REVISED DRAFT
McSORLEY CREEK ESTUARY RESTORATION FEASIBILITY STUDY

Prepared for:
King County
Department of Natural Resources and Parks

and

Washington State Parks

March 2016
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Prepared for:
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and
Washington State Parks

Primary Author – Confluence Environmental Company
Contributing Authors – Coast and Harbor Engineering, SvR Design Company, and Shannon & Wilson

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<td>ADA</td>
<td>Americans with Disabilities Act</td>
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<tr>
<td>CCC</td>
<td>Civilian Conservation Corps</td>
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<td>cfs</td>
<td>cubic feet per second</td>
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<td>Full Bluff</td>
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<td>Partial Bluff</td>
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<td>pre-Olympia coarse grain deposits</td>
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<tr>
<td>Qva</td>
<td>Vashon Advance Outwash</td>
</tr>
<tr>
<td>Qvt</td>
<td>Vashon Till</td>
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<tr>
<td>restored estuary</td>
<td>proposed restored estuary concept</td>
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<tr>
<td>shoreline armoring</td>
<td>refers to rock armoring on the Puget Sound shoreline</td>
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<tr>
<td>SLR</td>
<td>sea level rise</td>
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<tr>
<td>Streambank armoring</td>
<td>refers to rock armoring lining McSorley Creek</td>
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<tr>
<td>WRIA</td>
<td>Water Resource Inventory Area</td>
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1 INTRODUCTION

This feasibility study was conducted to identify and evaluate habitat restoration opportunities in the McSorley Creek estuary and Puget Sound shoreline areas within Saltwater State Park. Currently, these areas are extensively modified in ways that significantly impair stream and nearshore habitats and processes. Restoration of the park’s estuary and shoreline is a high priority for Chinook salmon recovery efforts in the watershed (Green/Duwamish and Central Puget Sound Watershed WRIA 9 Steering Committee 2005).

Conceptual restoration alternatives were evaluated to inform the selection of a preferred alternative that provides the optimal combination of habitat restoration and park facilities. The intent is to identify and qualify for salmon restoration grant funding to move the selected alternative through final design and construction in subsequent project phases. As such, the selected alternative will need to provide a significant uplift to salmon habitat elements. This report presents those restoration goals and objectives, as well as background on existing conditions, development of conceptual alternatives, evaluation of alternatives, and recommendations for selecting an alternative to subsequently design.

2 PROJECT BACKGROUND AND NEED

2.1 Background

The project area is located in Saltwater State Park in the City of Des Moines along the eastern shore of Puget Sound. The project area includes the park’s entire shoreline on Puget Sound, the lowermost 600 feet of McSorley Creek (i.e., downstream of the park entrance road bridge), the park area at the top of the coastal feeder bluff, as well as adjacent park areas in the vicinity of the lower creek reach. This portion of Saltwater State Park includes day use recreational areas, a parking lot, walking trails, and buildings (e.g., restrooms and snack shack).

The Puget Sound shoreline of Saltwater State Park and the corridor provided for McSorley Creek to flow through the park have been significantly modified from natural conditions through installation of rock armoring and fill material (Figures 1 and 2). Throughout this report, the rock armoring on the Puget Sound shoreline will be referred to as “shoreline armoring” and the rock armoring lining McSorley Creek will be termed “streambank armoring.” McSorley Creek has been confined to a straight, narrow channel lined with streambank armoring throughout its lowermost reach. These modifications have greatly reduced the quantity and quality of habitat in the lower creek system, as well as the creek’s estuary. Small creeks like McSorley Creek naturally support a relatively broad stream mouth where freshwater from the creek and saltwater from Puget Sound mix to form a tidal wetland estuary. Estuaries are typically highly productive habitats that provide food and refuge for a many species, including salmon (Simenstad et al. 1982). The estuarine habitats of small creeks like McSorley Creek are termed “pocket estuaries” and are highly utilized habitats for juvenile Chinook salmon that originate in larger rivers but utilize pocket estuary habitats more than other marine nearshore habitats (Beamer et al. 2006). Additional research has documented that juvenile Chinook from other river systems even move up into fully freshwater portions of small coastal streams like McSorley Creek (Beamer et al. 2013). Central Puget Sound currently only has approximately 3 percent the amount of area of tidal wetland area than was present historically (Collins and Sheikh 2005).
Figure 1. Aerial Photo of Saltwater Park Shoreline and Mouth of McSorley Creek
The park’s shoreline has been entirely modified north of the mouth of McSorley Creek through the placement of substantial amounts of shoreline armoring and fill material. These modifications were made to expand the upland recreational areas available in the park; however, in doing so, extensive beach habitat was buried and the natural connectivity between upland and aquatic habitats was interrupted. These upland-to-aquatic connections are vital to the nearshore conditions of Puget Sound. In particular, the modifications interrupt the delivery of sediment from the coastal bluff to the beach habitats. These sediments essentially “feed” the beach and these coastal bluffs are even commonly called “feeder bluffs.” The effects of the fill and shoreline armoring impact nearshore processes and habitats in the park, as well as over an extended distance to the north due to reduced availability of sediment in the intertidal beach system.
The mouth of McSorley Creek is constrained by the streambank armoring on both sides. To the north, this streambank armoring ties into the shoreline armoring. To the south, the creek mouth has been extended by shoreline armoring, forming a “groin,” which extends from the approximate historic shoreline location out approximately 50 feet into Puget Sound. Groins are hard structures constructed across the beach. The groin at McSorley Creek functions to keep the creek in its current location. Another effect of the groin is that it traps sand and larger sediment moving north along the Puget Sound shoreline. As a result, sand has accumulated to the south of the structure and has widened the beach in the park and in several adjacent properties to the south.

The upland park area to the south of the creek includes filled areas where the creek used to flow through what is now the parking lot. This portion of the park is also at low elevations, which has led to occasional flooding from McSorley Creek and Puget Sound. This flooding affects the park’s “Snack Shack” building, the parking lot, and the surrounding lawn areas.

The modifications present along McSorley Creek and the Puget Sound shoreline and the affected habitats are a focus of recovery efforts in Puget Sound. The Water Resource Inventory Area (WRIA) 9 Salmon Habitat Plan (Green/Duwamish and Central Puget Sound Watershed WRIA 9 Steering Committee 2005) identifies the restoration of the McSorley Creek estuary and Puget Sound shoreline as a high priority project for restoration due to its benefits for Chinook salmon. At a regional scale, habitat restoration and protection is a priority strategic initiative identified in the Action Agenda of the Puget Sound Partnership (Puget Sound Partnership 2014). The proposed estuary and shoreline restoration would improve several vital signs for Puget Sound which have been identified by the Puget Sound Partnership (Hamel et al. 2015) as key indicators of the health and recovery of Puget Sound. Most notably, the proposed restoration would address the estuaries, shoreline armoring, and Chinook salmon vital signs.

The proposed restoration project advances prior restoration planning conducted by Washington State Parks in the 2007 Green Vision Plan Concept Report (Jones & Jones et al. 2007). That effort was championed by Governor Gregoire to advance recovery planning in Puget Sound by identifying sustainable design and low impact development opportunities in State Parks along the marine shoreline. The shoreline restoration concepts presented in Jones & Jones 2007 formed the starting point for the restoration alternatives developed and evaluated in this feasibility report.

### 2.2 Project Goals and Objectives

The overall goal of the Project is restoration of natural estuarine and marine nearshore processes in a manner that maintains or improves recreational opportunities and long-term sustainability of Saltwater State Park.

The specific project objectives to achieve this goal are:

- Restore the McSorley Creek pocket estuary and tidal wetland by expanding the area available for the lower creek and estuary
- Reconnect feeder bluffs to the intertidal zone to restore natural sediment supply processes in the park
- Remove impediments to longshore sediment transport processes
- Increase the availability of suitable high intertidal spawning areas for forage fish
- Improve the resiliency of park habitats and park amenities to sea level rise (SLR) and flooding while maintaining a diversity of recreational opportunities
- Improve the recreational opportunities for people to access the beach and utilize park amenities

The project is identified as a high priority restoration project in the watershed’s Salmon Habitat Plan (Green/Duwamish and Central Puget Sound Watershed WRIA 9 Steering Committee 2005). The project’s restoration objectives are closely aligned with each of the following regional restoration objectives from the WRIA 9 Salmon Habitat Plan:

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

The restoration-focused subset of project’s objectives is well aligned with available restoration grants focusing on Chinook salmon recovery and overall Puget Sound ecosystem recovery. These are competitive funding sources; therefore, it is important that all of the objectives are achieved. The types of projects that tend to fare the best in the grant application review are those that maximize the restoration opportunity within the constraints of a site. Therefore, the greater the degree to which the objectives are achieved, then the greater is the likelihood of being awarded funding. With this in mind, the alternatives were developed to identify a fundable project, and where two options for a specific project element were available, the option that best improved natural processes or habitats was selected.

3 EXISTING CONDITIONS

The development and evaluation of restoration alternatives were informed by the compilation and/or collection of data on several relevant topics affecting the restoration feasibility and design. New data were collected on sediment transport capacity in McSorley Creek, coastal processes, geology, and cultural resources. The findings are summarized below and the full reports are provided as appendices.

3.1 Fish Resources

McSorley Creek is a salmon-bearing stream that flows approximately 1 mile through the park before draining into Puget Sound. The creek supports some spawning by coho and chum
salmon as well as cutthroat trout. Juvenile salmon from other river systems, notably including the Endangered Species Act listed Chinook salmon, utilize the park’s available shoreline habitats. A juvenile salmon study approximately 3 miles north documented Chinook, coho, chum, and sockeye salmon, and cutthroat trout using Puget Sound shoreline beach habitats (Brennan et al. 2004).

