography of the site (National Agriculture Imagery Program 2006)

Neither project-specific site investigations nor geotechnical or coastal modeling were part of the scope of this work.

The intent of this study was to perform a preliminary, high-level feasibility evaluation of potential restoration opportunities for aquatic and riparian habitat that is currently affected by the presence of a wooden bulkhead and several wooden groins at two shoreline locations within the Park. The main objective that guided the development of each alternative was reducing the amount of artificial shoreline structures while protecting upland recreation features important to the Park.

This study is limited to a focused set of potential restoration options discussed with SPSSEG and Washington State Parks (Parks) during the site visit. While not part of the scope of this study, there is an additional option for the bulkhead area that would likely be low in cost and provide the highest restoration benefit: relocating the picnic area to an entirely different part of the park, and removing the entire bulkhead. This option may not be compatible with

Parks site use however. A detailed evaluation of this alternative could be included as part of a more detailed alternatives analysis for shoreline restoration.

## 1.1 Site Description

The Park site is a 152-acre State of Washington public facility located on the south shores of Puget Sound adjacent to May Cove and Carr Inlet. Figure 1 is a vicinity map of the site. Figure 2 provides detail on the study areas described in this report. In addition to day use and camping facilities, the Park has a boat launch and dock, and 2 miles of saltwater shoreline.

The existing shoreline generally has a northeast exposure. The longest fetch distance (distance across open water where wind can blow unimpeded) is approximately 9 miles at a 30 degree heading across Carr Inlet. The shoreline consists of natural beach, a picnic area on higher ground (Bulkhead Area) protected by approximately 700 linear feet of wooden bulkhead with rock toe protection, natural unarmored steep bluffs (feeder bluffs), and a sand spit (Sand Spit Area) that protects a private marina and the Park public dock. The Sand Spit Area has a series of wooden groins that are spaced approximately 75 feet apart, and extend from the backshore area approximately 50 feet into the shallow intertidal zone. In addition, the Sand Spit Area has a low wooden bulkhead (less than 2 feet high) protecting a grassy picnic area near the dock, and a taller wooden bulkhead (3 to 4 feet high) at higher elevations along the backshore.

# 2 PRELIMINARY ENGINEERING CONSIDERATIONS

This section presents both coastal engineering and geotechnical considerations associated with the potential shoreline restoration alternatives.

## 2.1 Coastal Engineering Considerations

### *2.1.1 Physical Characteristics of Shoreline*

The project area shoreline is located along the southern extent of Carr inlet in south Puget Sound and faces approximately north-northeast (Figure 1). Carr inlet is a body of water between Key Peninsula and Gig Harbor Peninsula. Its southern end (the mouth of the inlet) is connected to the southern basin of Puget Sound. The centerline water depths within Carr Inlet range from approximately 450 feet at its mouth to approximately 70 feet at its northern extent.

Penrose State Park includes 2 miles of saltwater shoreline that varies from east to west and includes a shallow intertidal embayment, armored headland, natural beach-bluff system, and a sand spit partially modified with a small groin field. Beach sediment varies in size from coarse sands through gravel, with the occasional larger cobble. Non-native rock has been placed along the toe of the bulkhead, and some of this rock has migrated to other locations along the shoreline. There is evidence of hard pan along the entire stretch of shoreline, with a higher prevalence of emergent hard pan in the vicinity of the picnic area. The Washington State Department of Ecology (Ecology) has mapped drift cells for the project area that show east to west transport along the entire stretch of shoreline, with the exception of the picnic area headland, which is mapped as a divergence zone. There is additional visual evidence of westerly sediment drift along the sand spit groin field (more sand has built up on the easterly side of the groin).

The slope of the intertidal beach varies depending on the type of shoreline system. The intertidal embayment to the east of the picnic area (headland) is quite flat with an approximate slope of 1 vertical to 30 horizontal (1V:30H). This area is backed by a low-lying grassy area, which was previously a wetland and has been filled to create public open space. The picnic area slope fronting the bulkhead line is steeper, but still mildly sloped, with an approximate slope of 1V:15H. The stretch of natural shoreline located between the bulkhead

and the sand spit is also about 1V:15H and is backed by a non-armored feeder bluff. The bluffs along this reach are quite steep with variable elevations. The shoreline along the sand spit is characterized by a mild slope (1V:25H) in the upper intertidal area with a large mud flat extending into the lower intertidal area. The top elevation of the sand spit appears to be only a few feet above MHHW elevation.

### *2.1.2 Tides*

Tides within Puget Sound are semi-diurnal mixed, which means that there are two high and two low tides per day, but they are not equal. In addition, the tide range varies from large differences between high and low tide to smaller differences approximately every other week. This creates a complex tidal elevation and current structure along the project shoreline.

National Oceanic and Atmospheric Administration (NOAA) does not provide any tidal data, predictions or benchmarks of tidal heights at the project area location. The NOAA tidal benchmark that is closest to the project area is located at Arletta, Washington, on Fox Island (Station ID 9446491, located at 47° 16.8' N, 122° 93.1 W) and is based on the 1983 to 2001 tidal epoch. The tidal heights at Penrose State Park most likely differ somewhat from those provided for Arletta; however, the data provide a sufficient level of accuracy for completion of the alternatives analysis. Tidal heights for the Arletta benchmark referenced to mean lower low water (MLLW) for that location are provided below:

- MHHW = 13.3 feet
- Mean High Water = 12.4 feet
- Mean Tide Level = 7.7 feet
- Mean Low Water = 2.9 feet
- MLLW = 0.0 feet

### *2.1.3 Waves and Sediment Transport*

Sediment transport along the project shoreline is driven by waves and, to a lesser degree, by tidal currents. Littoral drift is a long-term continuous process that is caused by waves approaching the shoreline at an angle. The net littoral drift direction for most of the project area shoreline is from east to west, per Ecology's designation, and over time, fine sediment

and gravels will migrate westward along the project shoreline. In addition to littoral drift, episodic beach and bluff erosion will occur in response to storm events. These erosive events are caused by storm waves that are created in the deeper waters of Carr Inlet during high wind events and propagate into the project area. The longest fetch direction that affects the project site is approximately 9 miles at a 30 degree from north bearing across Carr inlet. Therefore, the largest waves that could impact the project shoreline would be caused by high wind events that blow from the northeast towards the site. While prevailing wind patterns in South Puget Sound are from southerly directions, storm events with high northeasterly winds do occur on a less frequent basis.

A complete wind-wave evaluation for the project site is expected to require substantial engineering effort. Long-term wind records do not exist at the site. The closest location for long-term wind data is at Tacoma Narrows Airport, 8 miles to the east. While the distance between the project location and wind data record is not large, the complex topography of the area makes it difficult to predict wave directions from one location to another in Puget Sound. In addition, overland wind speeds are often difficult to translate to overwater wind speeds, which are required to accurately calculate wave heights. Because of these complexities, and the conceptual nature of the alternative designs described here, a wind-wave analysis and choice of design wave would be best performed during detailed design.

That said, it is possible to get a range of possible wave heights that could impact the site during a reasonable wind event from the northeast. A review of available storm information for the Seattle area, compiled by Wolf Read and made available on the Office of the Washington State Climatologist Website (www.climate.washington.edu), provides an average wind speed at Tacoma of 55 miles per hour over 16 documented storms. Assuming that the wind directions were from the northeast and that wind speeds were measured from standard heights above ground level, an average potential storm wave height can be calculated using fetch limited wave calculations per the Shore Protection Manual (USACE 1984). Using a fetch distance of 9 miles and an average water depth in Carr Inlet of 150 feet, significant wave heights within Carr inlet could be approximately 7 feet. In order to evaluate the storm wave height at the project site, these deeper water waves would need to be transformed from deep water to the project area. This transformation will typically reduce the height of the waves because of various physical processes, such as refraction and

wave breaking. In particular, the tidal flat fronting the bulkhead may induce wave breaking of larger storm waves because the water is relatively shallow in that area. However, during high tide, water depth along portions of the shoreline will be on the order of 10 feet, which may allow large storm waves to impact the project area.. During detailed design, the design wave height would be evaluated based on the desired storm recurrence interval for the project, the project life, depth of water at the toe of the slope or structure, and an in-depth evaluation of site-specific wind patterns.

## 2.2 Geotechnical Engineering Considerations

### *2.2.1 Bulkhead Removal*

Where the wooden bulkhead is proposed to be removed, there is a significant amount of backfill present. This material will need to be excavated and removed to prevent loss of the retained soil into the water column once the bulkhead has been removed. Park staff may wish to consider whether an on-site location is available to beneficially reuse the bulkhead backfill as site fill. This is typically a much more cost-effective option than off-site transportation and disposal.

Anchor QEA's scope of work did not include any explorations of the bulkhead backfill. To design a bulkhead removal, it is recommended that a series of geotechnical borings and/or test pits be conducted to sample the backfill material and provide geotechnical and geologic characterization of this fill material. If beneficial reuse is considered, Park staff may also need to consider whether soil chemistry analysis should be performed on the backfill. While there may be no reason to suspect the presence of chemical contamination in the soil, chemistry sampling may be prudent because the original source of the backfill material and the construction of the bulkhead wall do not appear to be particularly well documented.

### *2.2.2 Bluff Recession*

Based on site observations, it appears that the existing wooden bulkhead is protecting what would otherwise be a feeder bluff along the shoreline. In areas where the bulkhead is removed, the shoreline bluff is expected to return to a more natural, over-steepened condition where active slope sloughing will occur over time. This sloughing will provide a

source of finer-grained silts and sands to the beach below the bluff. At the same time, it will result in a loss of land at the top of the bluff.

Based on a review of aerial photography at the site, it appears that the natural rate of bluff recession is on the order of a few feet per year. The rate of retreat is a function of the amount of erosion that is occurring at the base of the bluff. The erosion is directly affected by the wave environment and is most likely episodic. During storm events, erosion is expected to increase as wind-generated waves impact the base of the bluff. In relatively calm periods and at lower tides, erosion is expected to be minimal if it occurs at all. There is a lack of long-term, site-specific wave and wind data for the project area. Due to this data gap, the nature (wind direction and magnitude) and frequency of storms events will be difficult to predict reliably. In addition, there is little historical information regarding shoreline and bathymetry changes along the project area shorelines; therefore, the expected rate of bluff erosion is difficult to accurately forecast. It is likely that the erosion, while gradual over a long-term scale, may actually occur as a series of peak years where significant bluff recession occurs, interspersed with relatively "quiet" years where little bluff recession occurs.

We recommend that Park staff review which site features may potentially be lost due to bluff recession where the bulkhead is removed, and be prepared to close or reroute trails as necessary to accommodate the changes in the bluff over time.

### *2.2.3 Picnic Area Slopes*

For Alternative B2, where the picnic area is retained but the bulkhead is removed, the shoreline slopes will need to be protected from incoming waves to prevent erosion-related loss of the higher ground at the picnic area. This protection is typically provided by rock, which is sized to resist a design wave height generated during a storm with a particular recurrence interval. Selecting the design wave would occur during detailed design; however, it is reasonable to expect that the design wave will be sufficiently large that the shoreline protection material will need to be of a size on the order of the rock that is present at the base of the wooden bulkhead today.

Ideally, the slopes will be flat enough to facilitate easy access to the shore below the picnic area and the low-tide sand spit that emerges offshore of the picnic area. Gentle slopes are

typically used for this access. While placing gravel and sand fill within intertidal areas in conjunction with bulkhead removal is generally looked upon favorably by permitting agencies, the placement of rock below MHHW would not be viewed favorably. Cutting back the upland slopes to achieve gentle slopes for beach access, as opposed to filling and placing rock within the intertidal area, would increase the permitting feasibility of this alternative. Given properly sized and installed shoreline armor, and assuming good work practices during construction, other significant geotechnical issues are not anticipated associated with the Picnic Area slopes.

# 3 ALTERNATIVES FOR SHORELINE RESTORATION

This section briefly describes the major construction components for each alternative and reviews the estimated cost and permitting considerations for each proposal. In all cases, the alternative would require additional steps including design, permitting, and contractor procurement before construction would begin.

## 3.1 Bulkhead Area Proposals

Bulkhead Area alternatives include partial bulkhead removal and full bulkhead removal with different beach access and recreation facility protection options. Figure 3 illustrates plan views of all of the Bulkhead Area alternatives and section line locations, which correspond to conceptual section graphics for each alternative (Figures 4 through 7). While access from other parts of the Park was not addressed in this study, there is a federal requirement for disabled access that would need to be addressed if changes to any recreational facilities, such as the picnic tables or trails, are proposed.

### *3.1.1 Alternative B1 – Partial Bulkhead Removal*

Alternative B1 entails the following major construction components:

- Excavate backfill from behind bulkhead in the removal area and transport to on-site stockpile area
- Remove a portion of the wooden bulkhead to the west of the picnic area (headland); approximately 400 feet of the western portion of the bulkhead would be removed
- Construct new wooden bulkhead return wall to transition from remaining bulkhead back to the natural unarmored shoreline
- Place beach gravel, and topsoil
- Repair remainder of wooden bulkhead as necessary (optional)
- Plant native riparian trees and shrubs to the west of the bulkhead return wall
- Offsite disposal of wooden bulkhead material
- On-site reuse or offsite disposal of backfill material.

The partial removal of the bulkhead will return approximately 400 linear feet of armored shoreline to a natural unarmored sloping beach with an upland feeder bluff. The portion of

the bulkhead that will remain in place will protect the upland picnic area, which is heavily used by the public and an important feature of the park. The remaining bulkhead line will need to be maintained over time. The portion of the shoreline that remains unarmored may be subject to long-term and episodic erosion. Public access to the beach will remain unchanged from present day conditions; no direct access will be constructed as part of this alternative.

Figure 4 presents a conceptual view of Alternative B1.

