Bowman Bay Bulkhead Removal and Nearshore Enhancement, Preliminary Design Report—Final

Prepared for: Northwest Straits Foundation &
Skagit County Marine Resources Committee
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Introduction & Purpose

The purpose of this preliminary design report is to detail initial design recommendations for removal of shore armor from the east side of Bowman Bay within Deception Pass State Park, Skagit County, WA. A rock revetment fronts the barrier beach at the central portion of the park beach. This revetment is the only stretch of armored shore within the entire pocket beach. Coastal Geologic Services Inc. (CGS) was contracted by the Northwest Straits Foundation to assess the feasibility and development design drawings for bulkhead removal at the site.

Bowman Bay is a pocket beach located in Deception Pass State Park (Sheet 1). The site was armored prior to the 1970s to protect a fish hatchery and marine biology station that operated in the project area since 1947. In 2006, the armor was damaged in a storm and was repaired in early 2011. The current bulkhead consists of approximately 2,050 tons of armor stone and quarry spall stretching 540 ft along the shoreline. State Parks has no plans to change the use of this site and removing the armor is consistent with the agency's long-term plans for the site.

The purpose of this preliminary design report is to detail initial design recommendations for removal of shore armor and perform nearshore enhancement/ restoration at Bowman Bay. Site conditions and bulkhead removal feasibility will be briefly described followed by preliminary design alternatives. The preferred alternative is then described, including design considerations and analyses.

Funding for this report has been provided by: WDFW/DNR Marine and Nearshore Grant Program, US Environmental Protection Agency National Estuary Program, Skagit County Marine Resources Committee, Northwest Straits Commission, and the Puget Sound Partnership.

Existing Conditions

Site History

Bowman Bay is within the traditional territory of the Samish and Swinomish (Arthur 2014, Suttles 1974). Any design elements should consider cultural deposits such as shell middens within the project area.

During the field survey, extents of shell midden were documented through archaeologist-supervised test pits. All design elements should provide at least 8 inches of buffer between proposed grades and shell midden extents (Caldera Archaeology 2014).

The wetland south of the project area was mostly drained in 1934 for to make the area drier for recreational purposes. In 1947, the fish hatchery and marine biological station was constructed by the Washington Department of Fisheries (now Washington State Department of Fish and Wildlife). The station consisted of four concrete ponds parallel to the shoreline, a pier and small floating dock, a residential duplex, and lawn area. The station was demolished in 1972 and the concrete ponds were crushed and buried beneath dredge spoils from Bowman Bay (Caldera Archeology 2014). The demolished concrete ponds have an approximate 35 ft setback from the bulkhead crest. The revetment is described in the *Bulkhead* section below.

Beach

Bowman Bay is a 2,100 ft long pocket beach, located along the southwest shore of Fidalgo Island, on Rosario Strait. Deception Pass is located just south of the site, bringing strong tidal currents and nutrient upwelling to the area. The Bowman Bay beach faces west-southwest and is exposed to approximately 70-miles of fetch (open water distance over which waves form) from the WSW down Rosario Strait and the Strait of Juan de Fuca. This fetch exposes the site to both wind-generated waves over a very high energy exposure and also ocean swell which has been partially diminished in wave energy coming in the non-linear Strait of Juan de Fuca. This is a swash aligned beach and the beach sediment is largely contained between the bedrock headlands that demark the pocket beach. The current position of the shoreline has not adjusted significantly since the first mapping of this shore in 1885 (Figure 1). The southern extent of the beach is partially sheltered from the straits by a bedrock headland waterward of the beach.

The beach is composed primarily of gravel but contains enough sand such that it is a mixed sand and gravel beach. The beach has a moderately steep slope (5:1 to 6:1; H:V) for a Puget Sound region beach (Photo Pages 1 and 2). A minor storm berm comprised of coarse gravel and granules was observed waterward of the armor at the time of the survey. The beachface was composed of sand with gravel overlying a portion of rock armor. Considerably more driftwood had collected along the unarmored shore when compared to the intermittent drift logs waterward of the bulkhead. The slightly more sheltered conditions of the southern reach of the beach have likely contributed to the development of a broader upper beach and greater accumulations of beach wrack.

Water flows onto the mid-beachface south of the pier through a culvert. The approximately 12 in diameter concrete pipe was broken and partially filled with beach sediment at the time of the beach survey. The park beach contains a boat ramp located waterward of the parking lot. The boat ramp is constructed out of concrete and had been in place for many years, with minor repairs evident on the south side. A wooden pier extends approximately 450 ft from the upper beach to deeper water in the bay. The pier is located approximately 440 ft south of the boat ramp within the southern reach of rock bulkhead. A small floating dock and ramp are present near the south side of the end of the pier. The majority of wood in the pier appears to be creosoted, including all of the timbers and piles.

Uplands

The uplands at the project location consist of an expansive open lawn, large parking area, trail, waterfront benches, restroom facilities, septic system, drainage culverts, and other park infrastructure.