Surf smelt and Pacific sand lance are two forage fish species known to spawn in fine-grained substrates in the upper intertidal zone. Surf smelt tend to spawn on slightly coarser substrates than sand lance, but suitably sized spawning substrate for both species is provided at the preferred elevations along the park beach south of McSorley Creek. Surf smelt and sand lance spawning information is included in Appendix A. Surf smelt spawning has been documented on the park beach south of the creek in both 2016 (Gregersen unpublished data 2016) and 1995 (WDFW 2016). Surf smelt and sand lance spawning was observed immediately south of the park in 2006 (WDFW 2016).

The remainder of the park’s shoreline currently does not provide suitable conditions for viable forage fish spawning. The creek delta area is too coarse and generally lower in tidal elevation than surf smelt or sand lance are known to spawn. North of the creek, there are narrow patches of suitably sized substrate; however, these patches are lower in elevation than where the fish spawn and the substrates are too highly mobile in front of the shoreline armoring to support egg incubation.

3.2 McSorley Creek and Estuary

Sediment transport conditions in McSorley Creek were described in a technical memo provided in Appendix B. The following is a summary of findings related to sediment transport processes.

The McSorley Creek drainage basin receives runoff from a mostly developed landscape within incorporated Cities of Des Moines, Federal Way, and Kent, Washington. Based on the USGS StreamStat analysis of McSorley Creek (USGS 2015) the total drainage basin area is 2.96 square miles. King County GIS mapping shows that the headwaters of McSorley Creek originate near South 272nd Street and State Route 509 (Pacific Highway South) in Federal Way. From the headwaters, the stream flows through a forested wetland complex and then in an open channel through a forested ravine approximately 2.25 stream miles to its mouth, in the park.

Based on information in the park’s construction drawings, the lowermost reach of the creek was rerouted in 1952. The stream was rerouted by excavating a portion of the bluff to the north. McSorley Creek was moved into a constructed channel approximately 175 feet north of its natural location, in the previous location of the excavated bluff. The creek was straightened and confined with extensive streambank armoring all the way to the mouth.

Review of stream gage information shows that a USGS stream gage existed on McSorley Creek from 1986 to 1988. Measured daily flows during this time period ranged from 0.16 cubic feet per second (cfs) to 65 cfs. USGS StreamStats analysis of the McSorley system estimates that flows would be 60.7 cfs for the 2-year peak and 108 cfs for the 10-year peak.
The channelized conditions in the lower creek result in creek sediment being transported into Puget Sound just beyond the armored creek mouth. Restoration of the creek and estuary will alleviate the confinement posed by existing modifications and give the creek and estuary more room to function naturally. In doing so, sediment will be deposited in the lower creek and estuary as occurs in natural systems. This will re-establish a more dynamic area where, over time, the stream channel can be expected to shift (meander) within the available space. The larger the estuary, the more capacity there will be for long-term sediment deposition and scour in the footprint of the restoration area. The size of the estuary needs to be large enough to accommodate episodic deposition at a scale that matches the sediment load. The geomorphic analysis included in Appendix B provides a basic analysis of sediment transport capacity, which equates to an upper limit of the sediment load. Additional sediment source investigation work is needed to develop a more precise estimate of actual sediment load rather than relying on an estimate based on transport capacity alone. In the absence of additional analysis, the risk of lost habitat function resulting from sediment deposition can be mitigated by including the largest possible area to establish more capacity for sediment accumulation.

3.3 Coastal Processes

Coastal processes were detailed in a technical memo provided in Appendix A. The following is a summary of findings related to existing coastal processes.

3.3.1 Park Background

As described above, a portion of the bluff located north of McSorley Creek was excavated in 1952 to allow relocation of the creek. Excavated bluff material was used as fill behind new shoreline armoring (labeled “revetment” in Figure 3) in order to move the shoreline seaward approximately 180 feet at the new creek mouth. This work significantly modified natural coastal processes in the park area. The presence of the shoreline armoring extending well into the intertidal zone precludes the ability of the beach fronting the shoreline armoring to build a natural beach profile based on the natural beach slope, as is seen on the accreting beach at the south side of the park. The beach to the south has a fully developed profile which includes a beach berm just above Mean Higher High Water (MHHW) and is sloped approximately 8H:1V.

3.3.2 Site Environmental Conditions

The site is relatively exposed to wave energy from the north due to long fetch\(^1\) and shoreline orientation, and wave energy should be factored into the design of restoration concepts. Though smaller in fetch length, and therefore less capable to generate larger waves, the predominant wind and wave direction is from the south. Based on a field assessment and engineering analysis, it is estimated that the long-term sediment transport is directed northward at the project, consistent with the Washington Coastal Atlas findings. However, net northerly

\(^1\) Fetch is the length of water over which wave-generating wind blows. Assuming the same wind and geographic conditions, longer fetches will produce larger waves than shorter fetch distances.
drift appears weak and actual net drift direction may vary year-to-year due to variable meteorological conditions. Feeder bluffs exist to the north and south offsite of the park.

McSorley Creek is also a sediment source, indicated by its dynamic delta, which migrated with the creek relocation in 1952. The bluffs located in the park are not active as feeder bluffs due to the presence of the shoreline armoring and fill, which disconnect the erosion processes. A summary of these sediment sources is shown in Figure 4. The existing shoreline area south of the creek has accreted seaward approximately 70 feet since the 1952 construction due to net south-to-north littoral drift and the effect of the rock groin, which forces the retention of sediment. If the current extent of the groin remains in place, the beach will continue to accrete and advance seaward. Reduction of the seaward extent of the groin (partial or full removal) may result in landward-directed adjustment to the beach (erosion) within the area south of the creek mouth. Any new groin or similar features will need to be built to such an extent to maintain the existing beach profile.

Subsequent project phases must take into consideration the potential effects of groin and creek mouth modifications on both updrift and downdrift shorelines, as well as the McSorley Creek estuary. If it is deemed necessary to protect versus move infrastructure at the top of the bluff, then bluff toe protection should be provided in areas where protection of infrastructure is required by project criteria. As shown in Figure 4, should the beach fill be removed, it’s likely a sediment sink (meaning, more sediment is leaving than entering) would occur for natural beach rebuild, reducing the net north-directed sediment drift rate during that rebuilding period. Reducing the net rate to the north could cause beach erosion to the north for a period of time until the project site beach reaches a new equilibrium for longshore sediment processes.
3.3.3 Material Reuse

The potential use of the existing fill in the beach restoration was preliminarily considered and will be further evaluated during design. Maximizing the reuse of fill materials in the design, as appropriate, will minimize offsite disposal costs and new materials costs, which would all be considerable. Although fill materials are from the bluff and would have naturally helped form a beach over time, the fill materials differ from existing beach sediments due to the natural sorting process of the beach sediments by waves and currents. Based upon the grain size analysis conducted (Appendix C) the fill materials contain a significantly larger percentage of fine sediment than the beach as the fill material typically has a mean grain size of less than 1mm. Material with a high percentage of fine sediments will be more highly mobile than larger sediments. If a large mass of fill material were left on the beach as the primary beach face sediment, the high percentage of fine material would likely result in a beach that would not be usable for recreation or fish habitat purposes for potentially several years, as the sediments were sorted. This is because a potentially large volume of the fine material would be transported away which could result in beach scarps that can be difficult to walk across. The loss of a potential large volume of beach face material would also impact the sustainability of the design and increase the potential need for future maintenance to add material. The loss of fine material along the beach face would also likely increase turbidity in the nearshore area. A cost-benefit analysis will be conducted to help inform decisions about the reuse of fill material.

Fill materials may also be suitable for reuse in the uplands to raise grades in park areas currently vulnerable to flooding and sea level rise, in accordance with the geotechnical recommendations by Shannon & Wilson (2015) (Appendix C). Select rocks from the shoreline...
Armoring may be suitable for reuse in toe stabilization features. Rock may also be used for subtidal habitat features for rockfish and recreational divers; if the rock were used for these reasons, the features would be designed so as to not impact shoreline processes or nearshore fish activity, including juvenile salmonids.

### 3.3.4 Sea Level Rise Analysis

Large portions of the project area are vulnerable to flooding during high-water events such as king tides and peak creek flows. Figure 5 shows the high water level experienced at the mouth of McSorley Creek during a recent king tide. State Parks has indicated that a portion of the parking lot and Snack Shack occasionally floods. Projected SLR associated with climate change would be expected to increase flooding in the low lying areas of the park. To evaluate the areas susceptible to flooding with SLR, three potential scenarios were evaluated relative to existing king tide conditions. Figure 6 shows the estimated inundation areas relative to sea level rise increases of 1, 3, and 5 feet.

![Picture of stream bunk armoring](image)

**Figure 5.** Water Level Near Top of Streambank Armoring at Mouth of McSorley Creek during King Tide  
*(photo credit: Kollin Higgins)*
Figure 6. Sea Level Rise Analysis Showing Potential Inundation Areas with 1, 3, or 5 Feet of Sea Level Rise
3.4 Coastal Geology

Coastal geology was detailed in a technical memo provided in Appendix C. The following is a summary of findings related to existing coastal geology.

The exposed soils in the bluffs to the north of Saltwater State Park are assumed to be representative of those in the bluff at the park. These glacially derived strata were deposited prior to and during the last glacial episode to reach the central Puget Lowland. The geologic units discussed herein are documented on the geologic map of the Poverty Bay Quadrangle (Booth et al. 2004). Except for the beach sediments and artificial fill at the park, all of sediments have been overridden by about 3,000 feet of ice at least once.

The lowest and oldest geologic unit is pre-Olympia Coarse Grain Deposits (Qpogc), composed of interbedded layers of sand and gravel, but containing scattered fine-grain lenses. This unit makes up the lower part of the sea bluff, standing nearly vertically. Water is typically perched on top of this layer in Puget Lowland bluffs, but none was observed during our reconnaissance in the park or on the exposed bluffs to the north of the park.