### *3.1.2 Alternative B2 – Full Bulkhead Removal with Beach Access*

Alternative B2 entails the following major construction components:

- Excavate backfill and transport to on-site stockpile area
- Remove wooden bulkhead
- Place beach gravel and beach access stairs
- Install shoreline protection (riprap or similar) to protect elevated picnic area slopes and beach access
- Offsite disposal of wooden bulkhead material
- On-site reuse or offsite disposal of backfill material

The removal of the bulkhead and slope regrading will improve the quality of the intertidal habitat in that area. However, in order to protect the upland picnic area, the shoreline will be armored to some degree to limit the magnitude and spatial extent of future erosion. This armoring would limit the restoration benefits of the alternative as the rock would maintain the disconnection between the bluff and the beach. Direct public access to the beach area will be constructed as part of this alternative. The shoreline protection and public access (i.e., stairs) will need to be maintained over time, and some loss of beach or bluff may occur during low frequency (high magnitude) wave events.

Figure 5 presents a conceptual view of Alternative B2.

### *3.1.3 Alternative B3 – Full Bulkhead Removal with Elevated Deck*

Alternative B3 entails the following major construction components:

- Excavate backfill and transport to on-site stockpile area
- Remove wooden bulkhead
- Placement of beach gravel
- Construct elevated dock structure and view platform (3,500 square feet)
- Offsite disposal of wooden bulkhead material
- On-site reuse or offsite disposal of backfill material

This alternative allows the shoreline along the existing bulkhead line to return to a more natural state (mild slope with backing feeder bluff) while providing a protected picnic area upland. The picnic area will be relocated to an elevated deck area built on piles. The elevated deck will need to be maintained over time. The shoreline and bluff, once armoring is removed, may be subject to long-term and episodic erosion. Erosion of the bluff may eventually threaten the landside connection of the elevated deck. Public access to the beach will remain unchanged from present day conditions; no direct access will be constructed as part of this alternative.

Figure 6 presents a conceptual view of Alternative B3.

### *3.1.4 Alternative B4 – Full Bulkhead Removal with Log Crib Structure*

Alternative B4 entails the following major construction components:

- Excavate backfill and transport to on-site stockpile area
- Remove wooden bulkhead
- Construct log crib structure and plant coir fabric-wrapped topsoil with riparian shrub species (9,000 square feet)
- Offsite disposal of wooden bulkhead material
- On-site reuse or offsite disposal of backfill material

The removal of the bulkhead and slope regrading will improve the quality of the intertidal habitat in that area. However, in order to protect the upland picnic area, the shoreline will be protected through bio-engineering methods to limit the magnitude and spatial extent of future erosion. To provide greater habitat benefit than traditional rock or wall shoreline armoring, a wooden crib wall is proposed. This structure, held together by interlocking and

cabled logs and large woody debris, would have two associated planting benches. The upper terrace would vary in size in order to accommodate enough space for each picnic table. The use of large woody debris in the structure and overhanging vegetation from the riparian plants would provide greater intertidal habitat benefits than traditional rock or wall armoring. However, the long-term stability of this structure could be compromised as the beach sediment lowers and the logs decay.

Figure 7 presents a conceptual view of Alternative B4.

## 3.2 Sand Spit Area Proposals

Figure 8 illustrates plan views of the Sand Spit Area proposals and section line locations, which correspond to conceptual section graphics for each alternative (Figures 9 and 10).

### *3.2.1 Alternative S1 – Repair Wooden Terminal Groin*

Alternative S1 entails the following major construction components:

- Remove interior wooden groins (eastward of terminal groin at far western end of spit)
- Repair and potentially improve wooden terminal groin
- Offsite disposal of wooden groin material

This alternative will remove much of the creosote-treated piling from the intertidal area and create a continuous unarmored shoreline reach along the sand spit area. The terminal groin will be designed and constructed to retain approximately the same volume of sediment that is currently being held with the existing groin field. As the shoreline adjusts to the groin removal and reaches a more natural equilibrium state, some areas of the shoreline will move slightly landward and others waterward. However, it is not anticipated that any net loss of beach area will occur provided the terminal groin is designed and constructed to specific site conditions.

Figure 9 presents a conceptual view of Alternative S1.

### 3.2.2 Alternative S2 – Replace Wooden Terminal Groin with Rock Groin

Alternative S1 entails the following major construction components:

- Remove all wooden groins
- Construct new terminal rock groin to replace existing far-western wooden groin
- Offsite disposal of wooden groin material

This alternative is identical to S1, except that all of the creosote wooden piling will be removed from the sand spit area. The wooden terminal groin described in Alternative S1 will be replaced with a rock groin. Beach response will be similar to that described for Alternative S1.

Figure 10 presents a conceptual view of Alternative S2.

### 3.2.3 Additional Sand Spit Project Elements

In addition to the groin field, a low-profile bulkhead runs along the upland backshore of the sand spit from the picnic area westward. Removal of this bulkhead was considered as part of this alternatives analysis. It could be done independently or in conjunction with Alternatives S1 or S2.

The bulkhead is located just upland of MHHW for most of its length, and therefore has little direct impact on intertidal habitat. However, it retains sediment and vegetation in upland backshore areas and most likely provides some erosion protection for those areas during storm events. While removal of the bulkhead may provide an additional sediment source to the beach area along the northwestern side of the spit, increased erosion of the picnic area and upland areas along the length of the spit may be possible during storm events. In addition, overwash of the spit during storms may transport sediment into the Park's boat dock area, increasing the need for maintenance dredging.

# 4 PERMITTING CONSIDERATIONS

The permitting requirements for implementation of each alternative are dependent on a number of key issues related to the proposed work. These issues will be better understood through future design and planning but generally relate to whether any material will be placed in the water, whether any work will occur below the ordinary high water (OHW) or MHHW lines, the type of shoreline modifications proposed, and the extent of excavation.

## 4.1 U.S. Army Corps of Engineers Section 10/404

A Section 404 approval would be required from the U.S. Army Corps of Engineers (Corps) for fill activities (including placement of rock and beach gravel) below the MHHW line. In addition, a Section 10 permit would be required for placement of structures (return bulkhead) in waters of the U.S. from the Corps.

Depending on the nature of the proposed alternatives, it may be possible to apply for Nationwide Permit(s) (NWPs), which are permits that cover a range of activities included under Section 10 and Section 404. For example, a NWP 3 is for routine repairs and replacement of structures (e.g., bulkhead), or a NWP 27 could be issued for restoration activities. As long as the proposed activity complies with the national and regional conditions associated with that NWP, a NWP could be issued. A Joint Aquatic Resources Permit Application (JARPA) would be used to apply for the permits. A set of design-level plans (typically 30 percent), including cross-sections, would need to accompany the JARPA.

Large volumes of excavation can sometimes lead to additional permit requirements, especially in areas with archaeological resources. To determine the likelihood of such resources, a survey would be needed within the Bulkhead Area where excavation is proposed to varying degrees in each alternative. If a project includes excavation that removes or alters archaeological resources or Native American grave sites, an Archaeological Excavation Permit from the Department of Archeology and Historic Preservation would be required (Ecology 2009). Because the material behind the bulkhead is placed fill, and none of the project alternatives involve significant excavation below original shoreline grade, archaeological resource concerns are not anticipated to be significant

### *4.1.1 Differences between Alternatives*

Alternative B1, the partial bulkhead removal, may qualify for a Nationwide 3 permit. Alternatives B3 and B4 would likely fall under a Nationwide 27, Shoreline Restoration though Alternative B4 might be considered a wooden bulkhead by the permit agencies and in this case would not be considered restoration. Alternative B2 would likely require an individual Section 404 permit because of the large volume of rock bank protection. The Nationwide permit process generally takes 90 to 120 days; the Section 404 permit could take up to 6 months. Ideally, a meeting would be scheduled with the Corps reviewer for Pierce County before making any decisions on project alternatives based on Corps permit considerations.

## 4.2 National Environmental Policy Act

For permit approvals, the Corps is required to comply with the National Environmental Policy Act (NEPA). Except for major project actions (those that require an Environmental Impact Statement [EIS]), or if federal funding is used to construct the project, the Corps typically handles NEPA internally by preparing a memorandum for the file demonstrating how the proposed project complies with NEPA. The Corps uses NEPA regulations and information in the JARPA to complete their NEPA analysis.

### *4.2.1 Differences between Alternatives*

None of the alternatives are expected to result in impacts sufficient to trigger a NEPA EIS process.

## 4.3 Endangered Species Act

The permit approval required by the Corps would provide the federal nexus that triggers the need to address Endangered Species Act (ESA) requirements. Projects that receive federal funding are also required to comply with ESA. If ESA compliance is required, a Biological Assessment (BA) that addresses the existing habitat and the effects of the project on species listed for protection under ESA and designated critical habitat would need to be submitted. This ESA consultation is expected to result in determinations of "Not Likely to Adversely Affect," and would therefore be an informal consultation.

### *4.3.1 Differences between Alternatives*

The Services (National Marine Fisheries Service [NMFS] and U.S. Fish and Wildlife Service [USFWS]) are generally most supportive of designs that incorporate riparian planting, full bulkhead removal, and gravel beach area. Alternatives B1, B3, and potentially B4 would be the least likely to generate written comments from the Services that would require a response. Rock protection such as that proposed in Alternative B2 will likely generate comments requiring justification of the rock use, and it may be more difficult to obtain concurrence with this alternative.

## 4.4 Hydraulic Project Approval

A Hydraulic Project Approval (HPA) would likely be required from the Washington Department of Fish and Wildlife (WDFW) for any work that uses, diverts, obstructs, or changes the natural flow or bed of state waters. The JARPA would also be used to apply for this permit. Prior to submitting the JARPA to WDFW, a State Environmental Policy Act (SEPA) determination would need to be issued by the lead state agency.

### *4.4.1 Differences between Alternatives*

Construction techniques and sequencing may determine the ease of obtaining an HPA from WDFW; the greater the amount of work that can be done "in the dry," the easier it will be to obtain a HPA. The Bulkhead Area proposals could conceivably avoid the placement of any material in the water or work below OWH or MHHW if all beach development was pursued through upland excavation only and construction work was implemented in the dry with the protection of the existing bulkhead. Meeting these requirements could potentially be difficult if the Park is interested in retaining a greater amount of upland lawn/picnic area. Additionally, working in the dry by scheduling the bulkhead removal after all grading, beach, and toe work could be difficult given the deteriorated nature of the bulkhead and the space needs of construction equipment. WDFW may look more favorably upon the log crib structure (Alternative B4) than alternatives that require toe rock. Alternative B2, which requires a large amount of riprap, will probably be the most challenging alternative for the HPA.

For the Sand Spit Area, Alternative S1, which includes terminal groin enhancement, could meet the OHW and MHHW line requirements if the enhanced groin was not extended further waterward from its existing extent. Alternative S2, which includes rock placement, would likely require these permits, as the new rock would need to be placed below these water lines.

## 4.5 State-Administered 401 Water Quality Certificate Program

This federal permit program is administered by the states because water quality standards differ by state. A 401 Water Quality Certification (WQC) is required from Ecology when applying for a federal permit to conduct any activity that might result in a discharge of dredge or fill material into water or wetlands, or any excavation in water. The JARPA would be submitted to Ecology for this certification. Ecology would provide input to the lead agency for both the shoreline permit and SEPA review processes.

### *4.5.1 Differences between Alternatives*

If a Nationwide 27 Corps permit is issued, approval from Ecology may be required to satisfy the 401 requirement. This usually takes the form of a Letter of Permission rather than a full 401 Water Quality Certificate. If an individual 404 permit is needed from the Corps, an individual 401 WQC is also required. Alternatives B1, B3, and B4 are likely to fall under the Nationwide permit criteria. Alternative B2 may require an individual 404 permit.

## 4.6 Coastal Zone Management Act Compliance

Project activities that require a federal permit or receive federal funding require a determination of consistency with the Coastal Zone Management Act (CZMA). A Coastal Zone Management Certification will be issued by Ecology for non-federal agency projects.

### *4.6.1 Differences between Alternatives*

Unless an individual 401 WQC is required, the CZMA compliance will be handled internally by Ecology as part of the 401 Letter of Approval process. If no Letter of Approval is issued, CZMA compliance will be handled internally by the Corps as part of the nationwide permit

approval process. The CZMA application is a simple one-page form and would not be expected to cause any delays in the permitting process.

## 4.7 SEPA

A SEPA review would be required for the project. Parks would act as the lead agency for SEPA review. Based on project information provided in a SEPA environmental checklist, Parks would evaluate the proposal's likely environmental impacts. Parks would issue a threshold determination: Determination of Non-Significance (DNS), Mitigated Determination of Non-Significance (MDNS), or a Determination of Significance (DS). If a DS were issued for the project, an EIS would need to be prepared.

### *4.7.1 Differences between Alternatives*

A MDNS is anticipated for all project alternatives.

## 4.8 Local Shoreline Substantial Development and Conditional Use Permits

Local or county governments can require Shoreline Conditional Use permits for projects within 200 feet of the OHW mark (Ecology 2009). Placement of fill or groin materials below the OHW mark requires a Conditional Use permit unless these materials are placed to protect or restore ecological function (Washington Administrative Code [WAC] 173-26-231).

### *4.8.1 Differences between Alternatives*

While placement of rock armoring or groin materials (Alternative B1, B2, S2) would likely require this permit, placement of large woody debris within the log crib structure of Alternative B4 could potentially meet the ecological function exception. The Conditional Use element of the Shoreline permit will probably not significantly delay or complicate the permit procedure.

## 4.9 Other Considerations

Work windows are another consideration for implementation of each alternative. Prohibited times and areas have been developed for the protection of migrating juvenile salmon, Pacific herring, surf smelt, sand lance, rock sole, lingcod and other fish or shellfish

within particular sites (WAC 220-110-271). Further assessments of species presence would be required to determine these work windows, but the window would likely occur between June 15 and October 1. In addition to these broad timing requirements, tidal work windows also exist with beach construction activity prohibited during tidal inundation (WAC 220-110-280).

# 5 ESTIMATED PROJECT COSTS

This section describes the planning level project costs, which were developed for each alternative and are summarized in Table 1. Cost estimate details for each alternative are presented in Appendix A. For all construction costs, a 15 percent mobilization, 30 percent general contingency, 8.8 percent sales tax, and 35 percent design, engineering, and permitting multiplier was applied for an anticipated total project cost estimate. The project costs were calculated in 2009 dollars and do not include any costs for monitoring or possible required mitigation.