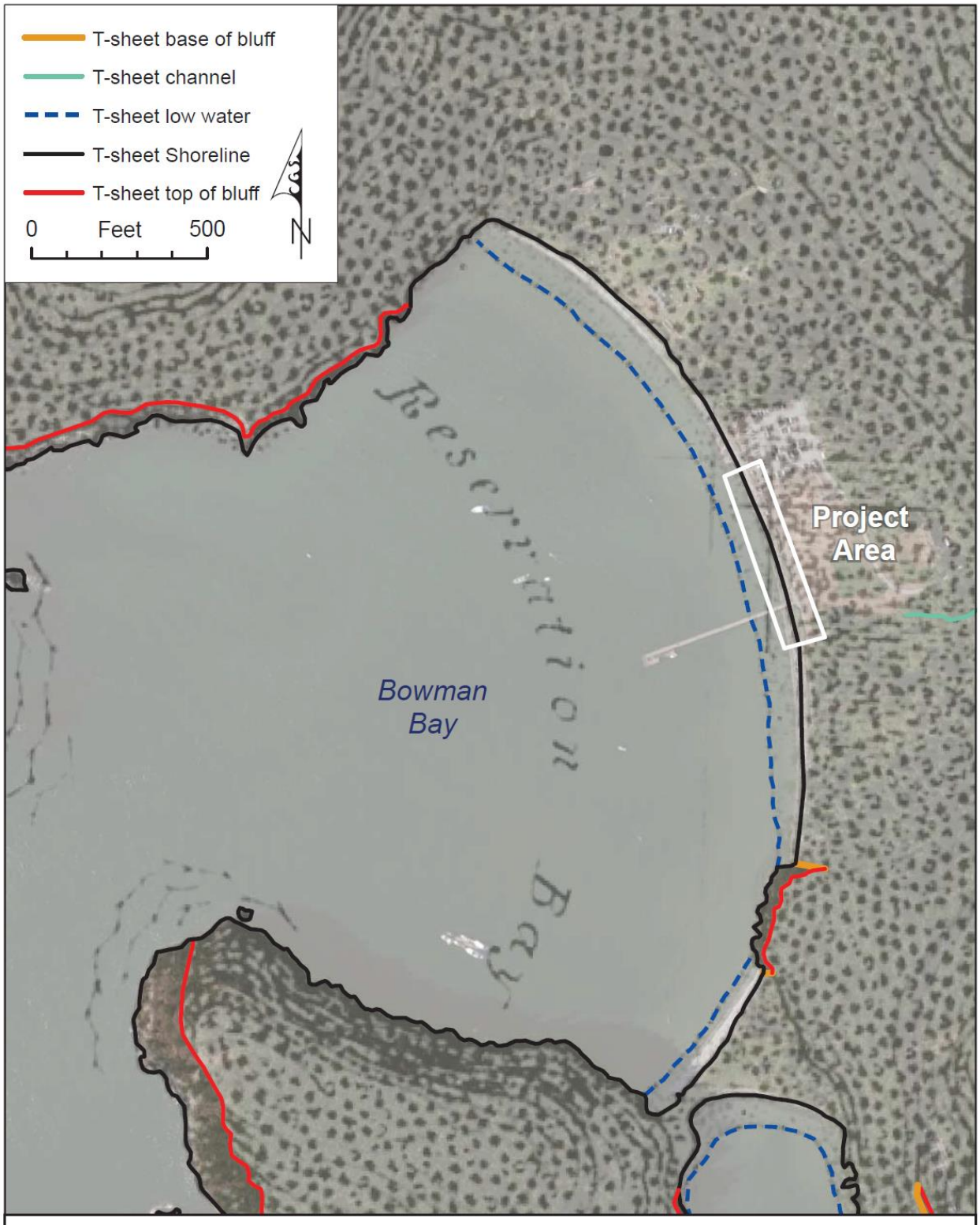

Figure 1. Excerpt of T-Sheet #1667 mapped 1885 showing the east side of Bowman Bay

A pier and boat ramp extend into the intertidal area of the park (described in *Beach* section above). The project area has a bulkhead detailed in the next section. Outside of the lawn area, the project area has intermittent dunegrass patches within the quarry spall apron landward of the bulkhead crest (Photo Pages 1 and 2). An on-site septic system is located in the lawn area landward of the bulkhead to serve the park restroom. The setback of the septic system is 150 ft from the toe of the existing armor.

A sediment grain size characterization of the fill material landward of the revetment was completed to determine reuse or disposal options. Samples were collected by CGS from test pits excavated by Parks staff. Sediments in the test pits were visually analyzed and described. Representative samples were collected from distinctly different types of sediments with recorded depth in feet below the surface.

Each of three representative fill types were observed and sampled during the January 21, 2014 site visit (Photo Page 3). The samples were dried, visually inspected, and characterized by grain size and texture based on the Unified Soil Classification System (USCS). These materials were noted in the field as Fill sediment, Dredge sediment, and Sandy Fill and each of these were sampled for sediment classification. The depth and stratification of these fill materials are noted in Sheet 3 of the design sheet set. The USCS classification for each of the fill materials observed and sampled are as follows:

- Fill: This material was described as orange-brown, silty sand with few pebbles and small cobble, and was relatively non compact. This material is classified as a SM, containing silt rich sand and sand-silt mixtures. This material contains too many fines to be suitable for reuse as beach material, but may be suitable for use as soil for salt-tolerant plantings.
- Dredge: This material was gray silt and sand with lenses of silt and clay and highly variable. Shell fragments and small pebbles present, relatively compact. This fill material was interpreted to be from Bowman Bay dredge spoils based on understanding of historic land uses. Due to the fine-grained nature of the dredge material, sample classification using USCS was not necessary; the sample contains too many fines to be suitable for any reuse on site. If excavated, this sediment will need to be hauled away for disposal.
- Sandy Fill: This sediment was tan, fine to medium sand with few pebbles, and relatively non-compact. Despite the appearance of this material as clean sand, it contains a higher portion of fines and is therefore a SM on the USCS classification containing silt rich and sand-silt mixtures. This material contains too many fines to be suitable for reuse as beach material, but may be suitable for use as topsoil for plantings.