The geologic map indicates that Vashon Advance Outwash (Qva) overlies Qpogc on the park bluff. This is corroborated by the presence of madrone trees that have an affinity to free-draining glacial soils, and the nature of the soil in the landslide deposit on the beach to the north of the park. The Qva unit is composed of relatively clean sand and gravel.

The upper geologic unit at the site is Vashon Till (Qvt), as shown on the geologic map. This is confirmed by the large blocks of till on the beach at the toe of the recent landslide on private property to the north of the park. Till is a mixture of sand and silt, with varying amounts of gravel. It is very dense and, where unweathered, has a relatively low permeability.

A steep (near-vertical) bluff forms the coastal slope from Zenith Bluff, about 1.5 miles to the north, southward to Saltwater State Park, as shown in Figure 7. In this zone, the lower 30 to 50 feet of the bluff is bare, owing to continual wave attack from the southwest. Because the soils in the bluff are very dense, the bluff stays near-vertical, and regresses slowly. The bare lower bluff continues southward to the northern edge of the state park. On the slope within the park, the inclination is about 45 to 50 degrees. It does not have the lower vertical bluff that is typical to the north. The City of Des Moines has classified this slope, including the park and private properties to the north, as a geologically hazardous area for landslides and erosion. The Washington State Coastal Zone Atlas categorizes the bluff as unstable (Ecology 2014).

The bluff in the park shows signs of past shallow instability based on the accumulation of landslide debris at the toe of the slope in three places. One of these accumulated debris locations is shown in Figure 8. Additionally, the natural tree cover on the slope is locally missing or deciduous in an otherwise coniferous forest. No signs of active instability were observed on the bluff in the park during the reconnaissance for this study.
Figure 7. Near-Vertical Bluff to North of Saltwater State Park

Figure 8. Debris at Toe of Steep Slope
To the north of the park, instability has occurred on private properties (Figure 9). A review of Google Earth photographs indicates that a landslide occurred on the upper part of the bluff between the summers of 2010 and 2011 on the property adjoining the northern park line. More recently, a landslide occurred on the same property and extended northward on March 20, 2015. The total width of the recent landslide is about 280 feet. All of the mobile soil was from the upper bluff. The lower bluff stayed intact, and the moving upper bluff soil and debris cascaded over it and onto the beach.

![Figure 9. March 2015 Landslide North of Saltwater State Park. Lower bluff undisturbed; landslide debris on beach is from upper bluff.](image)

### 3.5 Cultural Resources

Archaeological and Built Environment cultural resources were detailed in a memo provided as Appendix D. The following is a summary of findings related to archaeological and cultural resources. In addition, Appendix E details the relocation and construction costs associated with moving the historic structures located on top of the bluff. Additional information on next steps for approval for modifying or moving cultural resources is detailed in Section 7.

Saltwater State Park was dedicated on August 20, 1933. In 1934 and 1935, the Civilian Conservation Corps (CCC) built Camp Saltwater at the site, which included buildings, two fire pits, shelters, trails, a sea wall, and drinking fountains. Many of these features are still extant. Also in 1934, Saltwater State Park Bridge (King County Bridge No. 3139) was constructed to span McSorley Creek. The bridge was determined eligible for listing in the National Register of
Historic Places (NRHP) in 2014. Additional buildings and structures were constructed in the 1960s by Parks, and some CCC features were modified or removed during this time.

Saltwater State Park maintains the previously documented archaeological site 45KI436 located in the south portion of the park. Site 45KI436 is recorded as a pre-contact and ethnohistoric shell midden (Solimano 1994, Smith 2009, Wilson 2010). Recent archaeological investigations at 45KI436, which were associated with the 2009 installation of a bio-retention system in the park, expanded the site’s original boundary and reported that no intact shell midden deposits were located within their project area (Smith 2009). At that time, it was recommended that the portion of site 45KI436 within the bio-retention system was not eligible for listing in the NRHP due to the prior disturbances to the shell midden from previous construction activities in the park (Smith 2009).

Archaeological sampling was conducted in eight test pits distributed throughout the project area. Shell material was found in all six of the eight test pits, but none was found to be in association with a cultural midden or have indicators of a cultural midden such as organically-stained sediment, fire-modified rock, lithics, and/or bone.

In one test pit located near the historic creek alignment and another test pit near the beach berm in front of the existing Snack Shack, historic period archaeological resources were identified. These historic-period resources included: (1) two buried saw-cut poles assumed to be remnants of an abandoned revetment used to manage the former course of McSorley Creek, and (2) a thick steel wire rope with a large bent piece of steel in the shape of a hook, approximately 1.5 feet in length.

Additional research, field investigation, and reporting of historic resources will be conducted in 2016 to inform restoration design activities.

4 ALTERNATIVES DEVELOPMENT

4.1 Alternatives Development Process

Restoration alternatives were developed to address the project goal and objectives described in Section 2.1. Initial concepts were developed by the consultant team following the completion of the site assessment work. King County and Washington State Parks provided input during a work session in November 2015, as well as several additional follow-up discussions. Two action alternatives and one no action alternative were developed and evaluated in this feasibility study. The restoration concept is identical for both action alternatives, except for the treatment of the bluff toe at the north extent of the park shoreline.

Action alternatives were developed to restore the McSorley Creek estuary and reduce the amount of fill and armoring in order to reconnect the feeder bluffs at the park to serve as sediment sources, provide habitat, and encourage natural beach formation. The action alternatives were also developed to improve the park’s functionality for visitors and reduce maintenance needs for State Parks by improving the sustainability of park amenities and
natural features. A third factor in the development of action alternatives was the preservation of historic and cultural features, notably the CCC park buildings and fire rings.

4.2 Description of Alternatives

4.2.1 No Action Alternative

The No Action alternative consists of the existing conditions shown in Figure 1. This alternative entails continuing regular maintenance responsibilities, as well as performing more substantial–and more costly–maintenance of many structures in the park that are aging. Of particular note for upcoming significant maintenance is the shoreline armoring north of McSorley Creek. Based on the field assessment (Appendix C), the shoreline armoring along approximately 50% of the shoreline length is showing signs of fracturing and erosion which appears to have led to wave over-topping to flood portions of the lawn and trail (Figure 10). Figure 11 shows wood deposited on top of shoreline armoring following high water events. Figure 11 also shows large rocks scattered across the beach as the shoreline armoring has been redistributed by wave energy. These conditions appear to be worst at the north end of the park.

Figure 10. Shoreline Armoring Overtopping and Evidence of Erosion During King Tide
(photo credit: Kollin Higgins)
Along the disconnected feeder bluff (i.e., the bluff that is landward of the shoreline armoring and fill) it is likely that the slope will continue to incur shallow landslides due to wet winters exacerbated by intense storms, as has been observed in recent decades. Any soil and woody debris (trees) that slide from the bluff will be deposited on the lawn areas in front of the bluff and could potentially damage or destroy some of the facilities there.

One of the buildings at the top of the bluff is very close to the edge (approximately 20 feet away) which makes it vulnerable in the event of a landslide. However, if recent decades are an indication of the future, then it is unlikely that Parks buildings at the top of the slope will be negatively impacted. If climate change results in increased precipitation and more storm events in the central Puget Lowland, potentially increasing landslide hazards, then the buildings at the top of the bluff could be at increased risk.

Figure 11. Wood Accumulation on top of Shoreline Armoring and Evidence of Armor Scattering across the Low Intertidal
(photo credit: Karen Bergeron)
Based on anecdotal information provided by Parks, the snack shack on site currently floods on an annual basis during king tide events. As shown in the SLR assessment (see Figure 6 and Appendix A), the No Action alternative would experience more frequent flooding and across a larger portion of the park with the projected SLR.

Under the No Action alternative, no improvements for salmonid or forage fish habitat would be made. The feeder bluff would remain disconnected from the nearshore. The creek would remain channelized and provide low quality habitat for juvenile Chinook. Additionally, the groin in place at the mouth of the creek will continue to retain sediment moving northward from the south, and the beach in front of the park and southward will continue to increase over time as more sediment accumulates.

4.2.2 Action Alternatives

The two action alternatives include identical treatment of the McSorley Creek estuary and the park areas south of the creek mouth. The action alternatives differ in the restoration treatments north of the restored estuary. The two action alternatives are named the Partial Bluff Reconnection Alternative and the Full Bluff Reconnection Alternative based on each alternative’s restoration treatment along the shoreline north of the restored estuary.

The action alternatives are intended to mimic potential environmental conditions, while allowing for natural adjustment. Natural adjustment could include beach face and crest retreating towards the bluff due to stream migration, which was considered during concept development.

This section is organized to first introduce restoration elements common to both action alternatives and then present the unique restoration elements of each action alternative. Following the introduction of the alternatives is a section describing a nearshore sediment transport analysis conducted to inform the conceptual features included in the alternatives.

Elements Common to Both Action Alternatives

The action alternatives differ in their treatment of the Puget Sound shoreline armoring and fill on the northern boundary of the park, but for the rest of the project area, the same restoration elements are included in both alternatives. Design features for both alternatives include:

- Widening of the creek bed and reconstruction of an estuary to provide salmon habitat
- Significant restoration of the beach to natural slopes, substrates, and location
- A newly constructed restroom, snack shack, and playground to improve the function and sustainability of park amenities
- Buried shoreline armoring as a last defense for shoreline change in key areas
- Modification of existing groin or replacement with 1-2 drift sills to reduce size of structure(s) while still retaining the beach profile on the south side of the project
- Change in parking layout to maintain parking spaces, changes in pedestrian beach access pattern, and a new pedestrian bridge
- Relocation of several CCC-era structures, including fire pits
The following sections go into greater detail on each of the common elements.