Cost estimates were prepared without the benefit of a detailed site survey. Soil volumes and quantity takeoffs have been estimated using best professional judgment after review of LIDAR topography and the existing site drawings that were provided by SPSSEG to Anchor QEA. Actual quantities would need to be verified by performing a site survey as part of detailed design.

Table 1 summarizes the estimated project costs for each of the Bulkhead Area alternatives.

**Table 1**
**Estimated Project Costs for Each Bulkhead Area Alternative**

| Alternative | Description | Estimated Cost |
|---|---|---|
| B1 | Partial Removal | $500,000 |
| B2 | Full Removal with Beach Access | $620,000 |
| B3 | Full Removal with Elevated Dock | $2,000,000 |
| B4 | Full Removal with Log Crib Structure | $1,300,000 |

It is important to note that the cost estimates assume that excavated soil from behind the bulkhead could be reused on site at the Park, and that offsite disposal of soil would not be required. Based on an estimated volume ranging from 1,300 to 2,700 cubic yards, offsite transportation and disposal could add an additional $200,000 to $400,000 to the estimated bulkhead project costs.

One of the most expensive elements within all of the Bulkhead Area alternatives was demolition and clearing; within this category, pile removal and disposal for the wooden bulkhead contributed the most cost. While the demolition category provided the greatest costs within project activities for Alternatives B1 and B2, the structural costs of B3 (elevated deck) and B4 (log crib structure) are higher than the demolition cost.

Table 2 summarizes the estimated costs for each of the Sand Spit Area alternatives.

**Table 2**
**Estimated Project Costs for Each Sand Spit Area Alternative**

| Alternative | Description | Estimated Cost |
|---|---|---|
| S1 | Repair Wooden Terminal Groin | $90,000 |
| S2 | Replace Wood Terminal Groin with Rock | $130,000 |

The project cost estimates for the Sand Spit Area were quite a bit less expensive in comparison to the Bulkhead Area alternatives. The costs of replacing the wooden terminal groin with a rock groin in Alternative S2 are higher than the terminal groin repair costs of Alternative S1. Within these costs, temporary facilities, such as the in-water silt curtain, were a substantial portion of the total costs due to the overall size of the area they would be protecting.

Combining the Bulkhead and Sand Spit Areas into one project could provide substantial cost saving benefits, allowing for one mobilization and demobilization phase during implementation. Combining demolition, especially pile removal and disposal, would save substantial costs even if building or planting activities were implemented separately.

Material costs could also be reduced, depending on the alternatives chosen for each site's implementation. Materials from one site might be available for construction activities at the other site; for example, some of the rock removed within the Bulkhead Area for Alternative B3 or B4 could be used to construct the proposed rock groin for Alternative S2. Materials reused within the Park, such as soil excavated for Bulkhead Area proposals, could also provide cost savings over said materials being disposed of off-site.

# 6 CONCLUSIONS

This report summarizes planning level design proposals for bulkhead and groin shoreline structure removal opportunities in Penrose Point State Park. Further detail on the implementation, permitting, geotechnical and coastal engineering considerations that shape these alternatives was also included.

This preliminary evaluation serves as a building block for a more comprehensive restoration feasibility study. This future, more detailed analysis should include the following components:

- Gather existing information on soils, sediment, and environmental conditions (wind/waves/tides)
- Develop base map of project area, including site topographic, structural, and bathymetric surveys
- Refine the preliminary alternatives analysis, incorporating the detailed site information and changes to the concepts presented in this report, and perform engineering evaluations to support the analysis
- Develop proposed restoration plans and design report

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# FIGURES

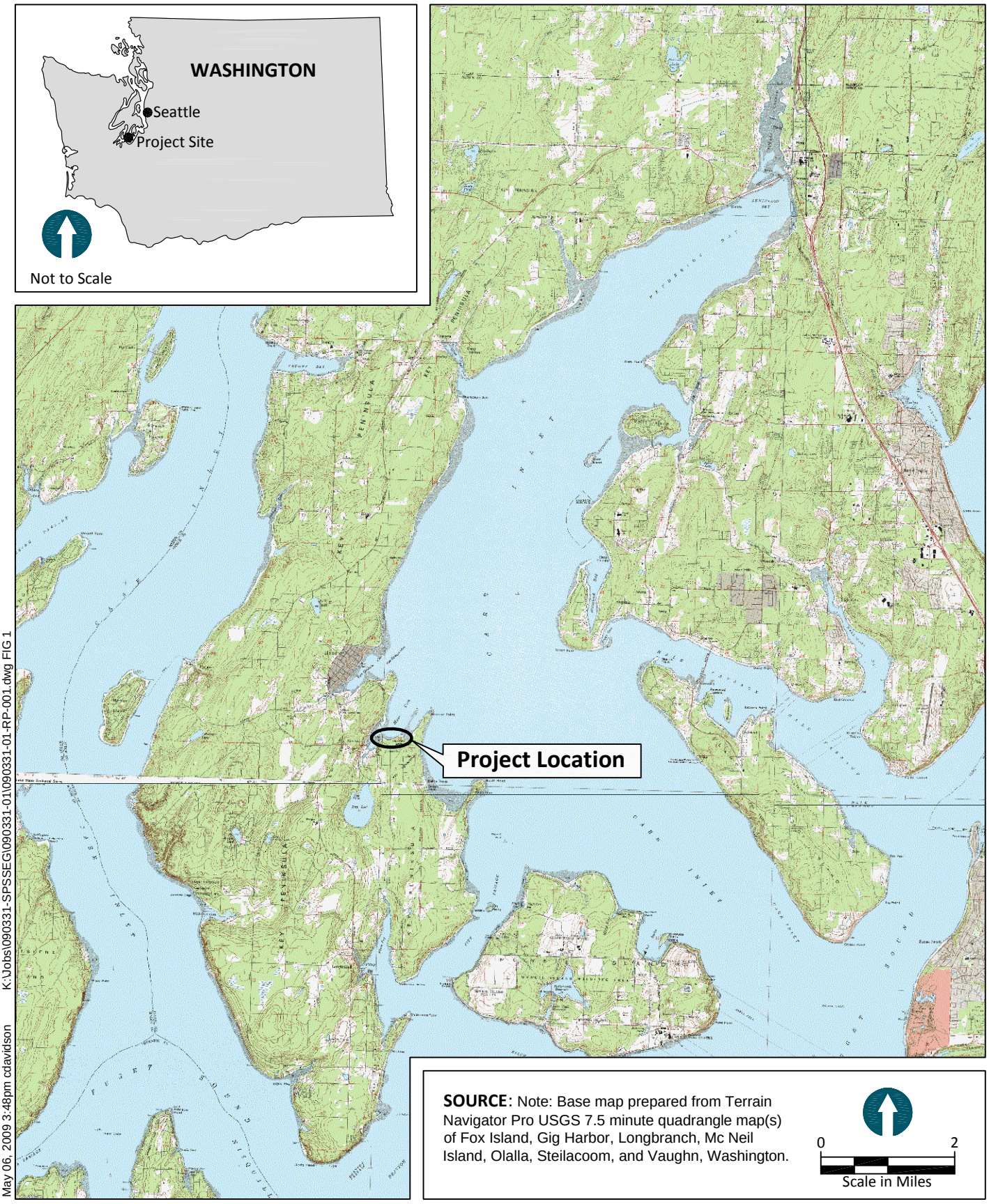


**Figure 1**
Vicinity Map
Penrose Point State Park

ANCHOR QEA




ANCHOR QEA

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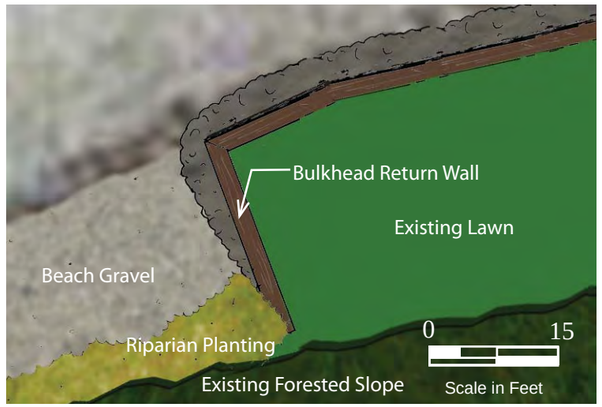
Feet

**Figure 2**
Park Study Areas
Penrose Point State Park

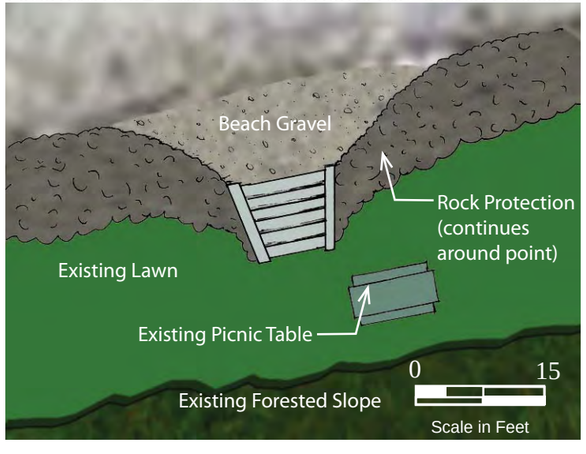
Alternative B1: Partial Bulkhead Removal



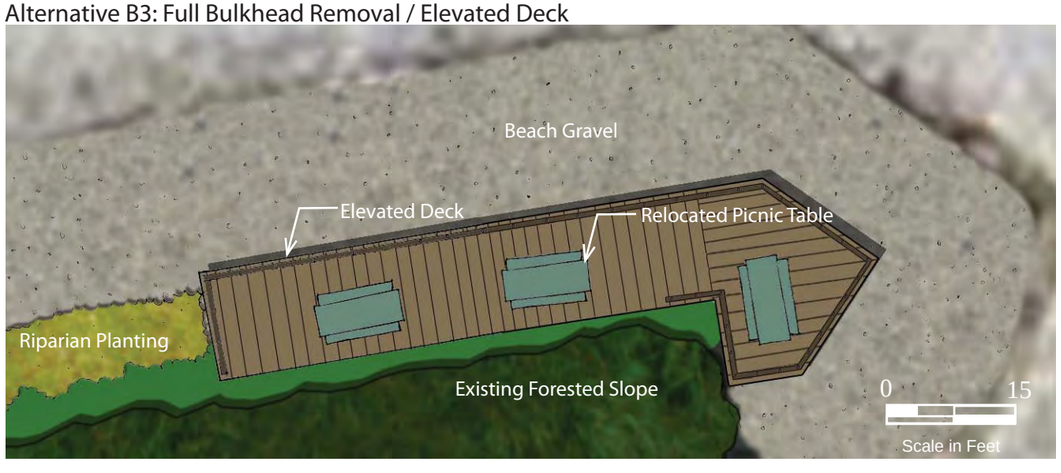




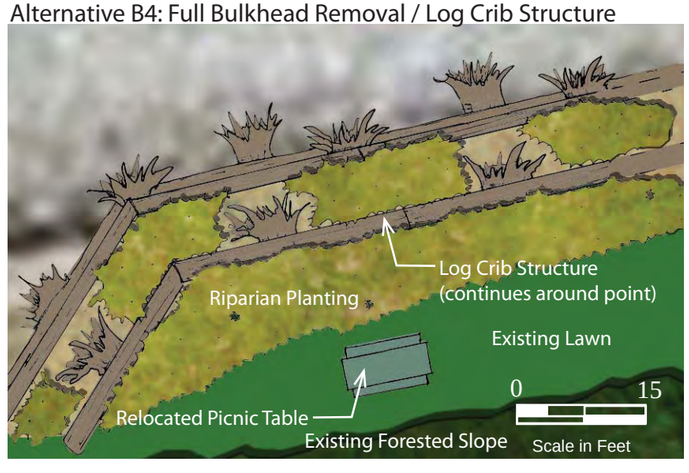
Alternative B2: Full Bulkhead Removal / Beach Access




Alternative B3: Full Bulkhead Removal / Elevated Deck




Alternative B4: Full Bulkhead Removal / Log Crib Structure

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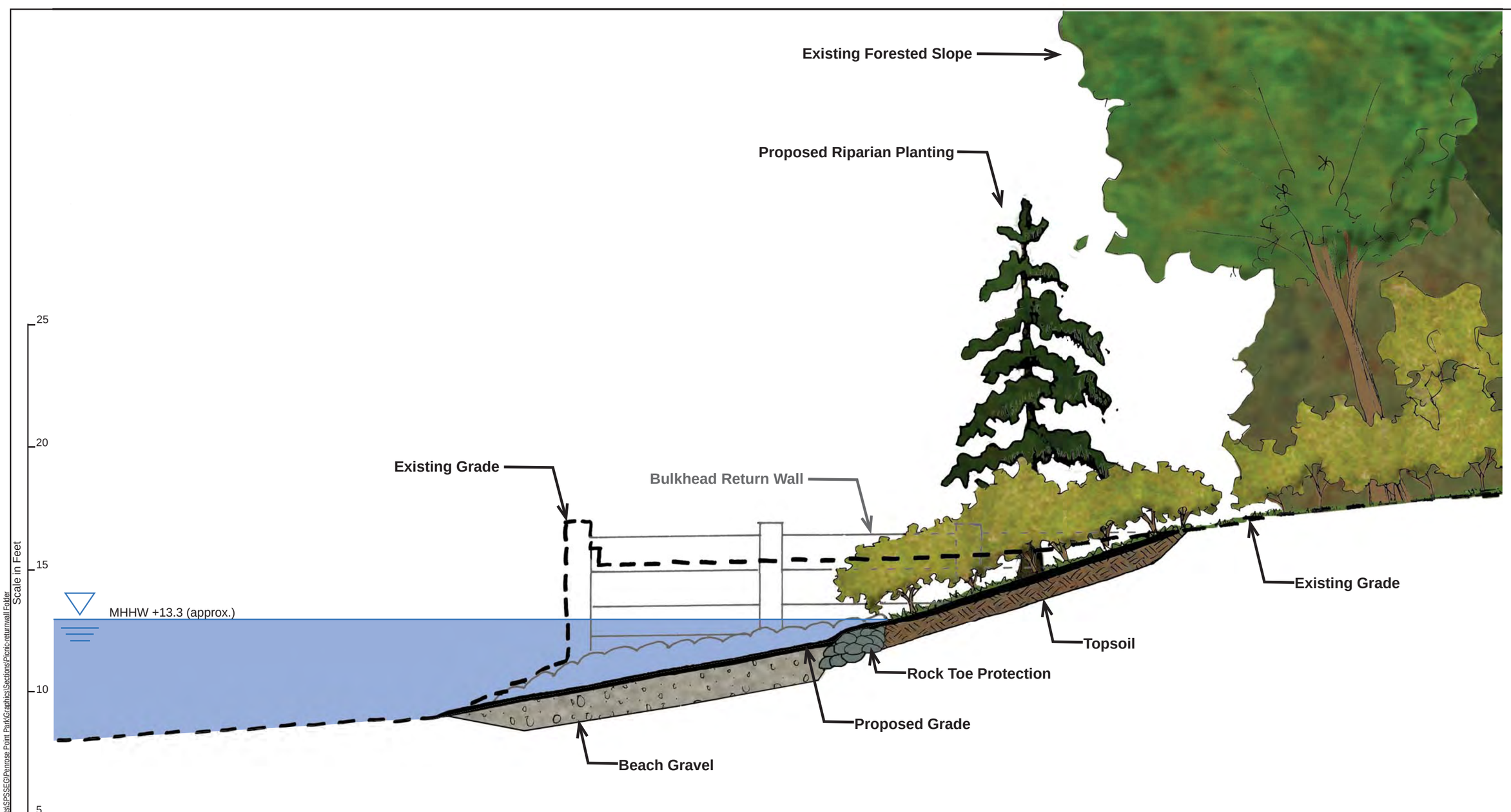
ANCHOR QEA