Bulkhead and Removal Feasibility

A rock revetment type bulkhead was observed across approximately 540 ft of shore extending from the concrete boat ramp southward past the pier. The bulkhead was comprised of 3 to 5.5 ft sized rock. The bulkhead had an exposed toe elevation of approximately +10 ft MLLW and a most waterward buried toe (below beach grade) elevation of approximately +8 ft MLLW. The full depth of embedment was not determined, but was assumed to be approximately 4 ft to account for the average size of rock used throughout the exposed portions of the bulkhead. The exposed bulkhead was, on average, approximately 4.5 ft high with a top elevation of +14 MLLW with small sections up to +15 ft MLLW. The front face of the bulkhead had an average slope of approximately 2:1 (H:V).

The adjacent sections of the park to the north and south do not have shore armor. Based on the field reconnaissance, no indicators of backshore erosion were present along the adjacent beaches. A review

of a series of historic aerial photos was also conducted. The beach and backshore area appears to only experience seasonal beach change with no or very minor backshore erosion. As seen in Figure 1, the project area shore has not translated substantially since 1885.

During the field reconnaissance, survey data from adjacent beaches to the north and south were obtained to reference sites during beach and backshore restoration design. The beach slope and extents of vegetation at the unarmored reference beaches were used to select the most appropriate upper beach slope and elevation, as well as backshore characteristics presented in the bulkhead removal design.

The currently armored shore is likely to react similarly to the adjacent shores if the revetment is removed. Erosion rates in the Puget Sound region typically vary between 1 to 6 in per year on average (Keuler 1988, Johannessen and MacLennan 2007). Rather extreme erosion rates can be as rapid as 1 ft per year; however, this is very uncommon in the region. Since the site is a swash-aligned pocket beach with almost no off-site shore modifications, adjacent unarmored beaches do not show evidence of erosion, and the site is not exposed to large vessel wakes, we expect that the erosion rate would be on the low end of this spectrum if long term erosion was to occur. Extensive field experience and experience completing many quantitative erosion rate determinations has allowed these authors to estimate that the site's natural erosion rate would be limited to 1-2 inches per year at most.

Ecology Assessment and Biological Imperative

The Bowman Bay nearshore ecosystem will benefit from bulkhead removal in many ways. Considerable research has documented several types of impacts to valued ecosystem processes (identified by the Puget Sound Nearshore Ecosystem Restoration Program (PSNERP)) including coastal processes, marine riparian areas, salmon and forage fish spawning habitats, eelgrass beds and shellfish areas (Clancy et al. 2009, Figure 2).

Sampling conducted by Washington Department of Fish and Wildlife (WDFW), has documented this beach as surf smelt spawning habitat (WDFW 2008, Figure 3). Neither sand lance nor herring spawning however have been documented by WDFW in Bowman Bay. Patchy and continuous eelgrass has been mapped throughout the bay and kelp is also found along the shores to the north and south.

This beach is valued as salmonid migratory habitat. Recent research on fish utilization in San Juan County showed that pocket beaches, such as Bowman Bay, have some of the highest utilization for juvenile salmonids, wild Chinook, and juvenile forage fish (Beamer and Fresh 2013). Although Bowman Bay is located in Skagit County, the nearshore environment is in very close proximity and nearshore conditions are very similar. Therefore San Juan County pocket beach habitat value is an appropriate analogue in this application. In addition, recent fish seining at Bowman Bay performed by Skagit River Systems Cooperative documented the presence of adult smelt, Chinook and pink salmon sub-yearlings (SRSC 2014).