**McSorley Creek Widening, Estuary Construction, and Beach Restoration**

In the figures presenting the action alternatives, the proposed restored estuary concept (hereafter called “restored estuary”) is shown during low tide conditions to show as much of the project features as possible. For simplicity, the channel is shown as a single channel, but it will naturally form multiple shifting channels across the low gradient, finer grained substrates that will be present at the estuary mouth. At higher tide stages, water levels will increase and the estuary will be more fully inundated.

The size of the restored estuary can be expanded as space allows. As shown, the restored estuary is approximately 300 feet long by 150 feet wide, which is estimated as the minimum size needed to achieve the restoration objective. If space allows based on decisions about park recreational areas, then increasing the estuary size would provide additional estuarine habitat and increase the certainty of the estuary functioning naturally.

Figure 12 depicts the direction and conceptual magnitude of erosional forces on the beach and estuary. The proposed concept is intended to reduce future maintenance needs by installing extra measures to extend the longevity of the design. To minimize the possibility that high stream flows and/or exceptionally high wave energy would cause the estuary to move from the

![Figure 12. Potential Erosional Forces on the Beach and in the Estuary](image-url)
designed estuary footprint into other park areas, some bank protection is expected to be needed. The type of stabilization is yet to be determined, but soft-shore armoring such as large wood structures would be used to the extent possible rather than rock (riprap). However, some locations may still require rock; specific locations that may require rock include: (1) where the creek is rerouted from its current alignment and the new pedestrian bridge is located, and (2) to protect a new restroom building if constructed on the fill pad north of the creek (see below).

The shoreline area on the north side of the restored estuary is expected to be depositional (that is, have sediments deposit and accumulate over time) as creek sediments encounter typically lower energy as the stream corridor widens and as the modified groin forming the south side of the estuary mouth shields the area from wave energy from the southwest. Anticipating this deposition, the conceptual alternatives include keeping a small footprint of the fill material in this area (see “Fill Pad” in Figure 12). Keeping this footprint of fill material reduces the likelihood of excavating material from an area that will naturally accumulate sediment. This strategy could allow for park amenities like a restroom and an Americans with Disabilities Act (ADA) compliant trail north of the restored estuary.

A strong preference of State Parks is to have the beach ready for recreational use and habitat immediately following beach restoration, while also encouraging natural processes to be restored. In order to provide immediate recreational access to the newly constructed features, the action alternatives are intended to “jump start” the beach front as opposed to waiting several years for sediments to accrete enough to form the beach. Bluff material that was placed on top of the natural beach has been considered for immediate re-use for beach face material. Based on the grain size analysis (Appendix C), the fill material contains a significant portion of fines (e.g., silt), which if re-used as beach face material, would likely not result in a satisfactorily usable recreational beach or fish habitat until sorting caused by wave action had moved the fines offshore. However, given the volume of material that would need to be sorted if the restoration used fill material as the beach face material, the necessary sorting to make it a fully usable and functioning beach could take up to several years. Therefore, as discussed in Section 3.3.3, not all the fill may be suitable for re-use for the new beach, and new material may need to be introduced.

When the fill material was placed in the 1950s, it buried native beach material. Natural beach sediment buried beneath the bluff material fill is not planned to be excavated. Once the fill material is removed as part of the restoration, the native beach material would serve as a base for placement of a new beach material layer. The profile of the native beach material does not necessarily reflect the profile that the beach will naturally shape to once natural processes act on the restored areas. It is proposed that additional beach substrate is placed to provide enough beach material to allow the natural processes to reshape the beach while maintaining the ecological and recreational function of the beach in the park. The design of additional beach material placement would allow for natural beach formation, as well as the transport of sediment offshore or alongshore. Based on observed wave climate and grain size analysis of beach profiles on site, the new beach material would likely be a gravel/sand or sandy gravel type material with median grain size diameter likely between 0.15 and 0.5 inch. In subsequent design phases, once the preferred alternative is selected, refinement of the gradation will be required.
The new beach would be created to mimic natural slopes, elevations, and substrate sizes, including the placement of suitably sized beach substrates. The concept behind this engineered beach is to reach equilibrium faster than a purely natural recovery scenario. The placement of new beach material is intended to facilitate and allow for environmental forces (e.g., waves, currents) to shape the beach to natural conditions, while reducing the risk of sediment recruitment that would cause a temporary deficit at beaches to the north. Installation of advance maintenance features (such as buried cobbles and revetment) is intended to limit future maintenance needs.

Sediment transport, discussed further below, is one of the nearshore processes being restored and necessitates planning for it during design. With this in mind, it is prudent to develop designs that have more sediment in the profile than is expected to be needed rather than too little. The risk with having too little sediment is that the restored beach can act as a sediment “sink,” which acts to reduce the net sediment drift rate to downdrift areas. This sink effect would continue until the restoration area reaches an equilibrium state in which sediment would be transported unimpeded through the site and into downdrift habitats. To avoid or minimize the risk of a sediment sink, the beach should be restored to mimic the expected beach profile and provide enough material to naturally redistribute across the beach. Therefore, both action alternatives include “sacrificial” sediment berms or beach areas that will be designed to avoid a sink and accelerate the establishment of a naturally dynamic beach environment.

**Newly Constructed Restroom/Snack Shack/Playground, and Buried Armoring**

The conceptual design for the action alternatives shows a new restroom on the fill pad on the shoreline north of the restored estuary. To protect the restroom building from potential erosion associated with episodic storms, it is proposed that rock armoring (riprap) and cobbles be buried in a small footprint around the restroom to form a last line of defense. Buried cobbles would be placed waterward of the buried armor rock so the cobbles would be exposed first and provide some protection against erosion before the armor rock would be exposed. The intent would be to avoid the armor rock being exposed, but in the case that conditions differ from what is expected, the armor would protect the restroom building from erosion due to creek migration or wave attack. Additional stabilization measures using large wood and vegetation may be proposed on the design surface to prevent exposure of the buried features while also supporting better ecological function in that area.

In addition to protecting the restroom from wave erosion, there is also a risk of damage to the restroom (or any other structures in this area) due to landslides. There is a maximum width of approximately 50 feet between the toe of the slope and the proposed outer extent of the upland area to remain on the shoreline north of the restored estuary. Since there is some potential for slides to occur that deliver sediment and fallen trees across this entire 50-foot width, a restroom placed in this area has an inherent risk of being damaged in a slide. The farther the restroom is located from the toe of the bluff, the less likely it is to be damaged by a slide. Design features such as a barrier wall between the restroom and the bluff would increase protection and reduce damage from a slide.
An alternate location for a restroom north of the restored estuary is near the pedestrian bridge. This location would avoid the need for the buried rock armoring described above for the shoreline location. Instead, this restroom location would be protected by the same stabilization measures used for the pedestrian bridge.

Other park amenities such as the snack shack and the playground are aging structures that will be replaced in the park design. These new amenities will be located in areas less prone to flooding while still convenient for park visitors.

**Groin or Sills South of Creek**

The groin that currently exists south of the creek mouth retains northward-directed sediment. Over the years, this retention has resulted in sediment deposition south of the groin and a widening of the beach profile in the park as well as for adjacent property owners several hundred feet to the south. Based on residential development that has occurred close to the shoreline in these nearby parcels, the alternatives were developed to continue to support a beach of similar width in the future. This is accomplished by continuing to have a hard structure across the beach that retains sediment moving from south to north. Two types of engineered structures were identified. One type of structure is a groin, which is the structure currently in place. Further analysis during design could inform how long and how tall (crest height) a new groin would need to be to retain the beach width. The groin would maintain the updrift beach profile and also protect the existing beach from erosion due to creek meandering. The toe of the groin on the creek side would be protected by buried and exposed cobble material. The figures depicting the action alternatives include a modified groin.

The second type of structure that could be used to retain sediments and preserve the width of the beach is a sill. Sills are similar to groins but smaller and shorter. Sills consist of rock installed at and below the beach profile grade to maintain the beach profile and allow some sediment to bypass the structure. Sills typically retain less sediment than a groin because they are built at the beach elevation that is desired to be maintained and the sills are not impermeable to sand movement through them. Figure 13 shows an example of a sill. This example is a sill soon after construction in Seahurst Park in Burien, WA. The photo shows finer grained material retained on the far side (downdrift side) of the sill consisting of rock and cobbles to the near side.

Because sills do not retain as much sediment as groins, two sills would be recommended to provide satisfactory certainty that the beach width south of the park would be maintained. One sill would be installed at or near the southern property boundary. The second sill location would be at the location of the existing groin or could be constructed farther south if a larger estuary than shown in the action alternatives is preferred.

The size of the sills will be determined during preliminary design. Seaward extent of the sill must be at a minimum to the break in slope of the beach. If the seaward extent of the sill does not extend to the break in slope, the beach would likely migrate landward, and the poor transition between features would risk structural failure of the terminus of the sill due to scour effects. The height of the sill would be to the existing beach grade.
The restored estuary would require changes to the parking lot and recreational areas in the south end of the park. Figure 14 shows the concept for a revised parking area. The concept was developed to provide at least the same number of parking spots as currently exist. The action alternatives impact 41 parking spaces, including 4 ADA-accessible spaces, and the concept provides 34 parking spaces, including 4 ADA-accessible spaces. There are additional opportunities to provide the remaining 7 or more parking spaces through re-striping the existing spots as well as changes in the proposed square footage of the proposed parking design. These additional opportunities are dependent on feedback from State Parks and would be further analyzed during design. The concept also provides a traffic circle near the beach to provide a drop-off/loading areas for recreational gear (e.g., for scuba diving, kayaking) and park users. The turn-around also provides the necessary turning radius for emergency vehicles. The concept includes preliminary ideas on relocating park amenities affected by the restoration along the shoreline, including the two historic CCC-era fire pits.