0 30 60
Scale in Feet

**Figure 3**
Bulkhead Area Plan
Penrose Point State Park




**Alternative B1: Partial Bulkhead Removal - Section/Elevation A-A'**

0 4 8

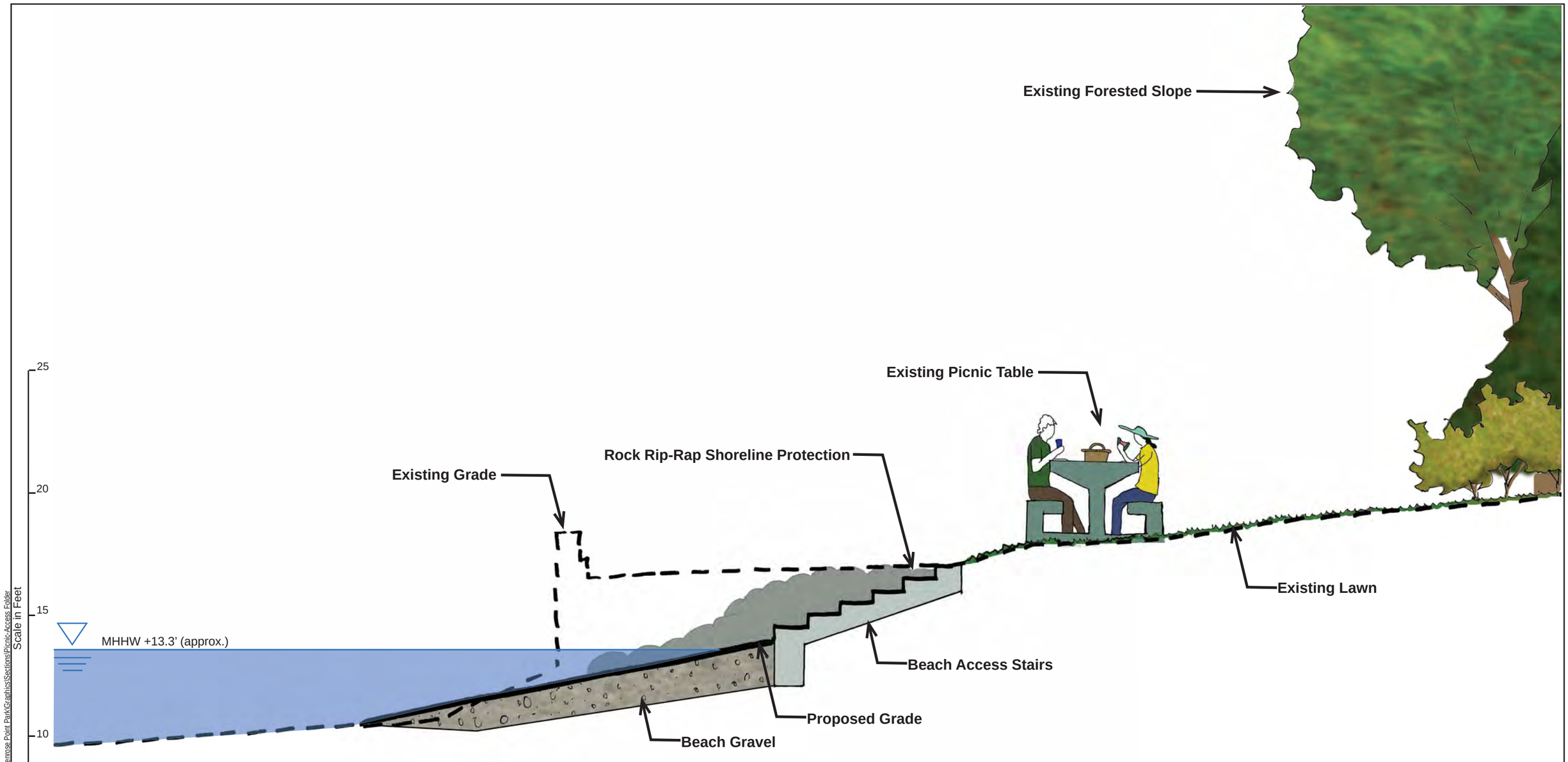
Scale in Feet

Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.

May 18, 2009 - bbermingham - I:\Projects\SPSSEG\Penrose Point Park\Graphics\Sections\Picnic-returnwall.Folder

ANCHOR QEA

**Figure 4**
Alternative B1
Penrose Point State Park



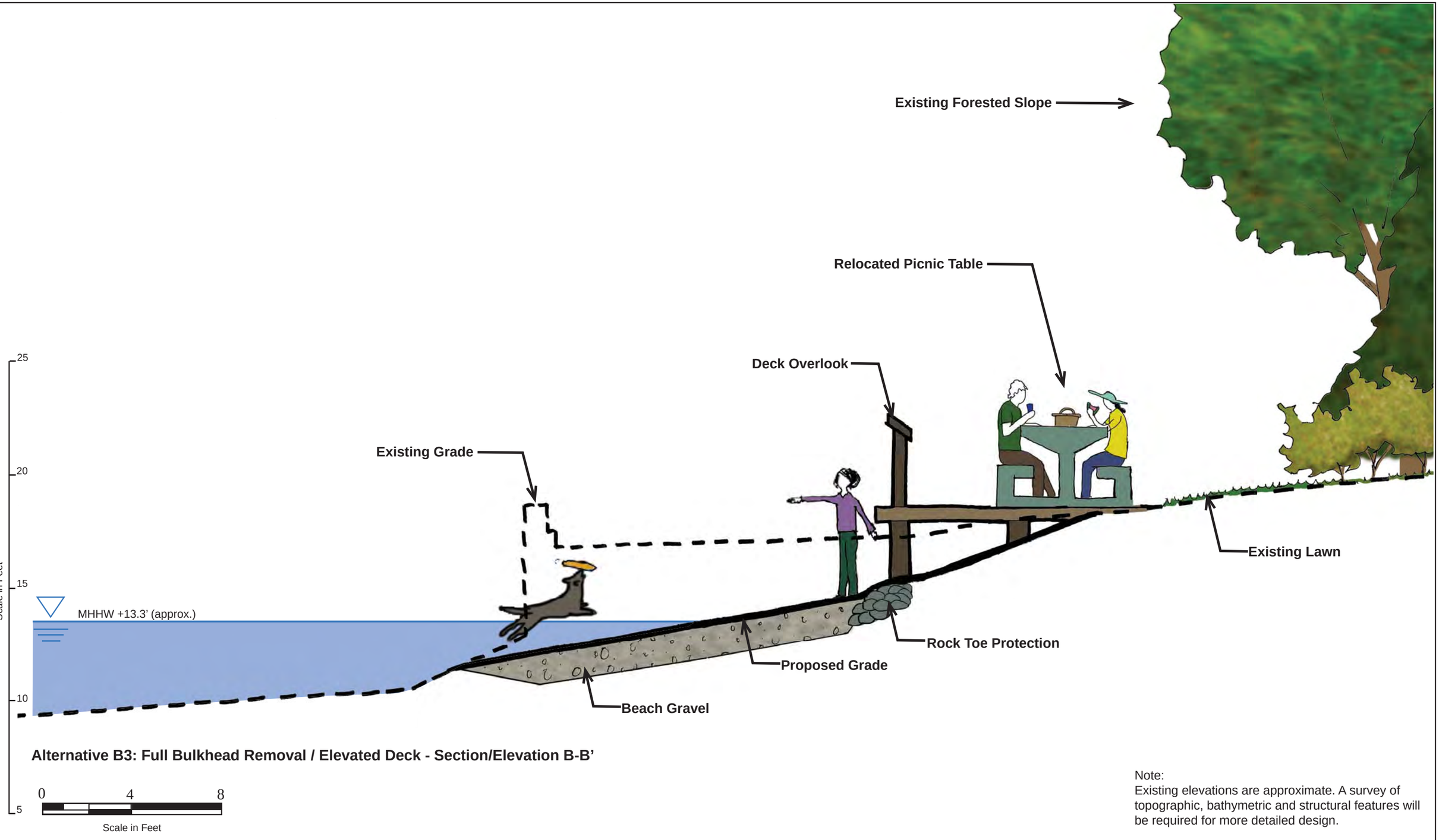

**Alternative B2: Full Bulkhead Removal / Beach Access - Section/Elevation B-B'**

Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.

May 18, 2009 bbermingham I:\Projects\SPSSEG\Penrose Point Park\Graphics\Sections\Picnic-Access.Folder

ANCHOR QEA

**Figure 5**
Alternative B2
Penrose Point State Park



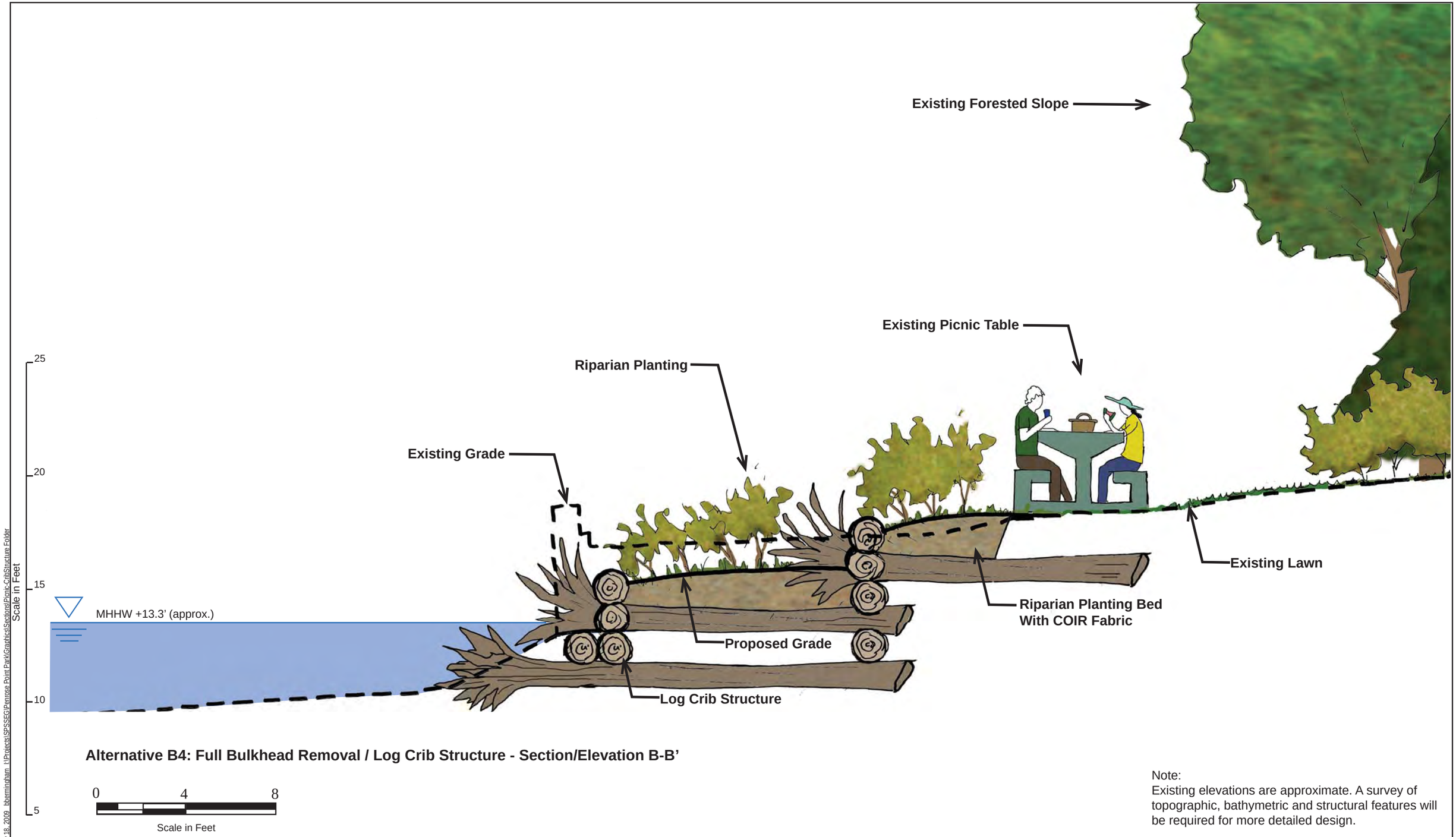

**Alternative B3: Full Bulkhead Removal / Elevated Deck - Section/Elevation B-B'**

Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.