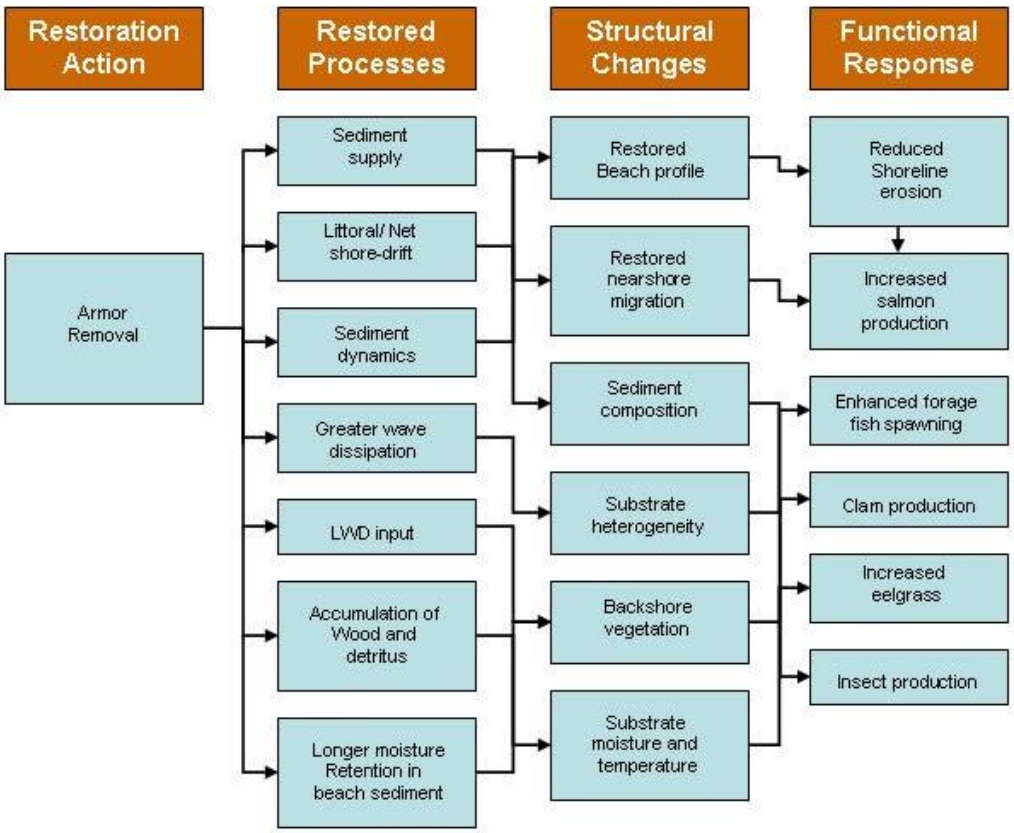

Figure 2. Conceptual model of impacts associated with armor removal (Clancy et al. 2009).

Disrupted physical processes associated with armored shores (relevant to the Bowman Bay site) include: added wave reflectivity which can lead to coarsening of beach sediment composition (MacDonald et al. 1994, Kraus 1988), increased sediment suspension and littoral drift rates (Miles et al. 2001), end scour along the shores adjacent to the armor as well as decreased beach width through direct burial (Griggs 2005, Johannessen and MacLennan 2007, Shipman et al. 2010), and loss of beach habitats (surf smelt and sand lance spawning areas) under the structure footprint and adjacent (Rice 2006). Sediment coarsening can also lead to loss and/or reduced forage fish spawn areas (Penttila 2007).

Armor is known to affect fish abundance, distribution, and behavior patterns (Toft et al. 2010). For example, shore armor creates additional deep water areas during high tides, which can result in increased predation to migrating juvenile salmonids (Williams and Thom 2001). Depleted sediment input and beach sediment coarsening may also lead to the loss of valued shellfish areas (Dethier 2006) and reduced eelgrass beds (Mumford 2007).

Negative impacts to marine riparian function are commonly associated with shore armor but largely depend on the level of impaired cross-shore connectivity resulting from the structure. The larger the shore armor footprint, the greater the impact to cross shore connectivity. The Bowman Bay armored is relatively wide in the cross shore direction at 20-2 ft. Impacts can include loss of overhanging riparian vegetation, large woody debris (LWD) recruitment and storage, and altered surface and groundwater and surface regime(s) (Brennan 2007). Cross shore connectivity is important as it allows for the exchange of groundwater and terrestrial nutrients, insects and invertebrates to the marine environment