Pedestrian access will be provided to the park shoreline areas north of the restored estuary by a new pedestrian bridge.
Figure 14. Conceptual Alignment of Parking Lot
**Historic Structure Relocation**

The proposed project would require relocating several NRHP-eligible structures, including the stone fire pit circles (c. 1935), the day use area fireplace (c. 1934), the day use comfort station 7 (c. 1934), and the Saltwater State Park foot bridge. Moving historic resources is generally considered a last resort to avoiding or minimizing an adverse effect. However, resources have been successfully relocated if moved by experienced contractors per the Secretary of Interior standards (please see Section 7 for more details regarding the process for moving NHRP-eligible structures).

Moving the fire pits would affect the resources’ integrity of location. However, the setting would be essentially the same, and no other aspects of integrity would be affected assuming strict adherence to the Secretary of Interior’s standards. All steps would be taken to evaluate potential effects to historic properties in compliance with Section 106 of the National Historic Preservation Act.

**Partial Bluff Reconnection Alternative**

This section describes the restoration elements included in the Partial Bluff Reconnection alternative (hereafter referred to as “Partial Bluff” alternative) for those areas north of the proposed McSorley Creek estuary restoration detailed above in the section describing restoration elements common to both action alternatives. This alternative entails reconnecting a portion of the feeder bluff north of the restored estuary, but retaining shoreline armoring at the northern-most part of the shoreline in front of the historic park buildings located at the top of the bluff (Figure 15). The reconnected portion would be an approximately 300 feet long between the existing fill area shown in Figure 15 and the southern extent of the shoreline armoring kept in place to protect the top of bluff buildings. In this portion of the shoreline, the feeder bluff would be reconnected by removing the shoreline armoring and fill material.

In this alternative, shoreline stabilization will be retained along the northernmost 300 to 400 feet of the park shoreline. The precise extent will be determined through analysis during design. Two engineering approaches were considered to maintain the stability of the lower bluff by preventing bluff toe erosion from waves (Figure 16). One approach was to fully remove the shoreline armoring and fill and install a new stabilization structure at the toe of the bluff. The materials and configuration of the bluff toe stabilization structure will be determined in design. The second approach was to retain a portion of the existing shoreline armoring and fill, taper it back into the reconnected portion of the feeder bluff, and replace the older, compromised materials with new materials.
Figure 15. Partial Bluff Reconnection Alternative
Figure 16. Two Shoreline Stabilization Approaches for Protecting Parks Buildings at Top of Bluff
The two approaches to maintaining existing levels of shoreline stabilization to protect Parks buildings at the top of the bluff were evaluated to identify the benefits and drawbacks. These benefits and drawbacks are described in Table 1.

The target material for the toe stabilization feature is soft-shore armoring such as large wood, but is subject to additional analysis. The stabilization feature would be partially or fully buried at the toe of the slope. It would be designed to preclude wave action from causing erosion of the bluff toe. Top elevation of the toe protection would be designed in a later phase of the project and would consider storm waves, tides, SLR, and the proposed beach profile. The toe

Table 1. Summary of Benefits and Risks of Bluff Protection Techniques Considered

<table>
<thead>
<tr>
<th>Technique</th>
<th>Benefits</th>
<th>Risks/Drawbacks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Install New Bluff Toe Stabilization Structure</td>
<td>• Provides comparable bluff toe stability as existing conditions</td>
<td>• May have perceived impact on neighboring properties due to a change in bluff toe protection type</td>
</tr>
<tr>
<td></td>
<td>• Removes impediments to sediment transport along the beach</td>
<td>• Though likely better for bluff toe conditions on neighboring properties, the end effects are less predictable than existing conditions</td>
</tr>
<tr>
<td></td>
<td>• Increases aquatic habitat, including forage fish spawning habitat</td>
<td>• Requires placement of beach material to balance short-term sediment budget</td>
</tr>
<tr>
<td></td>
<td>• Restores natural shoreline shape</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Allows slide material from upper bluff to reach beach (although the geologic analysis indicates little input from the upper bluff in recent decades)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Long-term sediment budget rate similar to existing conditions</td>
<td></td>
</tr>
<tr>
<td>Retain a Portion of Existing Shoreline Armoring</td>
<td>• Provides comparable bluff toe stability as existing conditions</td>
<td>• Requires construction of additional protection to tie the remaining shoreline armoring to the toe of slope (to prevent head-cutting or erosion behind shoreline armoring)</td>
</tr>
<tr>
<td></td>
<td>• Most similar to existing boundary conditions</td>
<td>• Requires placement of beach material to balance short-term sediment budget</td>
</tr>
<tr>
<td></td>
<td>• Lowest perceived impact to park structures and neighboring land</td>
<td>• Retain impediments to sediment transport along the beach caused by fill and shoreline armoring extending into the intertidal zone</td>
</tr>
<tr>
<td></td>
<td>• Most predictable end effects at park boundary</td>
<td>• Does not allow slide material from upper bluff to reach beach (although the geologic analysis indicates little input from the upper bluff in recent decades)</td>
</tr>
<tr>
<td></td>
<td>• May retain upland picnic area</td>
<td>• Long-term sediment budget rate may be less than the toe stabilization structure</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Retains shoreline armoring and fill in northern portion of park found to have greatest maintenance need for shoreline armoring due to rock fracturing and erosion</td>
</tr>
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</table>
stabilization feature would be designed to preclude failure due to scour at its toe or lowering of the beach (to a level to be determined in a later design phase). A berm of fish-mix type material would be placed on the upper beach as a sediment source to allow the site environmental forces to naturally re-shape the beach, while also minimizing the downdrift impact on sediment budget. The berm is considered sacrificial because some of its material is expected and intended to be transported away from natural wave action over a relatively short period of time as material is redistributed on the beach face.

“End effects” is a term referring to how wave action diffracting around the edges of shoreline armoring structures can increase erosion at the ends of the structures. The end effects associated with the bluff toe stabilization structure are less predictable than maintaining a portion of the existing shoreline armoring. As depicted in Figure 16, the stabilization approach of retaining a portion of the existing shoreline armoring and fill includes the installation of an engineered sacrificial feeder beach located immediately adjacent to the south. This design feature would provide additional material to be redistributed through wave action. As described above for the sacrificial berm, the feeder beach material is also considered sacrificial because it will be redistributed over time as wave energy processes act on it. End effects are discussed in more detail in the Nearshore Sediment Transport Analysis section.

With either approach to maintaining bluff toe stability, the bluff slope conditions and potential for impacts to the Parks buildings are the same as in the No Action alternative. That is, the slope would continue to incur shallow instability due to wet winters exacerbated by intense storms. The soil and woody debris would be deposited on the fill bench. It is unlikely that the Parks buildings at the top of the slope would be negatively impacted over the next several decades if the past several decades are an indication of the future. However, if climate change results in increased precipitation and storms in the central Puget Lowland, potentially increasing landslide hazards, then the buildings at the top of the bluff could be at increased risk.

In the middle portion of the shoreline where the feeder bluff would be reconnected, waves would directly act on the toe of the slope. Over time, the bluff would revert to a slope similar to that presently found in areas north of the park; that is, a near-vertical slope for the lower 30 to 50 feet of the bluff and a less steep upper bluff. There would likely be a sharp increase in wood and sediment delivery to the beach over the next several decades as natural processes re-equilibrate on the site. The delivery of material can be expected to occur in discrete 10- to 30-foot-wide slope failures from colluvial soils that cover the hard/very dense soils on the lower slope. This process would deliver desired materials to the beach.

As described above and in Table 1, both stabilization approaches have benefits and drawbacks to be considered in selecting the approach to use in the design. Importantly, either stabilization structure approach is feasible because both provide comparable bluff toe stability as existing conditions. The Partial Bluff alternative used in the figures and analysis depicts the bluff toe stabilization structure because it offers more ecological benefits by more fully restoring sediment transport processes and it better achieves the restoration objective of increasing forage fish spawning habitat.
Full Bluff Reconnection Alternative

This section describes the restoration elements included in the Full Bluff Reconnection Alternative (“Full Bluff” alternative) for those areas north of the proposed McSorley Creek estuary restoration detailed above in the section describing restoration elements common to both action alternatives. In this alternative, all shoreline armoring and fill north of the restored estuary would be removed (Figure 17). This alternative removes all shoreline armoring north of the restored estuary, fully restores longshore drift along the beach, and fully reactivates the feeder bluffs north of the existing fill area shown in Figure 17. A sacrificial berm of suitably sized material (e.g., reused fill material or fish mix) would be placed on the beach, similar as to the Partial Bluff alternative. Exact extent and profile of the berm would be determined in design.

Because the feeder bluffs would be fully activated, the historic Parks buildings would need to be moved landward from their present location near the edge of the bluff (see Section 7 for more details regarding the process for relocating these buildings). Moving historic resources is generally considered a last resort to avoiding or minimizing an adverse effect. However, resources have been successfully relocated if moved by experienced contractors per the Secretary of Interior standards. Additional consultation with State Historic Preservation Officer and deeper archival research of historic photographs and CCC building plans and method would greatly contribute to the success of the project. The cost of moving each building is roughly estimated to be $20,000 to $40,000, although a specific quote from a qualified contractor has not yet been obtained. The cost is dependent upon the bracing required for each structure. Additional costs would be required to attach new utility connections, laying a new slab, and demolishing the old slab. The cost of relocating the fire pits is not included in this estimate.