May 18, 2009 - bbirmingham - I:\Projects\SPSSEG\Penrose Point Park\Graphics\Sections\Picnic-Deck.Folder

ANCHOR QEA

**Figure 6**
Alternative B3
Penrose Point State Park




**Alternative B4: Full Bulkhead Removal / Log Crib Structure - Section/Elevation B-B'**

Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.

May 18, 2009 hbermingham I:\Projects\SPSSEG\Penrose Point Park\Graphics\Sections\Picnic-CribStructure.Folder

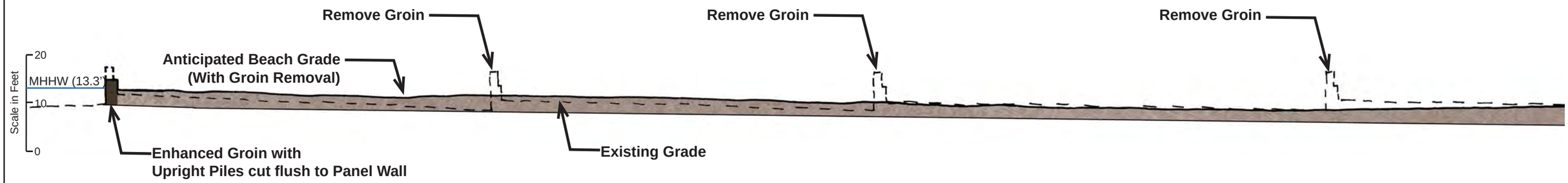
ANCHOR QEA

**Figure 7**
Alternative B4
Penrose Point State Park


May 18, 2009 bbermingham I:\Projects\SPSSEG\Penrose Point Park\Graphics\Plans\Groin-plan Folder

ANCHOR QEA

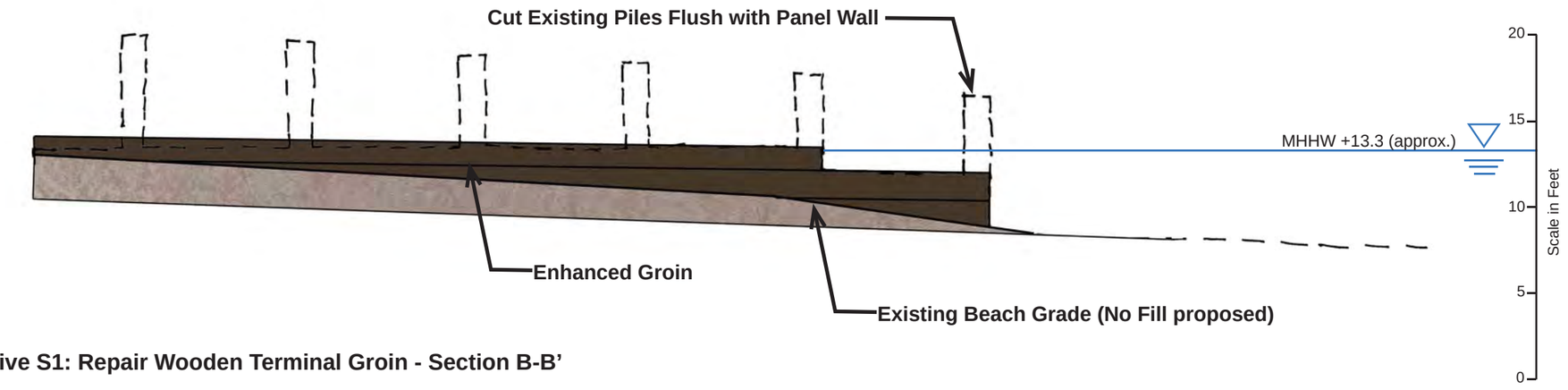
**Figure 8**
Sand Spit Area Plan
Penrose Point State Park




**Alternative S1: Repair Wooden Terminal Groin - Section A-A'**

0 20 40

Scale in Feet




**Alternative S1: Repair Wooden Terminal Groin - Section B-B'**

0 8 16

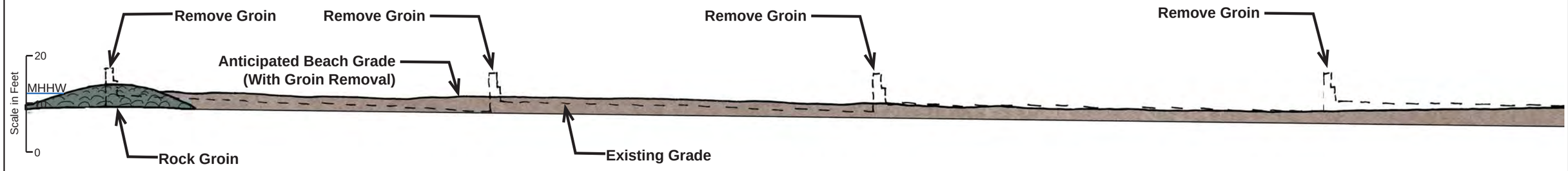
Scale in Feet

Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.

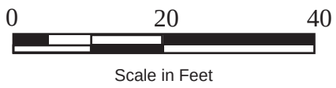


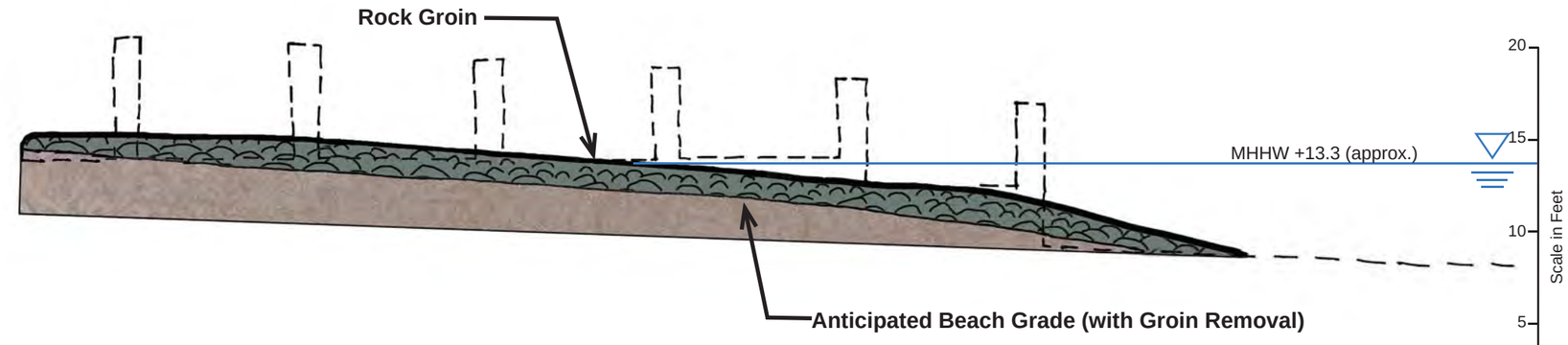
ANCHOR QEA

**Figure 9**
Alternative S1
Penrose Point State Park




**Alternative S2: Replace Wooden Terminal Groin with Rock - Section A-A'**




**Alternative S2: Replace Wooden Terminal Groin with Rock - Section B-B'**


Note:
Existing elevations are approximate. A survey of topographic, bathymetric and structural features will be required for more detailed design.



ANCHOR QEA

**Figure 10**
Alternative S2
Penrose Point State Park

# APPENDIX A
# COST ESTIMATE DETAILS

| Opinion of Probable Construction Cost - Alternative B1: Partial Bulkhead Removal | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Bulkhead Removal | 165 | CY | $20.00 | $ | 3,300 |
| b. Pile Removal | 185 | EA | $300.00 | $ | 55,500 |
| c. Pile Disposal (Rabanco) | 185 | TN | $100.00 | $ | 18,500 |
| d. Clear and Grub Vegetation | 8250 | SF | $0.25 | $ | 2,063 |
| e. Off-site disposal of clear/grub material | 310 | CY | $25.00 | $ | 7,750 |
| f. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| g. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 88,988 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 350 | LF | $8.00 | $ | 2,800 |
| b. Tree Protection Fence | 700 | LF | $8.00 | $ | 5,600 |
| c. Temp. Upland Silt Fencing (at bulkhead to remain) | 220 | LF | $6.60 | $ | 1,452 |
| d. In-Water Floating Silt Curtain | 760 | LF | $35.00 | $ | 26,600 |
| Subtotal Temporary Facilities | | | | $ | 36,452 |
| 3. Earthwork | | | | | |
| a. Cut and Fill on-site | 1,325 | CY | $15.00 | $ | 19,875 |
| b. Import and place beach gravel | 675 | CY | $55.00 | $ | 37,125 |
| Subtotal Earthwork | | | | $ | 57,000 |
| 4. Shoreline Protection | | | | | |
| a. Bulkhead return wall | 30 | LF | $350.00 | $ | 10,500 |
| b. Place toe protection rock for bulkhead and beach gravel (assume all available on | 220 | CY | $40.00 | $ | 8,800 |
| Subtotal Shoreline Protection | | | | $ | 19,300 |
| 5. Planting & Irrigation | | | | | |
| a. Organic Soil Ammendment (2" depth) | 40 | CY | $35.00 | $ | 1,400 |
| b. Planting | | | | | |
| *1. Native Shrubs 1 gal. 5' O.C.* | 300 | EA | $18.00 | $ | 5,400 |
| *2. Hydroseeding/lawn repair* | 3,000 | SF | $1.00 | $ | 3,000 |
| c. Mulch (3" depth) | 60 | CY | $35.00 | $ | 2,100 |
| d. Temporary Irrigation | | | | | |
| 1. Temprary irrigation system (assuming point of connection available) | 6,600 | SF | $1.50 | $ | 9,900 |
| Subtotal Planting & Irrigation | | | | $ | 21,800 |
| | | | Subtotal Construction | $ | 223,540 |
| | | | Mobilization 15% | $ | 33,531 |
| | | | Subtotal Construction + Mob. | $ | 257,070 |
| | | | Contingency (30%) | $ | 77,121 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 334,192 |
| | | | Sales Tax (8.8%) | $ | 29,409 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 363,600 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 127,260 |
| | | | Total Cost* | $ | 491,000 |

In providing opinions of probable construction cost, the Client (South Puget Sound Salmon Enhancement Group) understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, expressed or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Alternative B2: Full Bulkhead Removal with Beach Access | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Bulkhead Removal | 230 | CY | $20.00 | $ | 4,600 |
| b. Pile Removal | 255 | EA | $300.00 | $ | 76,500 |
| c. Pile Disposal (Rabanco) | 255 | TN | $100.00 | $ | 25,500 |
| d. Clear and Grub Vegetation | 11475 | SF | $0.25 | $ | 2,869 |
| e. Off-site disposal of clear/grub material | 425 | CY | $25.00 | $ | 10,625 |
| f. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| g. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 121,969 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 350 | LF | $8.00 | $ | 2,800 |
| b. Tree Protection Fence | 700 | LF | $8.00 | $ | 5,600 |
| c. In-Water Floating Silt Curtain | 1,050 | LF | $35.00 | $ | 36,750 |
| Subtotal Temporary Facilities | | | | $ | 45,150 |
| 3. Earthwork | | | | | |
| a. Cut and Fill on-site | 1,275 | CY | $15.00 | $ | 19,125 |
| b. Import and place beach gravel | 595 | CY | $55.00 | $ | 32,725 |
| Subtotal Earthwork | | | | $ | 51,850 |
| 4. Shoreline Protection | | | | | |
| a. Place toe protection rock for bulkhead and beach gravel (assume some available on-s | 935 | CY | $55.00 | $ | 51,425 |
| Subtotal Shoreline Protection | | | | $ | 51,425 |
| 5. CIP Concrete | | | | | |
| a. Stairs (6" riser, 18" tread typical) | 60 | LF | $100.00 | $ | 6,000 |
| b. Cheek Walls | 20 | LF | $100.00 | $ | 2,000 |
| Subtotal CIP Concrete | | | | $ | 8,000 |
| 6. Planting & Irrigation | | | | | |
| a. Planting | | | | | |
| *1 Hydroseeding/lawn repair* | 3,000 | SF | $1.00 | $ | 3,000 |
| Subtotal Planting & Irrigation | | | | $ | 3,000 |
| | | | Subtotal Construction | $ | 281,394 |
| | | | Mobilization 15% | $ | 42,209 |
| | | | Subtotal Construction + Mob. | $ | 323,603 |
| | | | Contingency (30%) | $ | 97,081 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 420,684 |
| | | | Sales Tax (8.8%) | $ | 37,020 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 457,704 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 160,196 |
| | | | Total Cost* | $ | 618,000 |