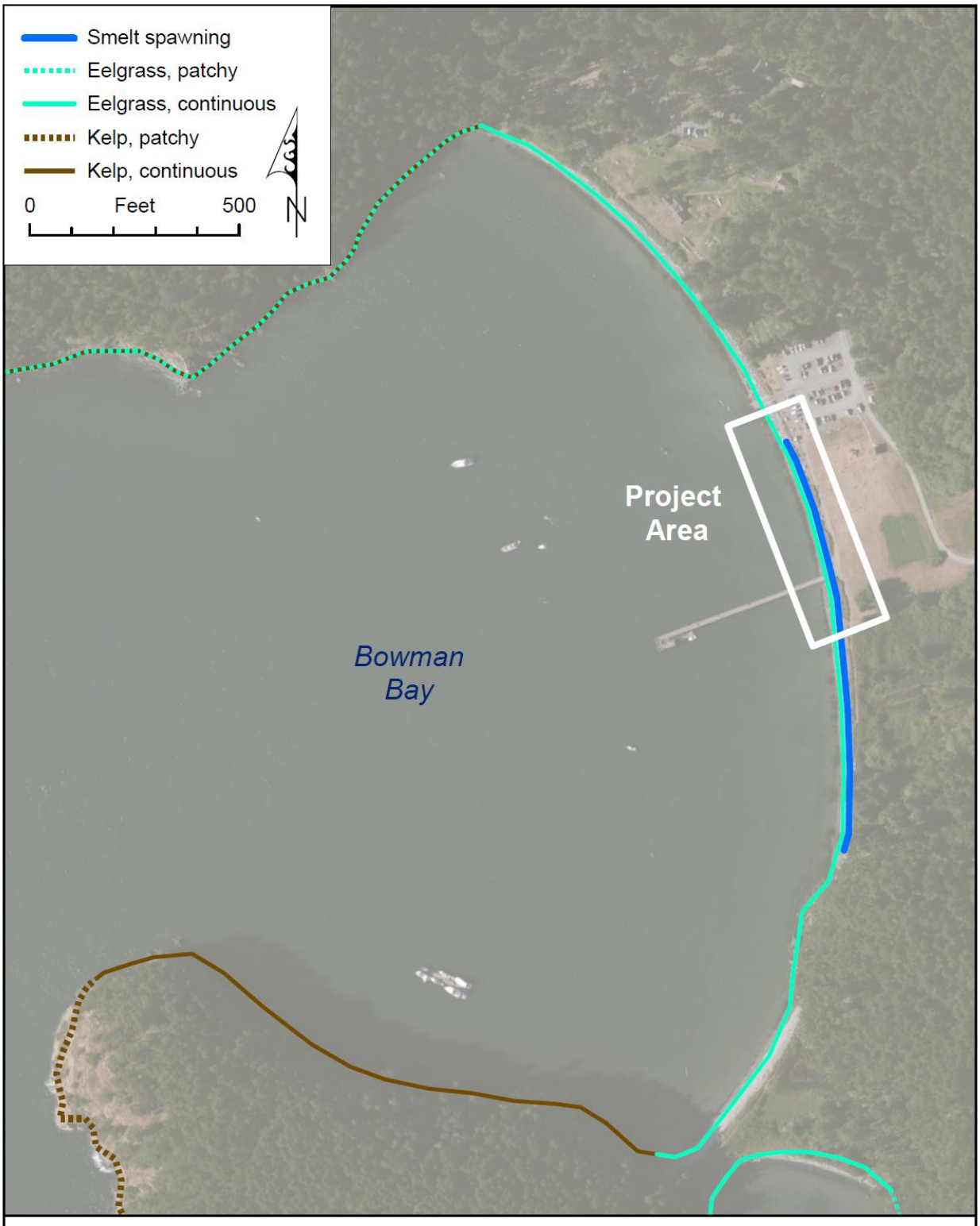

Figure 3. Smelt spawning areas, eelgrass, and kelp in Bowman Bay.

(upon which migrating salmon forage). Loss of overhanging riparian vegetation typically results in a reduction in shaded intertidal areas which leads to microclimate effects that can reduce the survival of forage fish spawn (Rice 2006).

Research conducted by People for Puget Sound documented the lack of co-occurrence between LWD and shore modifications in King County (Holsman and Willig 2007). LWD is in decline throughout the Puget Sound region, which was historically characterized as having abundant driftwood on regional beaches (MacLennan 2005). As compared to adjacent reference beaches, the armored shore of Bowman Bay has much less LWD. LWD provides several important geomorphic and ecologic functions and is known to enhance beach structure, moisture retention and provide solar protection for beach sediment that results in increased invertebrate and insect production, upon which salmonids forage (Tonnes 2008). LWD is typically recruited from unarmored marine riparian areas and also stored along unarmored beaches. Therefore, the presence of armoring largely precludes the presence of LWD on beaches.

Preliminary Design Alternatives

Elements of the uplands that constrain the design are setback distance requirements of an on-site septic system and demolished marine laboratory, visitor access to amenities and viewscape. These constraints also influence the design of beach nourishment placement. The minimum setback of the demolished and buried marine laboratory infrastructure was approximately 35 ft from the toe of the existing armor. The setback of the septic system is 150 ft from the toe of the existing armor. The Washington State Health Department requires a minimum septic system setback of 100 ft from Ordinary High Water Mark (OHWM). Access to the boat ramp and pier need to be maintained with the enhancement design. Minor park infrastructure including the trail, benches, and picnic areas can be relocated if needed for project implementation.

Three design alternatives were conceptualized for the revetment area at Bowman Bay:

1. Full armor removal, pier extension with piles, intertidal beach nourishment, and substantial upland vegetation enhancement
2. Full armor removal with re-grading, minor upper intertidal beach nourishment, and substantial upland vegetation enhancement
3. Armor removal with re-grading, uniform trail realignment, minor beach nourishment, and minimal upland vegetation enhancement for insignificant park infrastructure modification.

Alternative 1 — Full Armor Removal with Substantial Beach Nourishment

Alternative 1 would remove all shore armor from the project area. Approximately 1,370 CY (cubic yards) of rock would be removed and 7,060 SF of backshore area above MHHW would be recovered with full armor removal.

A pier extension using piles to connect the current pier to the trail in the uplands is proposed in Alternative 1. This type of pier/trail connection would be needed for achieving maximum beach recovery within the project area. The pier extension would be substantially more expensive than shore armor proposed in Alternatives 2 and 3 to maintain the current pier-trail connection.

Sediment import would be needed to fill the excavation trench left by armor removal above MHHW. The top 2 ft of graded sediment would be beach nourishment sediment while the lower elevation void left by bulkhead removal would contain the fill from on site with additional clean, lower quality import fill for cost savings. Approximately 1,250 CY of additional sediment would be needed for the entire trench, with 300 CY of that to be beach nourishment quality gravel and sand.