Where the fill and seawall are completely removed, waves would directly act on the toe of the slope. Over time, the bluff would revert to a slope similar to that presently found in areas north of the park; that is, a near-vertical slope for the lower 30 to 50 feet of the bluff and a flatter upper bluff. A sharp increase in wood and sediment delivery to the beach would be likely over several decades as natural processes re-equilibrate on the site. The delivery of material can be expected to occur in discrete 10- to 30-foot-wide slope failures from colluvial soils covering the hard/very dense soils on the lower slope. This process would deliver desired materials to the beach.

Following the natural erosion of colluvium that now covers the in-place glacial soils on the lower slope, it is then likely that the upper bluff soils could be undermined, leading to instability on the upper bluff. However, the duration of stability is impossible to predict. Similar scenarios at Seahurst Park and Eagle Landing Park indicate that landslides at unprotected beach slopes can destabilize in as little as 10 years in a narrow colluvial event, but it is more likely the bluffs will maintain their stability for five or more decades if left undisturbed by human modifications such as altered drainage, vegetation removal, excavation, or placement of fill.
Figure 17. Full Bluff Reconnection Alternative
Nearshore Sediment Transport Analysis Used to Inform Conceptual Design of Action Alternatives

A sediment drift feasibility-level evaluation was conducted for the proposed restoration concepts of the action alternatives. Because the action alternatives have many similar features, this section will evaluate the features which apply to both action alternatives. The evaluation is divided into the following locations:

- Sediment drift analysis and consideration of end effects at northern extent of park
- Beach profile north of the restored estuary
- Beach profile south of the restored estuary
- Creek mouth and estuary

Sediment Drift Analysis and Consideration of End Effects at Northern Extent of Park

Potential effects that different treatments of the bluff toe may have on sediment drift for the action alternatives were evaluated through empirical analysis. The analysis was based on findings in the technical studies conducted for this project, project site coastal processes, and the proposed restoration layouts. Based on the level of exposure to waves and activation of the bluff (i.e., full reconnection and partial reconnection), effects on the northward-directed sediment budget were assessed qualitatively. For the Partial Bluff alternative, potential end effects were evaluated related to the shoreline stabilization structures to maintain bluff stability in front of the Parks buildings at the top of the bluff. The potential end effects of the alternatives were evaluated empirically relative to present understanding of sediment transport patterns at the edges of shoreline stabilization features (described in Komar 1998).

In the Full Bluff alternative, additional sediment would become available due to bluff erosion caused by waves acting on the toe of the bluff, resulting in localized slides; these slides, which carry sediment into the nearshore environment, represent the reactivation of the feeder bluff. A portion of this displaced sediment would be transported in the direction of net sediment transport (to the north), and feed the beaches to the north.

In the Partial Bluff alternative, shorelines to the north of the park would receive increased sediment volume due to bluff erosion at the park relative to existing conditions, but less than with the Full Bluff alternative.

The Partial Bluff alternative would prevent waves from hitting the toe of the bluff in front of the Parks buildings located on top of the bluff. The potential for erosion higher on the bluff will be unchanged from existing conditions.

The bluff toe stabilization structure places the structure at the toe of the bluff. This location could produce an end effect creating an area of increased erosion adjacent to the downdrift (northern) end of the shoreline armoring, which occurs in some wave and sediment supply situations and results in a zone of increased erosion adjacent to the downdrift end of the shore protection. An example of erosion due to end effect is shown in Figure 18. As shown in the
diagram, erosion around the end of the shore protection structure must be prevented. The design will need to include techniques to lessen the potential for end effect erosion.

\[ Figure \ 18. \ Potential \ Effects \ D ue \ to \ the \ Presence \ of \ Shoreline \ Stabilization \ Measures. \ Adapted \ from \ McDougal \ et \ al. \ 1987 \]

The stabilization approach that entails retaining a portion of the shoreline armoring and fill would impact longshore sediment transport. The shoreline armoring would act like a partial groin and retain some of the northward directed sediment transport. Northward directed sediment would bypass the structure in the zone seaward of the armoring remnant. A sacrificial sand berm placed on the beach to encourage sediment bypassing would provide a short term sediment source to compensate for the sediment trapping as the beach adjusts in response to nearshore processes. Local end effects due to the shoreline armoring would likely be similar to existing conditions since the area appears to have reached a new equilibrium, and the footprint of the shoreline armoring in this area would remain the same.

**Beach Profile North of the Restored Estuary**

To determine an appropriate beach profile for the areas north of the creek, a preliminary analysis was conducted by developing a cross-section using a reference slope. For the purposes of this analysis, the slope measured at the beach south of the creek was used. That slope was 9 feet horizontal for every 1 foot vertical (9H:1V). Although this location is not a true reference site because its slope is influenced by the groin, it provides a suitable guide for the preliminary calculations used in developing the action alternatives. In addition, the measured slope is within range of typical beach slopes (7 to 10H:1V) of Puget Sound shores with comparable level of exposure to wave energy.
Beach Profile South of the Restored Estuary

In a review of historic photos (Appendix B), it has been observed that the beach to the south of the groin feature is slowly accreting, and appears to be fed by the feeder bluffs located to the south of the park. The existing groin functions to keep the creek channel in place and also consequently retains sediment moving longshore from south to north. The estuary restoration removes the need for the existing groin to continue to keep the creek in place; therefore, this discussion is focused on the beach sediment retention function of the existing groin.

To maintain the beach south of the park boundary, a structure is needed that retains the same amount of sediment as existing conditions. Two structural options were considered to provide this function: groins and sills. A groin could be modified from the groin already in place, or a new one could be built in a different footprint. Installation of two new low-crested sills would provide stability to the beach and would be a lower visual profile at the park. These design features are discussed in more detail above in the subsection titled “Groin or Sills South of Creek.” Either type of structure could be used to retain the beach; however, the sills allow sediments to flow northward in a more natural way, whereas a groin will not allow sediment to pass over it at all.

McSorley Creek Mouth and Estuary

Given sufficient room to move, McSorley Creek would meander through the estuary and creek bed at low tide. At high tide the estuary would be fully inundated with mixed tidal and creek water. The creek would continue to supply sediment to the beach system, although the restored estuary beneficially creates a natural depositional area. Sediment deposition in the estuary would change over time as wave and creek processes act on the area. It can be expected that episodic storms would deliver large volumes of sediment to the estuary which, over time, would be redistributed and transported in the nearshore system. In this way, the estuary can be expected to be dynamic, especially in the first years after construction as the habitats work toward a new equilibrium.

Depending on the tidal elevations and sediment size and stability, the restored estuary would be colonized by emergent marsh vegetation in addition to any vegetation planted during construction to accelerate the plant establishment process. Drift logs can be expected to be transported into the estuary. Some logs would be deposited on the shoreline; others would be carried off with the receding tide. Drift logs on upper beaches provide natural stabilization in storms with less than moderate energy to retain sediments and support marsh vegetation establishment.

5 ALTERNATIVES EVALUATION

5.1 Evaluation Criteria

Evaluation criteria were developed to compare the three alternatives. The evaluation criteria were developed based on the project’s goal and objectives. Four categories of criteria were
applied: (1) ecological benefits; (2) park recreational use, access, and aesthetics; (3) long-term sustainability; and (4) implementation ability. Each category has multiple metrics. These metrics are listed below.

**Category 1: Ecological Benefits**

A. Total area of McSorley Creek estuarine habitat created  
B. Total length of lowermost reach of McSorley Creek restored, including new length created via restoration  
C. Length of feeder bluff reconnected to shoreline (i.e., armor removed in front of identified feeder bluff and not replaced with hard or soft shoreline protection)  
D. Improvement of self-sustaining spawning habitat for forage fish, as calculated by areal extent of beach created (or space for beach to form naturally)  
E. Total area of marine and stream riparian buffer areas restored or enhanced (ranging from very limited spot improvements to full restoration of vegetated buffer)  
F. Percentage of parking lot with run-off treatment before entering Puget Sound  
G. Long-term stability (expected life span) of improvements and level of maintenance

**Category 2: Park Recreational Use, Access, and Aesthetics**

A. Number of parking spots  
B. Area of aquatic area enhanced for scuba diving use by reusing old riprap  
C. Area of lawn available to host events  
D. Number of dedicated picnic areas  
E. Length of park shoreline that is ADA accessible  
F. Length of park shoreline where people can access beach without stepping down large rocks (hard armoring)  
G. Area of dedicated play areas (i.e., playground)  
H. Length of trails (net loss/gain)

**Category 3: Long-Term Sustainability (flooding and landslides)**

A. Reduction in the number of park buildings in the 100-year floodplain of Puget Sound or at risk of flooding because they are located within the projected inundation area of a 3-foot rise in sea level  
B. Reduction in Parks buildings at risk of landslides  
C. Reduction in the area of the parking lot in the 100-year floodplain of Puget Sound or projected to flood based on a 3-foot rise in sea level  
D. Reduction in the area of lawn projected to flood based on a 3-foot rise in sea level

**Category 4: Implementation Feasibility**

A. Preservation of cultural resources (either without disturbance or through relocation)  
B. Overall capital cost of restoration and improvements  
C. Maintenance costs
D. Compatibility with goals of restoration-focused funding sources
E. Compatibility with goals of recreation-focused funding sources

Scores were assigned to each alternative for each metric. A scoring system of 0 to 5 was used for each metric, with 5 assigned to the alternative(s) best fulfilling the metric. A score of zero was assigned to the alternative(s) not fulfilling the metric to any extent. Scores between 0 and 5 were assigned according to the amount of partial fulfillment provided by the alternative.

The metric scores were then combined to provide a category score on the same 0 to 5 scale for each alternative. The formula for this was:

\[
\text{Category Score} = \frac{\text{sum of metric scores}}{(5 \times \text{number of metrics})}
\]

The overall score for each alternative was calculated by taking the average of the four category scores. In these calculations, all categories and metrics are weighted equally.