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*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Alternative B3: Full Bulkhead Removal with Elevated Deck | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Bulkhead Removal | 230 | CY | $20.00 | $ | 4,600 |
| b. Pile Removal | 255 | EA | $300.00 | $ | 76,500 |
| c. Pile Disposal (Rabanco) | 255 | TN | $100.00 | $ | 25,500 |
| d. Clear and Grub Vegetation | 22950 | SF | $0.25 | $ | 5,738 |
| e. Off-site disposal of clear/grub material | 850 | CY | $25.00 | $ | 21,250 |
| f. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| g. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 135,463 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 350 | LF | $8.00 | $ | 2,800 |
| b. Tree Protection Fence | 700 | LF | $8.00 | $ | 5,600 |
| c. In-Water Floating Silt Curtain | 1,050 | LF | $35.00 | $ | 36,750 |
| Subtotal Temporary Facilities | | | | $ | 45,150 |
| 3. Earthwork | | | | | |
| a. Cut and Fill on-site | 2,550 | CY | $15.00 | $ | 38,250 |
| b. Import and place beach gravel | 1,530 | CY | $55.00 | $ | 84,150 |
| Subtotal Earthwork | | | | $ | 122,400 |
| 4. Shoreline Protection | | | | | |
| a. Place toe protection rock for beach gravel (assume all available on-site) | 85 | CY | $40.00 | $ | 3,400 |
| Subtotal Shoreline Protection | | | | $ | 3,400 |
| 5. Structural | | | | | |
| a. Wooden Deck, Elevated | 3,500 | SF | $150.00 | $ | 525,000 |
| b. Handrail | 230 | LF | $75.00 | $ | 17,250 |
| Subtotal Structural | | | | $ | 542,250 |
| 6. Planting & Irrigation | | | | | |
| a. Organic Soil Ammendment (2" depth) | 45 | CY | $35.00 | $ | 1,575 |
| b. Planting | | | | | |
| *1. Native Shrubs 1 gal. 5' O.C.* | 325 | EA | $18.00 | $ | 5,850 |
| *2. Hydroseeding/lawn repair* | 1,050 | SF | $1.00 | $ | 1,050 |
| c. Mulch (3" depth) | 70 | CY | $35.00 | $ | 2,450 |
| d. Temporary Irrigation | | | | | |
| 1. Temprary irrigation system (assuming point of connection available) | 7,100 | SF | $2.00 | $ | 14,200 |
| Subtotal Planting & Irrigation | | | | $ | 25,125 |
| | | | Subtotal Construction | $ | 873,788 |
| | | | Mobilization 15% | $ | 131,068 |
| | | | Subtotal Construction + Mob. | $ | 1,004,856 |
| | | | Contingency (30%) | $ | 301,457 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 1,306,312 |
| | | | Sales Tax (8.8%) | $ | 114,955 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 1,421,268 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 497,444 |
| | | | Total Cost* | $ | 1,919,000 |

In providing opinions of probable construction cost, the Client (South Puget Sound Salmon Enhancement Group) understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, expressed or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Alternative B4: Full Bulkhead Removal with Log Crib Structure | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Bulkhead Removal | 230 | CY | $20.00 | $ | 4,600 |
| b. Pile Removal | 255 | EA | $300.00 | $ | 76,500 |
| c. Pile Disposal (Rabanco) | 255 | TN | $100.00 | $ | 25,500 |
| d. Clear and Grub Vegetation | 18360 | SF | $0.25 | $ | 4,590 |
| e. Off-site disposal of clear/grub material | 680 | CY | $25.00 | $ | 17,000 |
| f. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| g. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 130,065 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 350 | LF | $8.00 | $ | 2,800 |
| b. Tree Protection Fence | 700 | LF | $8.00 | $ | 5,600 |
| c. In-Water Floating Silt Curtain | 1,050 | LF | $35.00 | $ | 36,750 |
| Subtotal Temporary Facilities | | | | $ | 45,150 |
| 3. Earthwork | | | | | |
| a. Cut and Fill on-site | 2,720 | CY | $15.00 | $ | 40,800 |
| Subtotal Earthwork | | | | $ | 40,800 |
| 4. Structural | | | | | |
| a. Large Woody Debris | 160 | EA | $750.00 | $ | 120,000 |
| b. Anchored Log (18" dia.) | 2,640 | LF | $11.00 | $ | 29,040 |
| Subtotal Structural | | | | $ | 149,040 |
| 5. Planting & Irrigation | | | | | |
| a. Topsoil (2' depth) | 2070 | CY | $35.00 | $ | 72,450 |
| b. COIR fabric | 5800 | SY | $18.00 | $ | 104,400 |
| c. Planting | | | | | |
| *1. Native Shrubs 1 gal. 5' O.C.* | 575 | EA | $18.00 | $ | 10,350 |
| *2. Hydroseeding/lawn repair* | 3,000 | SF | $1.00 | $ | 3,000 |
| d. Mulch (3" depth) | 115 | CY | $35.00 | $ | 4,025 |
| e. Temporary Irrigation | | | | | |
| 1. Temprary irrigation system (assuming point of connection available) | 12,400 | SF | $2.00 | $ | 24,800 |
| Subtotal Planting & Irrigation | | | | $ | 219,025 |
| | | | Subtotal Construction | $ | 584,080 |
| | | | Mobilization 15% | $ | 87,612 |
| | | | Subtotal Construction + Mob. | $ | 671,692 |
| | | | Contingency (30%) | $ | 201,508 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 873,200 |
| | | | Sales Tax (8.8%) | $ | 76,842 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 950,041 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 332,514 |
| | | | Total Cost* | $ | 1,283,000 |

In providing opinions of probable construction cost, the Client (South Puget Sound Salmon Enhancement Group) understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, expressed or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Alternative S1: Repair Wood Terminal Groin | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Groin Wall Removal | 75 | CY | $20.00 | $ | 1,500 |
| b. Pile Removal | 20 | EA | $300.00 | $ | 6,000 |
| c. Pile Disposal (Rabanco) | 20 | TN | $100.00 | $ | 2,000 |
| d. Cut Piles flush with remaining terminal groin panel wal | 5 | EA | $30.00 | $ | 150 |
| e. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| f. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 11,525 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 450 | LF | $8.00 | $ | 3,600 |
| b. In-Water Floating Silt Curtain | 650 | LF | $35.00 | $ | 22,750 |
| Subtotal Temporary Facilities | | | | $ | 26,350 |
| 3. Structural | | | | | |
| a. Panel Wall Maintenance | 80 | LF | $40.00 | $ | 3,200 |
| Subtotal Earthwork | | | | $ | 3,200 |
| | | | Subtotal Construction | $ | 41,075 |
| | | | Mobilization 15% | $ | 6,161 |
| | | | Subtotal Construction + Mob. | $ | 47,236 |
| | | | Contingency (30%) | $ | 14,171 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 61,407 |
| | | | Sales Tax (8.8%) | $ | 5,404 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 66,811 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 23,384 |
| | | | Total Cost* | $ | 90,000 |

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*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Alternative S2: Replace Wood Terminal Groin with Rock Groin | | | | | |
|---|---|---|---|---|---|
| Item | Qty. | Unit | Unit Cost | | Subtotal |
| 1.Demolition & Clearing | | | | | |
| a. Wood Groin Wall Removal | 90 | CY | $20.00 | $ | 1,800 |
| b. Pile Removal | 25 | EA | $300.00 | $ | 7,500 |
| c. Pile Disposal (Rabanco) | 25 | TN | $100.00 | $ | 2,500 |
| d. Misc. debris disposal | 25 | CY | $35.00 | $ | 875 |
| e. Misc. demolition | 1 | LS | $1,000.00 | $ | 1,000 |
| Subtotal Demolition & Clearing | | | | $ | 13,675 |
| 2. Temporary Facilities | | | | | |
| a. Temp. Const. Fencing | 450 | LF | $8.00 | $ | 3,600 |
| b. In-Water Floating Silt Curtain | 650 | LF | $35.00 | $ | 22,750 |
| Subtotal Temporary Facilities | | | | $ | 26,350 |
| 3. Structural | | | | | |
| a. Place rock for Groin | 285 | CY | $65.00 | $ | 18,525 |
| Subtotal Earthwork | | | | $ | 18,525 |
| | | | Subtotal Construction | $ | 58,550 |
| | | | Mobilization 15% | $ | 8,783 |
| | | | Subtotal Construction + Mob. | $ | 67,333 |
| | | | Contingency (30%) | $ | 20,200 |
| | | | Subtotal Const.+ Mob.+ Conting. | $ | 87,532 |
| | | | Sales Tax (8.8%) | $ | 7,703 |
| | | | Subtotal Const. + Mob + Conting. + Tax | $ | 95,235 |
| | | | Design, Engr. And Permitting Multiplier (35%) | $ | 33,332 |
| | | | Total Cost* | $ | 129,000 |

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*All costs are in 2009 dollars. Costs do not include Monitoring.

| Opinion of Probable Construction Cost - Summary of Alternatives by Project Area | | |
|---|---|---|
| Alternatives | | Project Total |
| 1.Bulkhead Area | | |
| Alternative B1: Partial Bulkhead Removal | $ | 491,000 |
| Alternative B2: Full Bulkhead Removal with Beach Access | $ | 618,000 |
| Alternative B3: Full Bulkhead Removal with Elevated Deck | $ | 1,919,000 |
| Alternative B4: Full Bulkhead Removal with Log Crib Structure | $ | 1,283,000 |
| 2. Sand Spit Area | | |
| Alternative S1: Repair Wood Terminal Groin | $ | 90,000 |
| Alternative S2: Replace Wood Terminal Groin with Rock Groin | $ | 129,000 |

In providing opinions of probable construction cost, the Client (South Puget Sound Salmon Enhancement Group) understands that the Consultant (Anchor Environmental L.L.C.) has no control over the cost or availability of labor, equipment or materials, or over market condition or the Contractor's method of pricing, and the consultant's opinions of probable construction costs are made on the basis of the Consultant's professional judgment and experience. The Consultant makes no warranty, expressed or implied that the bids or the negotiated cost of the Work will not vary from the Consultant's opinion of probable construction cost.

*All costs are in 2009 dollars. Costs do not include Monitoring.

## Appendix B-6 Maple Hollow Restoration (Project ID#67)

### Project Description

This project will address a small gabion/concrete bulkhead and upland creosote stairs on a documented forage fish spawning beach. The project is located on the west side of Carr Inlet. The property is owned by the Department of Natural Resources and leased by the Key Pen Parks District. Through this development project SPSSEG worked with Key Pen Parks to develop a restoration plan for this shoreline. Key Pen Parks has now taken over implementation of the shoreline restoration project and is planning to remove shoreline armor, place beach logs at the toe of the slope, and plant the shoreline where the stairs are to be removed, with Pacific Willow, Alder and Salmon Berry. Project activities will restore the upper beach profiles, remove toxic creosote materials and restore a small section of bluff and riparian habitat.

The following design report (Waterfall Engineering 2010) was developed by Ken Pen Parks District.

**Figure 7.6. Ground photo (SPSSEG 2009) of concrete and gabion bulkhead at Maple Hollow Park.**

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CONSTRUCTION DOCUMENT FOR:

# MAPLE HOLLOW RESTORATION

PROJECT NUMBER: 10-1873


VICINITY MAP
*NOT TO SCALE*

## DRAWING INDEX:



LEGAL: LATITUDE – 47 Degrees 17' 44.57" N
LONGITUDE – 122 Degrees 44' 49.85" W
NE 1/4 of Sec. 24
Pierce County, Washington
Address: 48th St & Van Beek Rd, Lakebay, WA

MAPLE HOLLOW RESTORATION
KEY PEN PARKS

30% DESIGN NOT FOR CONSTRUCTION

REVISIONS

| REV | DATE | BY | APP'D | DESCRIPTION |
|---|---|---|---|---|
| | | | | |
| | | | | |
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| | | | | |

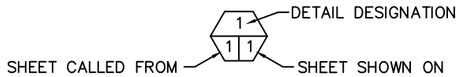
DESIGNED BY: WATERFALL ENGINEERING, LLC
DRAWN BY: DIMENSIONS DRAFTING
CHECKED BY:
DATE: 10/05/2010

**PROJECT LOCATION**

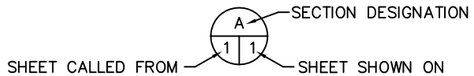
**COVER SHEET**

**1** SHEET **6** OF

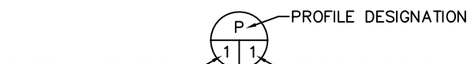
## SHEET SYMBOLS




DETAIL CALLOUT

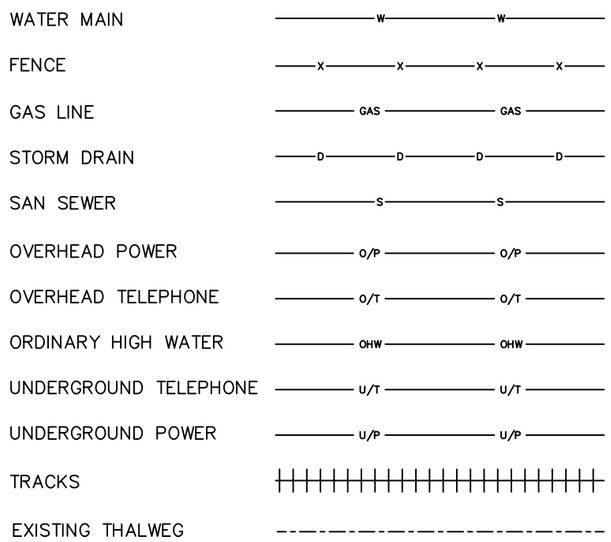



SECTION CALLOUT




PROFILE CALLOUT

## LINETYPES




## ABBREVIATIONS

| | | |
|---|---|---|
| " | – | INCHES |
| ' | – | FEET |
| APPROX. | – | APPROXIMATELY |
| B&B | – | BALLED AND BURLAPPED |
| BM | – | BENCH MARK |
| ℄ | – | CENTERLINE |
| CAL. | – | CALIPER |
| CFS | – | CUBIC FEET PER SECOND |
| CLR. | – | CLEARANCE |
| CMP | – | CORRUGATED METAL PIPE |
| CONC. | – | CONCRETE |
| DIA. | – | DIAMETER |
| ELEV. | – | ELEVATION |
| EQ. | – | EQUAL |
| FTG. | – | FOOTING |
| HDPE | – | HIGH DENSITY POLYETHYLENE |
| HT. | – | HEIGHT |
| GAL. | – | GALLON |
| I.D. | – | INSIDE DIAMETER |
| I.E. | – | INVERT ELEVATION |
| LBS. | – | POUNDS |
| LWD | – | LARGE WOODY DEBRIS |
| MAX. | – | MAXIMUM |
| MFG. | – | MANUFACTURER'S |
| MHW | – | MEAN HIGH WATER |
| MHHW | – | MEAN HIGHER HIGH WATER |
| MIN. | – | MINIMUM |
| MISC. | – | MISCELLANEOUS |
| MISC. | – | MISCELLANEOUS |
| MPH | – | MILES PER HOUR |
| O.C. | – | ON CENTER |
| O.D. | – | OUTSIDE DIAMETER |
| OHW | – | ORDINARY HIGH WATER |
| PK | – | PARKER–KALON |
| R.O.W. | – | RIGHT OF WAY |
| REQ'D | – | REQUIRED |
| SEC. | – | SECTION |
| S.F. | – | SQUARE FEET |
| SHT. | – | SHEET |
| SPEC'S. | – | PROJECT SPECIFICATIONS |
| STA. | – | STATION |
| SS | – | STAINLESS STEEL |
| TEMP. | – | TEMPORARY |
| TYP. | – | TYPICAL |
| W.S. | – | WATER SURFACE |
| WSDOT | – | WASHINGTON STATE DEPARTMENT OF TRANSPORTATION |
| WSEL | – | WATER SURFACE ELEVATION |

## NOTES

Survey based on NAVD 1988 Coordinates from Aspen Land Surveying LLC
Adjusted by Waterfall for Local Tidal Datum MLLW = 0.0.