Alternative 1 also includes beach nourishment sediment import within the intertidal to protect the midden from future exposure due to natural beach dynamics. Approximately 850 CY of beach nourishment sediment would be imported to cover 16,500 SF of beach, of which 550 CY of import would be placed below MHHW.

Alternative 1 allows for 9,000 SF of area for vegetation enhancement. Vegetation enhancement design would consider what is needed for habitat as well as views for the park visitors. Planting in the project area should be restricted to the identified fill material or should be done in imported topsoil. Approximately 175 CY of sandy soil and topsoil is needed for import for vegetation enhancement for Alternative 1. Approximately 9 logs with a minimum diameter of 20 IN and a minimum length of 12 FT will be imported and placed within the vegetation enhancement areas. The logs will be buried approximately 1/3 of the diameter and placed near the proposed OHWM. Any drift logs within the work area shall be moved for implementation but replaced within the project area before demobilization.

Armor removal and substantial vegetation enhancement would require trail realignment and park infrastructure relocation. In order to relocate picnic tables, benches, and barbeque pits, the concrete pads would be demolished, used concrete hauled off site, and the pads rebuilt.

Alternative 2 — Armor Removal with Re-grading and Substantial Vegetation Enhancement

Alternative 2 would remove most of the shore armor from the project area. Approximately 1,330 CY of rock would be removed and 6,820 SF of backshore area above MHHW would be recovered through armor removal.

To maintain the current pier-trail connection, approximately 40 CY of reused rock from the demolished bulkhead would be needed for shore armor surrounding the base of the pier at the pier/trail connection, where instability is already present. A total of 240 SF of upper beach and backshore would be covered by this rock, part of which is under the pier.

Sediment import would be needed to fill the excavation trench left by armor removal above MHHW. The top 2 ft of graded sediment would be beach nourishment sediment while the lower elevation void left by bulkhead removal would contain the fill from on site with additional clean, lower quality import fill for cost savings. A total volume of 950 CY of sediment import would be needed for the entire trench in Alternative 2 while of that 550 CY would need to be beach nourishment quality.

Alternative 2 allows for approximately 11,250 SF of area for vegetation enhancement. Vegetation enhancement design would consider what is needed for habitat as well as view for the park visitors. Planting in the project area should be restricted to the identified fill material or should be done in imported topsoil. Approximately 200 CY of sandy soil and topsoil is needed for import for vegetation enhancement for Alternative 2. Approximately 9 logs with a minimum diameter of 20 IN and a minimum length of 12 FT will be imported and placed within the vegetation enhancement areas. The logs will be

buried at least 1/3 of the diameter and placed near the proposed OHWM. Any drift logs within the work area shall be moved for implementation but replaced within the project area before demobilization.

Armor removal and substantial vegetation enhancement would require trail realignment and park infrastructure relocation. The meandering trail realignment proposed in Alternative 2 allows for good corridors for access to the beach as well as maintaining water views. The meandering realigned trail would allow for low plantings when the trail is closest to the beach for optimal viewing. In order to relocate the park infrastructure including picnic tables with benches and barbeque pits, the concrete pads would be demolished, hauled off site, and rebuilt.

Alternative 3 — Armor Removal with Re-grading and Uniform Trail Realignment

Alternative 3 is similar to Alternative 2 except with regards to upland modifications. Alternative 3 proposes the same amount of bulkhead removal and shore armor for pier-trail connection protection. Alternative 3 would be less costly by maintaining the park infrastructure locations and proposing a uniform trail realignment with less vegetation enhancement than Alternative 1 or Alternative 2.

Alternative 2 would remove most of the bulkhead from the project area. Approximately 1,330 CY of rock would be removed and 6,820 SF of backshore area above MHHW would be recovered due to armor removal.

As in Alternative 2, to maintain the current pier-trail connection, approximately 40 CY of reused rock from the demolished bulkhead would be needed for shore armor surrounding the pier-to-trail connection. A total of 240 SF of upper beach and backshore would remain covered.

Sediment import would be needed to fill the excavation trench left by armor removal above MHHW. The top 2 ft of graded sediment would be beach nourishment sediment while the lower elevation void left by bulkhead removal would contain the fill from on site with additional clean, lower quality import fill for cost savings. A total of 950 CY of sediment import would be needed for the entire trench in Alternative 2 while of that 550 CY would need to be beach nourishment quality.

Armor removal would require trail realignment. To minimize upland modification for cost savings, a uniform trail realignment that maintains park infrastructure location is proposed in Alternative 3.

Alternative 3 allows for the smallest amount of vegetation enhancement area. Only 4,200 SF of area will be enhanced between the realigned trail and beach. Vegetation enhancement design would consider what is needed for habitat as well as view for the park visitors. Planting in the project area should be restricted to the identified fill material or should be done in imported topsoil. Approximately 75 CY of sandy soil and topsoil is needed for import for vegetation enhancement for Alternative 3. Approximately 9 logs with a minimum diameter of 20 IN and a minimum length of 12 FT will be imported and placed within the vegetation enhancement areas. The logs will be buried at least 1/3 of the diameter and placed near the proposed OHWM. Any drift logs within the work area shall be moved for implementation but replaced within the project area before demobilization.