5.2 Evaluation of the Alternatives

The No Action, Partial Bluff, and Full Bluff alternatives were evaluated using the evaluation criteria. Table 2 provides the summary of scores for each alternative. The Full Bluff alternative received the highest overall score (4.5 out of 5) and the highest score in each of the four evaluation categories. The Partial Bluff alternative received an overall score of 4.0. The No Action alternative’s overall score of 1.7 was markedly lower than either of the action alternatives. The No Action Alternative received the lowest score in each of the four evaluation categories. The following subsections describe the results for each of the evaluation criteria categories.

Table 2. Summary of Evaluation Criteria Results by Alternative

<table>
<thead>
<tr>
<th>Category</th>
<th>No Action</th>
<th>Partial Bluff</th>
<th>Full Bluff</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ecological Benefits</td>
<td>0.7</td>
<td>4.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Park Recreational Use, Access, and Aesthetics</td>
<td>3.8</td>
<td>3.9</td>
<td>3.9</td>
</tr>
<tr>
<td>Long-Term Sustainability (flooding and landslides)</td>
<td>0.5</td>
<td>4.3</td>
<td>5.0</td>
</tr>
<tr>
<td>Implementation Feasibility</td>
<td>2.0</td>
<td>3.6</td>
<td>4.0</td>
</tr>
<tr>
<td>Average Score</td>
<td>1.7</td>
<td>4.0</td>
<td>4.5</td>
</tr>
</tbody>
</table>

5.2.1 Ecological Benefits of Each Alternative

The Full Bluff alternative received the maximum score (5 out of 5) and would provide the greatest ecological benefits of the three alternatives (Table 3). This score is due to the Full Bluff alternative including restoration of nearshore processes through the removal of all impediments to the connectivity of the feeder bluff to the beach. The reconnection of the feeder bluff to the beach would have benefits both onsite in the park and through an extended area to the north
through longshore drift processes that would naturally transport beach sediment over time from the park in a northerly direction.

**Table 3. Ecological Benefit Scores**

<table>
<thead>
<tr>
<th>Metric</th>
<th>No Action</th>
<th>Partial Bluff</th>
<th>Full Bluff</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Total area of McSorley Creek estuarine habitat created</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B. Total length of lowermost reach of McSorley Creek restored, including new length created via restoration</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>C. Length of feeder bluff reconnected to shoreline</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>D. Improvement of self-sustaining spawning habitat for forage fish, as calculated by areal extent of beach created (or space for beach to form naturally)(^a)</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>E. Total area of marine and stream riparian buffer areas restored or enhanced</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>F. Total parking area with run-off treatment before entering Puget Sound</td>
<td>4</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>G. Long-term stability (expected life span) of improvements and level of maintenance</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>Average Score</strong></td>
<td><strong>0.7</strong></td>
<td><strong>4.3</strong></td>
<td><strong>5.0</strong></td>
</tr>
</tbody>
</table>

\(^a\) For the Partial Bluff Reconnection, this metric would score lower if the stabilization approach retaining a portion of shoreline arming and fill were assumed instead of the bluff toe stabilization structure.

Although not reflected in the scoring criteria, the Full Bluff alternative also provides more certainty that suitable forage fish spawning habitat would be available throughout the shoreline north of the estuary, because either shoreline stabilization approach used in this alternative adds uncertainty to the longevity of suitable forage fish spawning habitat.

Both action alternatives would provide identical benefits for those portions of the park where the restoration treatments are identical, including the McSorley Creek estuary, riparian areas, and the shoreline south of the estuary. A reduction in paved area near the park’s waterfront (i.e., waterward of the vehicular bridge to the lower park) and improved stormwater treatment options that would be included in the design of areas that are repaved would provide ecological benefits in the area adjacent to the restored estuary.

The No Action alternative provides very little ecological contribution because the existing modifications have significantly impacted the creek and shoreline. Due to the existing modifications’ impact on stream, estuary, and nearshore processes, the ecological conditions of the park can be expected to diminish even further over time. This anticipated decline is related to the condition of the shoreline arming and consideration of climate change. As described in the description of the No Action alternative, the shoreline arming is fracturing in places and experiencing erosion. Without maintenance, it is expected that this may lead to armor rocks being scattered onto the beach. With maintenance, the shoreline arming footprint may increase in size and height to address the overtopping issues. The decline associated with
climate change is assumed based on the potential for increased precipitation causing destructive high flows through the fully channelized creek corridor and SLR contributing to more frequent flooding of the park.

5.2.2 Park Recreational Use, Access, and Aesthetics

The three alternatives were evaluated as providing approximately the same average score for the park recreational use, access, and aesthetics category (Table 4). The Partial Bluff and Full Bluff alternatives received the same scores on each metric and received an overall score slightly higher than the No Action alternative (3.9 versus 3.8). The scores of the action alternatives were higher than the No Action alternative for the enhancement of aquatic area for scuba divers, the length of shoreline where people can access the beach, and the availability of multi-use facilities. The action alternatives scored less than the No Action alternative for the availability of lawn areas, the number of dedicated picnic areas, ADA accessibility to shoreline trails, and the overall length of shoreline trails. The action alternatives provide lawn areas for host events with 200 people and picnic areas for those willing to picnic on the beach; however, there are fewer of these areas.

A preliminary design analysis found that either action alternative could maintain the same number of available parking spots as the No Action alternative. While there would be fewer dedicated picnic sites and less lawn area directly on the waterfront than with the No Action alternative, the action alternatives would provide more beach areas for picnics and improved beach access and amenities for scuba divers and other waterfront users.

Table 4. Park Recreation Scores

<table>
<thead>
<tr>
<th>Metric</th>
<th>No Action</th>
<th>Partial Bluff</th>
<th>Full Bluff</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Number of parking spots</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B. Area of aquatic area enhanced for SCUBA use by reusing old riprap</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>C. Area of lawn available to host events</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>D. Number of dedicated picnic areas</td>
<td>5</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>E. Length of park shoreline that is ADA accessible</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>F. Length of park shoreline where people can access beach without stepping down large rocks (hard armoring)</td>
<td>1</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>G. Area of dedicated play areas (e.g., playground)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>H. Length of shoreline trails (net loss/gain)</td>
<td>5</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>I. Multi-use facilities, including for SCUBA</td>
<td>3</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Average Score</td>
<td><strong>3.8</strong></td>
<td><strong>3.9</strong></td>
<td><strong>3.9</strong></td>
</tr>
</tbody>
</table>
5.2.3 Long-Term Sustainability

The Full Bluff alternative received the maximum score (5 out of 5) for each sustainability metric and for the category overall (Table 5). The Full Bluff alternative substantially increases the resiliency of the park habitats to SLR and geologic processes. The Partial Bluff alternative scores the same as the Full Bluff for all metrics except for reduction in the number of Parks buildings at risk of landslides. The No Action alternative received the zero scores on all four metrics for an overall category score of 1.0.

Table 5. Long-Term Sustainability Scores

<table>
<thead>
<tr>
<th>Metric</th>
<th>No Action</th>
<th>Partial Bluff</th>
<th>Full Bluff</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Total number of park buildings in the 100-year floodplain of Puget Sound or at risk of flooding because they are located within the projected inundation area of a 3-foot rise in sea level</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B. Number of Parks buildings at risk of landslides</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>C. Total area of the parking lot in the 100-year floodplain of Puget Sound or projected to flood based on a 3-foot rise in sea level</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>D. Total area of lawn projected to flood based on a 3-foot rise in sea level</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Average Score</td>
<td>1.0</td>
<td>4.8</td>
<td>5.0</td>
</tr>
</tbody>
</table>

5.2.4 Implementation Feasibility

The Full Bluff alternative provided the highest overall score (4.0 out of 5) for implementation feasibility (Table 6). The only metric for which the Full Bluff alternative did not receive a 5 was the capital cost metric.

Table 6. Implementation Feasibility Scores

<table>
<thead>
<tr>
<th>Metric</th>
<th>No Action</th>
<th>Partial Bluff</th>
<th>Full Bluff</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Preservation of cultural resources (either without disturbance or through relocation)</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>B. Overall capital cost of restoration and improvements</td>
<td>5</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>C. Maintenance costs</td>
<td>0</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>D. Compatibility with goals of restoration-focused funding sources</td>
<td>0</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>E. Compatibility with goals of recreation-focused funding sources</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Average Score</td>
<td>2.0</td>
<td>3.6</td>
<td>4.0</td>
</tr>
</tbody>
</table>
5.3 Permits Required for Each Alternative

Given the design similarities between the two action alternatives, the regulatory agencies with jurisdiction and corresponding permit requirements are very similar as well. The primary difference between the two is the additional cultural resources coordination needed to approve the relocation of the CCC-era ranger buildings. The required permits are as follows:

- Department of the Army (Corps of Engineers) Individual Permit (Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act). In addition, the Corps permit constitutes a federal nexus and therefore will be the lead agency for:
  - U.S. Fish and Wildlife Service/National Marine Fisheries Service Endangered Species Act Compliance
  - National Historic Preservation Act Section 106 Compliance
  - National Environmental Policy Act Compliance
- Washington State Department of Ecology (Ecology) Water Quality Certification (Section 401 of the Clean Water Act)
- Ecology Coastal Zone Management Act Consistency Determination
- Ecology National Pollutant Discharge Elimination System General Construction Stormwater Permit
- Washington Department of Natural Resources Aquatic Use Permit/Aquatic Right-of-Entry
- Washington Department of Fish and Wildlife Hydraulic Project Approval
- City of Des Moines Shoreline Substantial Development Permit/Conditional Use Permit. In addition, the City would likely be the lead agency for Washington State Environmental Policy Act Compliance.
- City of Des Moines Critical Areas, Grading, and Drainage Approvals
- City of Des Moines Building Permits (utilities and structures)

6 RECOMMENDATIONS FOR SELECTING PREFERRED ALTERNATIVE

This feasibility evaluation was conducted to help inform King County and Washington State Parks in their decision-making process on which alternative to select for going forward. As described above in the evaluation, each alternative provides different outcomes. This report does not identify a preferred alternative. Instead, the recommendations listed below are intended to inform King County and Parks in their decision-making process as they weigh their preferences for the future design and function of Saltwater State Park. Once those specifics are identified a preferred (or recommended) alternative will be developed to incorporate the design concepts described in this document as well as the additional feedback received from King County and Parks. That recommended alternative will be presented in a final feasibility evaluation.