BM 1003: X = 1082843.2970, Y = 724306.3870, Z = 35.2
BM 1051: X = 1082859.7380, Y = 724224.985, Z = 12.6
BM 2001: X = 1082887.907, Y = 724213.7280, Z = 7.9

*ESTIMATED QUANTITIES TO BE REMOVED:*
*CREASOTE WOOD STEP PLANKS: 450 LINEAL FEET*
*WIRE GABION BASKETS: 22 CY*
*CONCRETE: 4 CY*
*MISC DRAINS AND PIPES*

## LEGEND

*EXISTING CALLOUT*
NEW CALLOUT
EXISTING LIGHT POLE
GUY WIRE
SURVEY POINT
MAPLE 36"
EXISTING TREES TO REMAIN
BM1
PROJECT BENCH MARK
B–1
BORING LOCATIONS
SANDBAGS
1
NOTE CALLOUT
2+00
STATION CALLOUT
1
PHOTO CALLOUT

CONCRETE
FILL
ROCK/GRAVEL
UNDISTURBED GRADE
WETLAND DELINEATION
DEMO
#
ELEVATION CALLOUT
TREE TO BE REMOVED
TREE TO REMAIN

MAPLE HOLLOW RESTORATION
KEY PEN PARKS

30% DESIGN NOT FOR CONSTRUCTION

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DATE | BY | APP'D | DESCRIPTION |

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CHECKED BY:
DATE: 10/05/2010

**MAPLE HOLLOW**

**LEGEND AND NOTES**

SHEET 2 OF 6


## SITE PLAN - OVERALL

SCALE: 1"=150'

0 150

SCALE

MAPLE HOLLOW RESTORATION
KEY PEN PARKS

30% DESIGN NOT FOR CONSTRUCTION

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DATE | BY | APP'D | DESCRIPTION |
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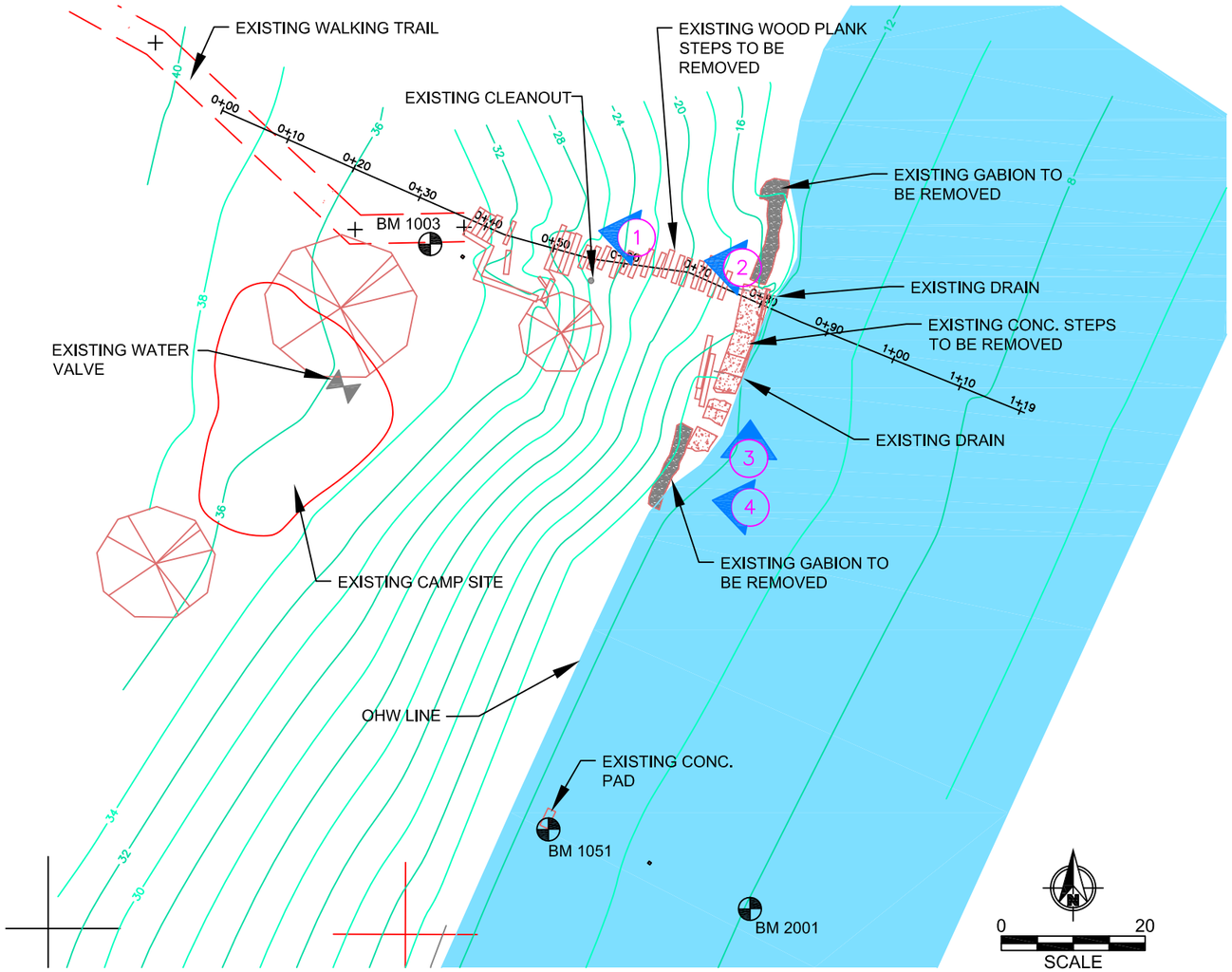
DATE: 10/05/2010

**SITE PLAN**

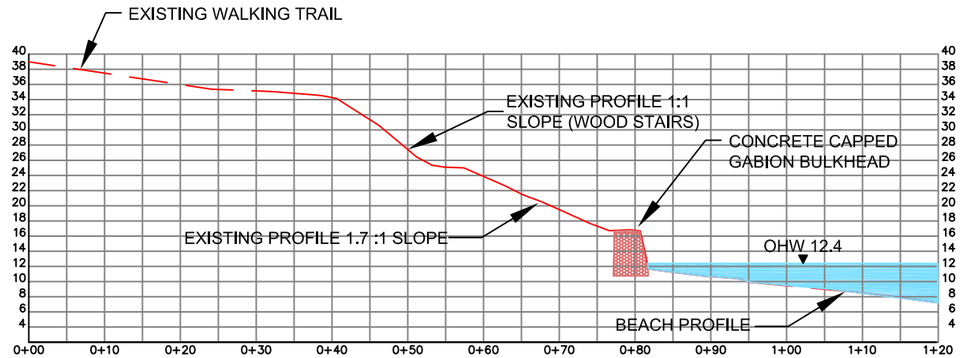
**OVERALL PARK AERIAL PHOTO**

SHEET 3 OF 6




## SITE PLAN - RESTORATION

SCALE: 1"=20'




## SLOPE PROFILE

SCALE: 1"=20'

PHOTO 1

PHOTO 2

PHOTO 3

PHOTO 4

# MAPLE HOLLOW RESTORATION
# KEY PEN PARKS

30% DESIGN NOT FOR CONSTRUCTION

| REVISIONS | | | | |
|---|---|---|---|---|
| REV | DATE | BY | APP'D | DESCRIPTION |
| | | | | |

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CHECKED BY:
DATE: 10/05/2010

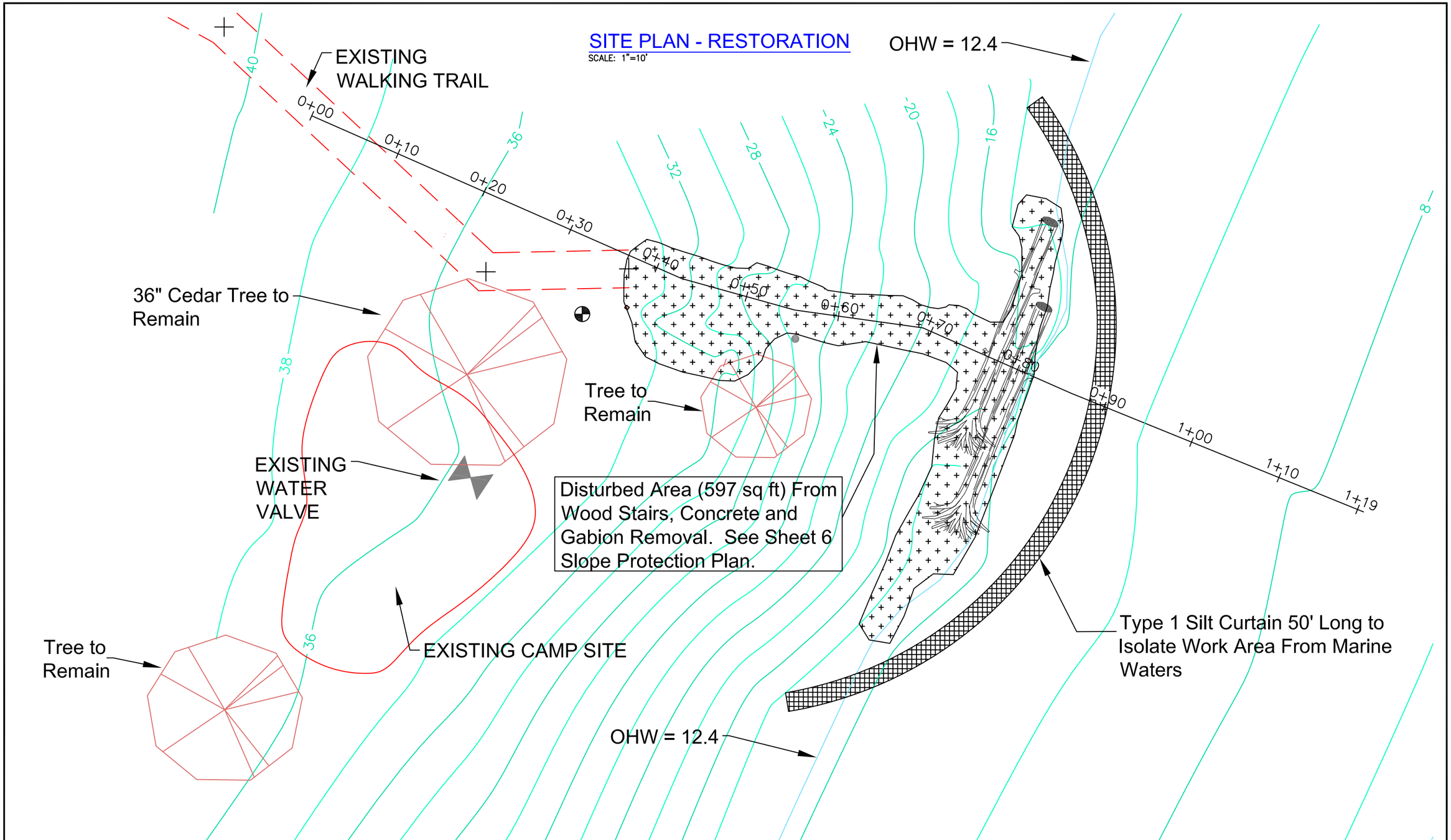
**EXISTING**

**SITE PLAN**

**4** SHEET **6** OF

## SITE PLAN - RESTORATION

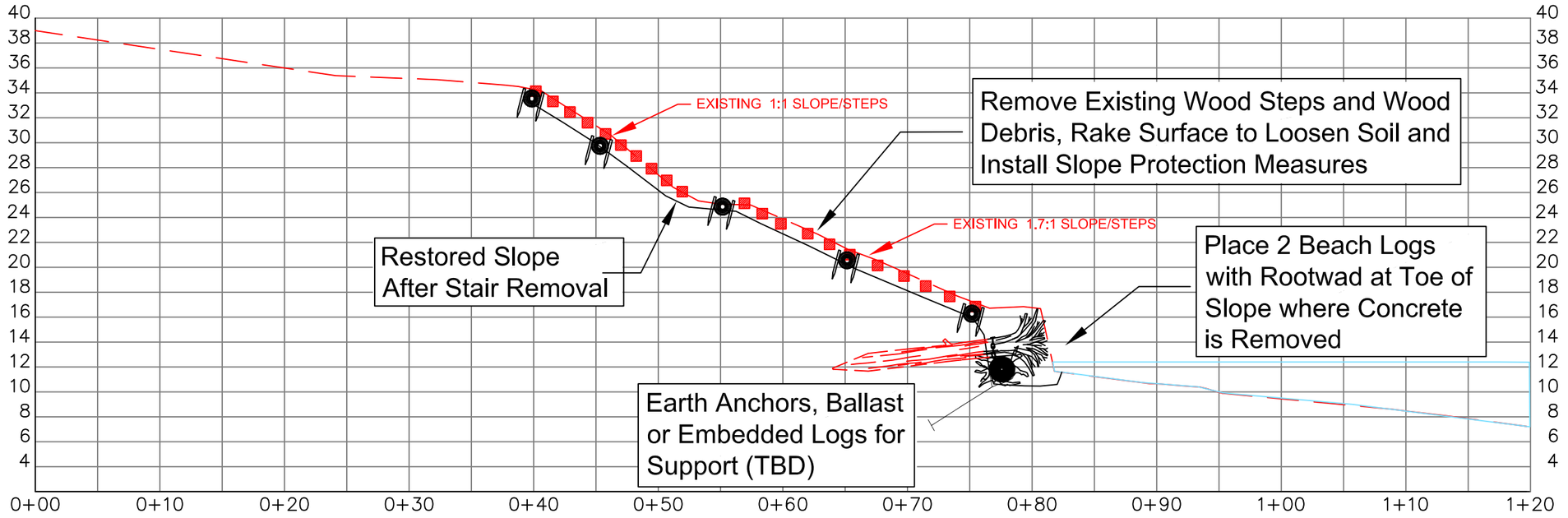
SCALE: 1"=10'