Preferred Alternative

The site presents a very good opportunity for coastal restoration. The bulkhead at the site appears unnecessary due to only minor park infrastructure landward of the bulkhead which can be relocated. The demolished hatchery ponds are setback at least 30 ft from the most landward regraded contour

from bulkhead removal. The proposed septic system drainfield setback from current OHWM at the project location is at least 140 FT, and State Health Department requires septic drainfields to be 100 ft landward of OHWM. The low erosion potential combined with insignificant threat to minor upland infrastructure lead to the conclusion that armor removal is feasible at Bowman Bay.

Removal of the revetment and restoration of a sloped upper beach is recommended for this site. All restoration and 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 et al. 2009).

Alternative 2 is the preferred alternative. Armor removal with substantial vegetation enhancement is both feasible and provides the most restoration benefit. Alternative 2 allows for substantial bulkhead removal and the most vegetation enhancement of all three alternatives without temporarily smothering forage fish habitat with beach nourishment placement, or the significant cost of a pier extension with piles. It also allows for more protection to the park infrastructure with more vegetation for habitat improvement and defense against wave attack. The project could also serve as an example and demonstration site for other parks. Alternative 2 also allows for all implementation work to be completed above MHHW to allow for upland access.

Design Considerations and Preliminary Analyses

Adjacent reference beaches without bulkheads at the same elevation had more large woody debris and salt-tolerant backshore vegetation as compared to the Bowman Bay armored shore. These are features that have been identified as important nearshore habitat components (Brennan 2007, Holsman and Willig 2007). Because of its shore armor, the project area has less large woody debris and backshore vegetation than it would with armor removal, as well as more exposed beach substrate.

Portions of the armor coverage area could be revegetated with native plants suitable for this area. Bulkhead removal would allow for expansion of marine riparian vegetation and would also increase the connectivity of this vegetation with the littoral/nearshore system (Brennan 2007). This would provide increased insect and organic material delivery from the marine riparian zone into the nearshore.

Armor removal would also allow the project shore to be more resilient. If the armor was to remain, it would cause increasing impairment of nearshore habitat. Habitat loss will result primarily due to sea level rise (SLR), as the beach will not be allowed to translate (move landward and gain elevation) due to the existing rock revetment (Figure 4, Johannessen and MacLennan 2007). Impacts to documented surf smelt spawning habitat will be amplified over time as sea levels rise and the spawning habitat area is constrained by shore armor (Krueger et al. 2010). Forage fish are important prey sources for Pacific salmon and other species that use the nearshore in Puget Sound (Penttila 2007). Surf smelt spawning extends above MHHW; therefore, armor removal would expand the potential spawning area with SLR.

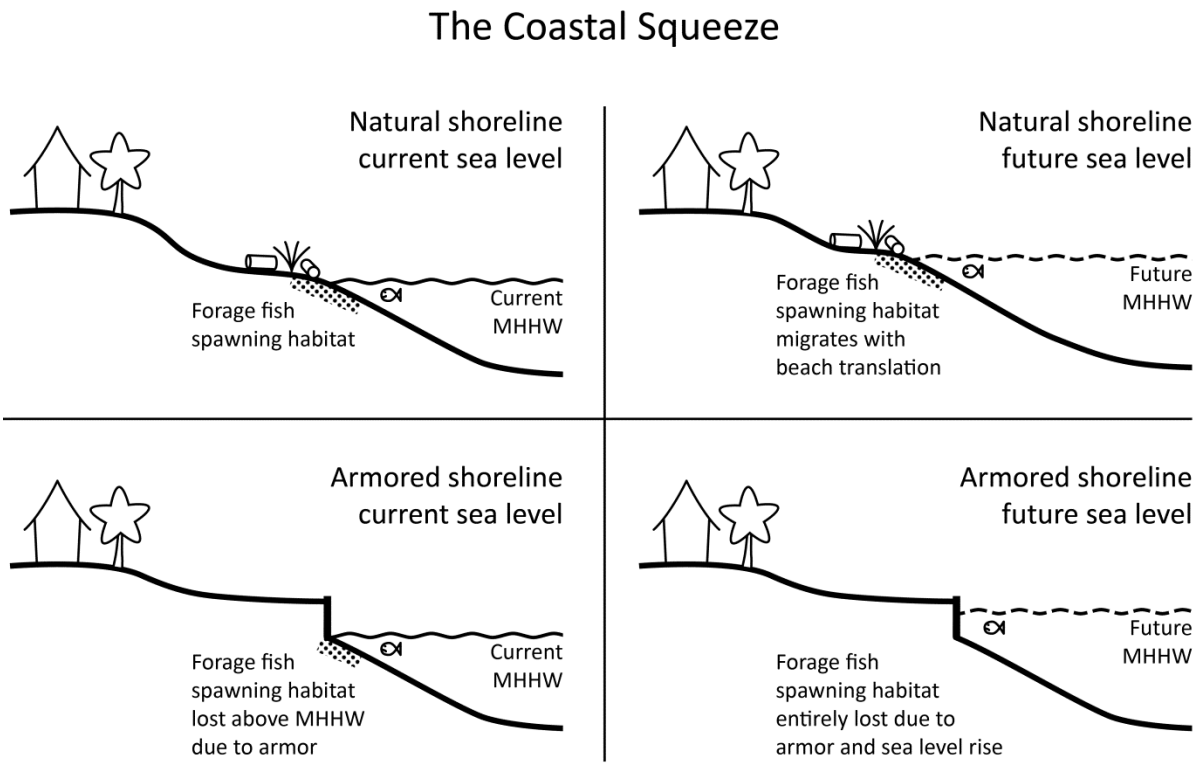

Figure 4. The coastal squeeze; how beach habitats narrow along armored shores rather than migrate inland (Coastal Geologic Services unpublished).

Results of a recent study in WRIA 2 (San Juan County) documented the greatest abundance of wild juvenile Chinook in pocket beaches as compared to other shoreforms (Beamer and Fresh 2012). This pocket beach has little or no sediment input and this beach is not accreting at this time, so habitat loss is inevitable with sea level rise unless this bulkhead is removed. In addition, the bulkhead is less likely to adequately prevent shoreline erosion with a considerable rise in sea level.

Permitting and Stakeholder Consultation

Permitting and stakeholder consultation is being conducted by the Northwest Straits Foundation and Washington State Parks.

Preliminary Design Drawings

The preliminary drawings for bulkhead removal and nearshore restoration actions are attached (Sheets 1 to 5). The drawings are intended to be of sufficient detail and format as to allow decisions as to which alternative to pursue as well as initial permit consultation to proceed, although are not intended for use in construction.

Bulkhead removal is expected to restore approximately 6,840 SF of beach, entirely above MHHW. A short portion of revetment, approximately 30 LF, would be retained in order to preserve the existing pier/trail connection. Reuse of approximately 40 CY of existing armor stone in the area to be retained will be necessary to provide a stable access within as small a footprint as possible.

Excavation of the bulkhead is intended to minimize disturbance of the backshore and restore a more natural condition. Vegetation planting is recommended for the exposed low bank and vegetation

enhancement areas are shown on the plan sheets, although a planting plan was not developed at this stage of the project. Approximately 11,250 SF of backshore area will be enhanced with this project.

Imported beach nourishment sediment is needed to fill the void created by armor removal. Sediment placed within 2 ft of the exposed grade would consist of mixed sand and gravel beach nourishment material to be placed entirely above MHHW at the uppermost beach and graded at a 5:1 slope to maintain at least an 8 in cover of the midden. Sediment below 2 ft in the bulkhead removal excavation prism would be of lesser quality sediment as a cost saving measure. Approximately 550 CY of beach nourishment sediment and 400 CY of lower quality material would be imported to fill the voids left by removal of the rock.

Additional needs for bringing the project to final design and implementation stage include:

1. Refinement of beach nourishment approach and design
2. Native vegetation planting plan
3. Final design drawings and quantities
4. Permit applications and permit approval

Construction Quantities and Preliminary Construction Cost Estimate

CGS estimated engineering costs using a method that was recently developed by consultant team leads (including Johannessen of CGS) for the Puget Sound Nearshore Ecosystem Restoration Project (PSNERP) as part of the process for selecting and developing restoration designs for a number of Puget Sound nearshore sites. The template was simplified to include only the items needed for this project. CGS also used best professional judgment and experience with similar projects in the greater Skagit County area to determine cost estimates. Uncertainties remain in a number of the quantities and more work will need to go into probably material costs for this site.

Preferred Alternative 2

A cost estimate was only developed for Alternative 2, the preferred alternative. The estimated project cost is approximately $178,180 including sales tax and contingency. The cost estimate table is attached. Project design details with substantial costs are the rock bulkhead removal ($49,875), trail demolition ($8,800), rock reuse for pier-to-trail connection protection ($2,100), minor park infrastructure relocation ($2,500), trail realignment ($12,500), beach nourishment import ($16,500), fill material import ($3,600), topsoil import ($6,000), and vegetation enhancement ($2,600). Contractor mobilization of 10% of construction costs ($11,112), erosion control measures ($3,798), archaeology oversight ($4,800), construction oversight for 1.5 weeks ($5,769), and a 20% contingency ($29,697) are also included in the cost estimate.

Limitations of This Report

This report was prepared for the specific conditions present at the subject property to meet the needs of the specific client. No one other than the client should apply this report for any purposes other than that originally contemplated without first conferring with the engineering geologists/geologist who prepared this report. The findings and recommendations presented in this report were reached on the basis of brief field visits and background information that included examination of surface features, bank exposures, soil characteristics, beach features, and coastal processes. In addition, conditions may

change at the site due to human influences, floods, earthquakes, groundwater regime changes, or other factors. Thank you for engaging the professional services of Coastal Geologic Services, Inc. If we can be of any additional assistance please contact our office at (360) 647-1845.

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ATTACHMENTS:

Photo Page 1. Ground photographs of the project area taken 1/21/2014.

Photo Page 2. Ground photographs of the project area taken 1/21/2014.

Photo Page 3. Ground photographs of the test pit stratigraphy and fill materials taken 1/21/2014.

Sheet 1. Bowman Bay Nearshore Enhancement and Armor Removal – Vicinity Map

Sheet 2. Site Plan – Existing Conditions

Sheet 3. Site Plan – Proposed Conditions, Alternative 1

Sheet 4. Site Plan – Proposed Conditions, Alternative 2

Sheet 5. Site Plan – Proposed Conditions, Alternative 3

Cost Estimate. Alternative 2