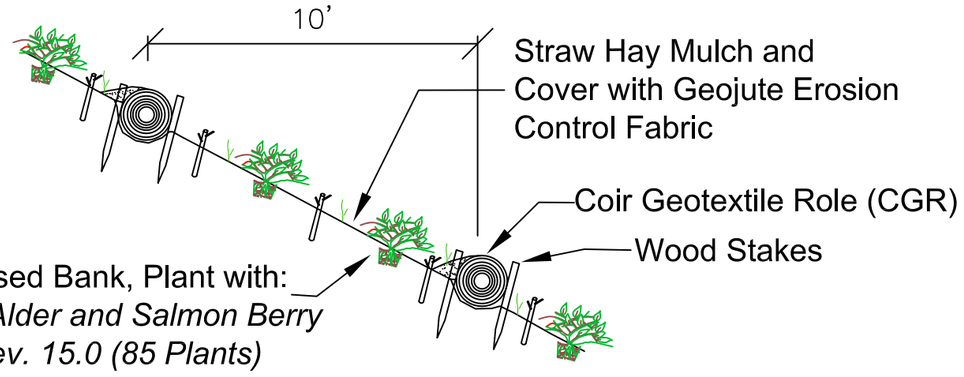



| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Key Pen Parks | MAPLE HOLLOW RESTORATION<br>KEY PEN PARKS | 30% DESIGN NOT FOR CONSTRUCTION | REVISIONS<br>REV / DATE / BY / APP'D / DESCRIPTION | DESIGNED BY: WATERFALL ENGINEERING, LLC<br>DRAWN BY: DIMENSIONS DRAFTING<br>CHECKED BY:<br>DATE: 10/05/2010 | PROPOSED<br>RESTORATION SITE PLAN | SHEET 5 OF 6 |

## PROFILE

SCALE: 1"=10'




## SLOPE PROTECTION MEASURES

SCALE: 1"=10'

1. After material has been removed from the slope and earth is exposed, trench 4 inches into the soil, place geojute, cover with Coir Geotextile Role (CGR) and stake on both side (minimum 8 stakes per 20 foot length of CGR).

2. Geojute shall be secured by embedding beneath CGRs and then roll fabric down slope, overlapping edges a minimum of 6 inches. Geojute shall be staked per manufactures specifications.

3. If slopes are left bare during construction and exposed to rain for more than 24 hours, clear plastic sheeting shall be installed until slope protection measures can be completed.

4. After slope protection is complete, cut and repair geojute as needed to install plants.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Key Pen Parks | MAPLE HOLLOW RESTORATION<br>KEY PEN PARKS | 30% DESIGN NOT FOR CONSTRUCTION | REVISIONS<br>REV / DATE / BY / APP'D / DESCRIPTION | DESIGNED BY: WATERFALL ENGINEERING, LLC<br>DRAWN BY: DIMENSIONS DRAFTING<br>CHECKED BY:<br>DATE: 10/5/2010 | **PROFILE AND**<br>**SLOPE PROTECTION MEASURES** | SHEET 6 | OF 6 |

# 8.0 Appendix C. Explanation of habitat scoring criteria using the Nearshore Project Selection Tool (NPST 2009).

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## Juvenile Salmon Nearshore Project Selection Tool Beneficial Model

The Chinook and Bull Trout Recovery Approach for South Puget Sound (NOAA Fisheries 2007) outlined discrete habitat types found along the shoreline that were hypothesized to be beneficial to juvenile salmonids. Each of these habitats contributes to the four essential nearshore eco-system functions beneficial to juvenile salmonids described by Simenstad (1982) and William and Thom (2001).The habitat types identified and mapped were:

- Known forage fish spawning beaches
- Feeder bluffs
- Pocket estuaries
- Salmonid bearing freshwater tributaries
- Eelgrass beds
- Emergent Marsh

This document attempts to further refine the spatial mapping by evaluating the attributes of:

- Saltmarsh
- Inter-tidal vegetation
- Eelgrass
- Documented forage fish spawning areas
- Proximity to salmon bearing streams
- Proximity to fresh water inputs
- Embayments/pocket estuaries

Feeder bluffs were not included in the analysis because a sufficiently robust dataset does not exist that is appropriate for this exercise. The prioritized sediment sources from the Thurston and Mason County and the Nisqually to Point Defiance nearshore assessments are included in the GIS product as a separate layer.

Two juvenile beneficial models were created- one that rates all of the shoreline equally, outside of the above attributes, titled *All Salmonids* and a second titled *Fry Migrant* that gives extra weight to habit attributes located closer to the Nisqually River that are hypothesized to benefit Nisqually natal fry migrant Chinook. Puyallup River fry migrants were considered but were excluded from this analysis. Virtually the entire project area (South Sound) is outside of the hypothesized use area and the nearshore attributes that were affected adjacent to the Tacoma Narrows did not benefit from additional scoring.

A scoring mechanism was employed that provides a maximum score of 5 points per attribute. Differential weighting factors were employed for the *All Salmonids* and *Fry Migrant* models. A total of 87 points and 60 points are possible for each ShoreZone unit in the *Fry Migrant Chinook* model and the *All Salmonid* model respectively.

| Beneficial | Fry Migrant Chinook | All Salmonid | Model Attribute | Source Attributes |
|---|---|---|---|---|
| **Saltmarsh** | **Scores** | | SALTM_SCORE | *Salicornia* (SAL)[a], *Triglochin* (TRI)[a] |
| Continuous | 5 | 5 | | |
| Patchy | 3 | 3 | | |
| None | 1 | 1 | | |
| **Intertidal Vegetation** | | | VEG_SCORE | Ulvoids (ULV)[a], *Gracilaria* sp. (GCA)[a], soft brown algae (SBR)[a], *Sargassum* sp. (SAR)[a], red algae (RED)[a], bull kelp (NER)[a] |
| Continuous | 5 | 5 | | |
| Patchy | 3 | 3 | | |
| None | 1 | 1 | | |
| **Eelgrass** | | | ZOS_SCORE | *Zostera marina* and *Z. japonica* (ZOS)[a] |
| Continuous | 5 | 5 | | |
| Patchy | 3 | 3 | | |
| None | 1 | 1 | | |
| **Forage Fish Score** | | | FORAGEFISH | Documented surf smelt (*Hypomesus pretiosus)*[b] and Pacific sand lance (*Ammodytes hexapterus*)[b] spawning beaches |
| 76 - 100% | 5 | 5 | | |
| 51 - 75% | 4 | 4 | | |

| | | | | |
|---|---|---|---|---|
| 26 - 50% | 3 | 3 | | |
| 1 - 25% | 2 | 2 | | |
| 0% | 1 | 1 | | |
| | | | | |
| **Forage Fish %** | | | FORAGE_PERC | Shoreline[a], Documented surf smelt (*Hypomesus pretiosus)*[b] and Pacific sand lance (*Ammodytes hexapterus*)[b] spawning beaches |
| NULL, 1 - 100 | NULL, 1 - 100 | NULL, 1 - 100 | | |
| **Embayment Score** | | | EMBAYMENT_SCORE | Shoreline[a], Embayments[c] |
| Unit is completely within embayment | 5 | 5 | | |
| Unit is partially within embayment | 3 | 3 | | |
| Unit is not within embayment | 1 | 1 | | |
| **Embayment Weight** | | | EMB_WEIGHT | Embayments[c], Streams[d], Nisqually River head[a] |
| < 5 miles from Nisqually | 4 | | | |
| 5 - 10 miles from Nisqually | 3 | | | |

| | | | | |
|---|---|---|---|---|
| > 10 miles from Nisqually | 2 | | | |
| | | 2 | | |
| **Proximity to Nisqually** | | | NISQ_PROX | ShoreZone Segments[a], Fish Distribution[d], Streams[d] |
| < 500 ft | 5 | | | |
| 500 ft - 1/2 mile | 4 | | | |
| 1/2 mile - 1 mile | 2 | | | |
| > 1 mile | 1 | | | |

| | | | | |
|---|---|---|---|---|
| **Proximity to Tier-1 Stream[1]** | | | TIER1_PROX | ShoreZone Segments[a], Fish Distribution[d], Streams[d] |
| < 500 ft | 5 | 5 | | |
| 500 ft - 1/2 mile | 4 | 4 | | |
| 1/2 mile - 1 mile | 2 | 2 | | |
| > 1 mile | 1 | 1 | | |
| **Proximity to Salmon-Bearing Stream** | | | OTHER_PROX | ShoreZone Segments[a], Fish Distribution[d], Streams[d] |
| < 500 ft | 5 | 5 | | |
| 500 ft - 1/2 mile | 4 | 4 | | |
| 1/2 mile - 1 mile | 2 | 2 | | |
| > 1 mile | 1 | 1 | | |

| **Proximity to Non-Salmon-Bearing Stream** | | | NSALM_PROX | ShoreZone Segments[a], Fish Distribution[d], Streams[d] |
|---|---|---|---|---|
| < 500 ft | 5 | 5 | | |
| 500 ft - 1/2 mile | 4 | 4 | | |
| 1/2 mile - 1 mile | 2 | 2 | | |
| > 1 mile | 1 | 1 | | |

**Fry Migrant**
**Chinook**

BENEFIT_SCORE = [SALTM_SCORE] + [VEG_SCORE] + ([ZOS_SCORE] * 2)

+ ([EMBAYMENT_SCORE] * [EMB_WEIGHT]) + ([NISQ_PROX_SCORE] * 4)

+ ([TIER1_SCORE] * 3) + ([OTHER_SCORE] * 2) + ([NONSALM_SCORE] * 2) + ([FORAGEFISH] * 2) - 18

**All Salmonid**

BENEFIT_SCORE = [SALTM_SCORE] + [VEG_SCORE] + ([ZOS_SCORE] * 2)

+ ([EMBAYMENT_SCORE] * 2) + ([TIER1_SCORE] * 3)

+ ([OTHER_SCORE] * 2) + ([NONSALM_SCORE] * 2) + ([FORAGEFISH] * 2) - 15

| **Data set** | **Organization** | **Online Linkage** |
|---|---|---|
| [a]ShoreZone | WDNR | http://fortress.wa.gov/dnr/app1/data/itd/state_DNR_ShoreZone.zip |
| [b]Forage Fish | WDFW | https://fortress.wa.gov/dfw/public/phs/data/marine/foragefish_gdb.zip |
| [c]SSHIAPGeomorphology | NWIFC | N/A |
| [d]SSHIAPHydro | NWIFC | N/A |

## Juvenile Salmonid Nearshore Project Selection Tool Limiting Model

The limiting layer provides quantitative data on potential nearshore restoration projects. The intent was to identify what was degraded and by how much for a subset of nearshore stressors to provide recommended management actions. Information was obtained for each unit from the Washington Department of Natural Resources ShoreZone Inventory[1].

Each Shorezone unit was designated as being either a "mudflat" or "open shoreline" using the ShoreZone, bc_class (British Columbia coastal class) classification system. Codes 29 and 31 (mudflat; organic/fines) were used to designate mudflats - all other codes were categorized as open shoreline. Differential scoring was applied to the attributes of modified shoreline (SM_TOT_PCT) and riparian percentage (RIPAR_PCT) to identify areas where overhanging vegetation and shoreline armoring are hypothesized to have less of a detrimental effect for the mudflat and organic/fines designations.

A scoring mechanism was employed that provides a maximum score of .25 per attribute. For each Shorezone segment a total of 1.15 points are possible. No weighting factors were employed.

| **Limiting** | **ShoreZone Attribute** | **Mudflat** | **Open Shoreline** | **Model Attribute** |
|---|---|---|---|---|
| **Shoreline Armoring** | SM_TOT_PCT | **Scores** | | SM_TOT_SCORE |
| Percentage of shoreline length | | % x 0.1 | % X 0.25 | |
| **Boat Ramps** | RAMP | | | RAMP_SCORE |
| More than one boat ramp per 500 feet of shoreline in ShoreZone unit | | 0.1 | 0.1 | |
| **Docks** | PIERDOCK | | | PIERDOCK_SCORE |
| More than one dock ramp per 300 feet of shoreline in ShoreZone unit | | 0.1 | 0.1 | |
| **Small or** | SLIP_SMALL | | | SLIPSMALL_SCORE |

| | | | | |
|---|---|---|---|---|
| **Recreational Slips** | | | | |
| More than 50 slips | | 0.25 | 0.25 | |
| 30 to 49 slips | | 0.2 | 0.2 | |
| 10 to 29 slips | | 0.1 | 0.1 | |
| **Large Slips (Ocean-going vessels)** | SLIPLARGE | | | SLIPLARGE_SCORE |
| One or more slips | | 0.25 | 0.25 | |
| **Railroad** | RAILROAD | | | RAILROAD_SCORE |
| Railroad is in contact with shoreline | | 0.1 | 0.1 | |
| **Riparian Overhanging Losses** | RIPAR_PCT | | | RIPAR_SCORE |
| Percentage of shoreline length | | % x 0.1 | % X 0.25 | |

**LIMITING_SCORE** = 1.15 - [SM_TOT_SCORE] - [RAMP_SCORE] - [PIERDOCK_SCORE] - [SLIPSMALL_SCORE] - [SLIPLARGE_SCORE] - [RAILROAD_SCORE] - [RIPAR_SCORE]

[1]Nearshore Habitat Program. 2001. The Washington State ShoreZone Inventory. Washington State Department of Natural Resources, Olympia, WA. URL: www.dnr.wa.gov/htdocs/aqr/nshr/index.html