The No Action alternative is not a tenable option over the long-term. The park is expected to require substantial maintenance efforts to continue to provide the same level of recreational opportunity. As suggested by regular flooding that occurs in the southern park area, the SLR...
analysis conducted in this evaluation (see Appendix B) indicates that based on elevation alone (i.e., without consideration of waves and storm surge) a large portion of the park is too low in elevation to avoid flooding. This includes areas north and south of McSorley Creek. As a result, the snack shack will require protection or can be expected to deteriorate due to repeated flooding. In addition, the geological analysis (see Appendix C) determined that the shoreline armoring is reaching the end of its design life. The rock materials are fracturing and substantial replacement quantities would be needed in the coming years.

Another drawback of the No Action alternative is the lost opportunity for funding that could address large maintenance needs in a way that makes significant ecological improvements. The action alternatives evaluated in this study include the types of restoration (e.g., estuary restoration and shoreline armor removal) that are priorities in the region and for which there are currently available funding sources. These funding sources provide the opportunity to refurbish the park to improve its amenities and sustainability and reduce maintenance needs as part of the restoration project. Although it is foreseeable that target funding sources would be available in future years, there is no certainty that these grant programs will stay viable in the long-term (i.e., the amount of funding available may not remain at its current level). The No Action alternative would also be a missed opportunity for State Parks to complete the restoration objectives identified through the development of the Green Vision Plan. It would also be a missed opportunity for a key state agency to provide leadership as a good steward of the environment at Saltwater State Park, while at the same time working to improve and protect the park’s recreational, educational, and cultural value. The existing conditions significantly impair the ecological conditions and State Parks could be a big part of the restoration work in the region.

In terms of the two action alternatives, both would provide meaningful improvements to the ecological conditions in the park. Clearly, the Full Bluff Reconnection Alternative provides greater benefits and more certainty that the benefits are self-sustaining. As a result, the Full Bluff alternative is expected to be more competitive for restoration and recreational funding grants within the watershed and regionally. The Partial Bluff alternative can also be expected to be supported by a variety of restoration- and recreation-focused funding sources, but may be scrutinized for the amount of feeder bluff to remain disconnected by the stabilization structure to protect the Parks buildings at the top of the bluff.

The following bullets describe the benefits and drawbacks of the action alternatives. These benefits and drawbacks are summarized in Table 7 on the next page.
Table 7. Summary of Benefits and Risks/Drawbacks Associated with Each Alternative

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Benefits</th>
<th>Risks/Drawbacks</th>
</tr>
</thead>
</table>
| No Action                       | ▪ No immediate capital costs  
▪ No imminent interruption to existing park recreational opportunities                                                              | ▪ Lost opportunity to improve park conditions that would benefit the Puget Sound ecosystem        |
|                                 | ▪ More maintenance in future to address periodic flooding that already occurs (and is projected to get worse) and to rebuild the shoreline armoring that is nearing the end of its design life | ▪ Continued risk of Park buildings at top of bluff being damaged or destroyed during landslide    |
|                                 | ▪ Continued risk of Park buildings at top of bluff being damaged or destroyed during landslide                                               | ▪ Lost opportunity for funding that can help for park improvements associated with the restoration |
|                                 | ▪ Lost opportunity to update the park experience for visitors, including addressing users’ interest in using beaches and viewing wildlife in restored habitats as well as recreation such as SCUBA diving | ▪ Lost opportunity to update the park experience for visitors, including addressing users’ interest in using beaches and viewing wildlife in restored habitats as well as recreation such as SCUBA diving |
| Partial Bluff Reconnection      | ▪ Reconnects approximately one-third of the length of the feeder bluff with the beach, thus restoring some of the sediment supply and transport processes  
▪ Contributions to Puget Sound recovery efforts in the region  
▪ Reduces maintenance needs in the park by removing existing shoreline armoring and fill  
▪ Less potential for impact to adjacent properties than Full Alternative  
▪ Restored beach will be available for wildlife and park users immediately after construction  
▪ Project goals and objectives align it fairly well for multiple restoration and recreation focused grant funding sources  
▪ Improved public access to Puget Sound beaches  
▪ Improved recreational park amenities | ▪ Less reconnection of the feeder bluff than the Full Alternative  
▪ Maintenance of the restored beach is more likely necessary depending on the sediment input and deposition conditions after construction  
▪ Some maintenance of the bluff toe stabilization structure may be needed if it is to remain fully or partially buried  
▪ Continued risk of Park buildings at top of bluff being damaged or destroyed during landslide  
▪ The partial reconnection could result in more effort needed to explain project design to restoration focused funding sources interested in more of the bluff being reconnected  
▪ More potential than currently for landslides to occur that put park visitors at risk  
▪ Depending on design of stabilization (i.e., retained portion of shoreline armoring or toe stabilization feature) more predictability of end effects at park boundary. |

*Table continues on next page*
### Alternative | Benefits | Risks/Drawbacks
--- | --- | ---
**Full Bluff Reconnection**
- Reconnects the full extent of the feeder bluff considering the one area where fill remains is expected to naturally be a depositional area; this restores long-term sediment supply and transport processes
- Significant contribution to Puget Sound recovery efforts in the region
- Eliminates maintenance needs along the shoreline with the reconnected feeder bluff because natural beach processes will be expected to maintain the site
- Removes Parks buildings from potentially vulnerable area at the top of the bluff
- Restored beach will be available for wildlife and park users immediately after construction
- Project goals and objectives align it very well for multiple restoration and recreation focused grant funding sources
- Parks will be viewed as good steward of the environment
- Improved public access to Puget Sound beaches
- Improved recreational park amenities
- Potential for perception by adjacent landowners that the restoration project is the reason for any future changes to their beach or bluff
- Less control or predictability of bluff condition at park boundary
- More potential than currently for landslides to occur that put park visitors at risk
- Some maintenance of the restored beach may be necessary depending on the sediment input and deposition conditions after construction

The Full Bluff Reconnection:

- The Full Bluff alternative re-establishes natural processes along more of the park shoreline and would be expected to require the least maintenance into the future. The alternative moves the Parks buildings at the top of the bluff to an area set further back. Although these structures are not considered to be imminently threatened because of the overall stability of the lower park of the slope and the vegetation and water management practices at the top of the slope, there is always the possibility of a large slide of coastal bluffs. Therefore, moving the buildings away from the top of the bluff would essentially eliminate any risk of losing the buildings in a landslide.
- The Full Bluff alternative provides the maximum amount of ecological restoration. This outcome will be particularly appealing to potential restoration-focused funding sources and will further establish State Parks as good stewards of the environment. Funding sources could be identified to help cover the cost of park upgrades that would otherwise need to come from Parks’ capital improvement budget.
- The Full Bluff alternative would be expected to result in erosion of the lower 30 to 50 feet of the bluff over time as wave energy acts on the toe of the bluff. This will result in the lower bluff looking more like the shoreline north of the park that is exposed substrate without vegetation and at a steeper vertical angle. The erosion of the lower bluff and the relocation of the Parks buildings away from the top of the bluff may affect the upland
stability of the neighboring properties. Reactivating the bluff erosion processes would lead to less controllable and predictable conditions at the park’s northern property line.

The Partial Bluff Reconnection Alternative:

The Partial Bluff alternative would provide lesser benefits along the shoreline by not reconnecting more of the feeder bluff. Either approach to stabilizing the shoreline (i.e., bluff toe stabilization structure or partial shoreline armoring) will provide the same stability conditions for the Park buildings at the top of the bluff as currently exists. That is, the stabilization structure will prevent slides originating low on the bluff by toe erosion, but will not change the current conditions in the upper bluff. Either shoreline stabilization structure in the Partial Bluff alternative is expected to provide less concerns among adjacent landowners than the Full Bluff alternative. This is particularly true for the approach that retains a portion of the shoreline armoring because that portion of the shoreline will look like it does in existing conditions.

7 ADDITIONAL ANALYSIS NEEDED TO SUPPORT DESIGN

The conceptual designs depicted in the action alternatives were developed based on available information, including information collected as part of this feasibility study. The design of either action alternative would require additional studies and analyses to properly engineer the shape, size, location, and materials to be used in the restoration treatments. The following bullets provide a list of the additional technical studies and analysis identified to support design. In addition to those listed below, additional analyses may be identified through review and discussion.

- Wave modeling of the estuary at high tide in a storm so that appropriate bank stabilization and advance maintenance features may be analyzed
- Reference beach analysis to determine the slopes and substrate sizes for the restored beach
- Nearshore wave modeling and analysis of wave conditions at the exposed bluff toe;
- Selection and sizing of the toe stabilization measures
- Equilibrium stream channel dimension analysis, including additional sediment source investigation in the watershed
- Analysis to determine required bottom elevation of restroom to preclude flooding given SLR projections
- Cost vs. benefit of replacing existing parking in the immediate vicinity of beach
- Structural stability of park entrance road, including with a falling weight deflectometer to confirm the subgrade condition along the length of the road and at the site of the current road distress. We recommend that a boring be drilled and sampled to evaluate the subsurface conditions. The boring should be installed prior to the winter so a vibrating wire piezometer can record water levels throughout the wet season.
- Evaluation of potential effects of relocating the historic structures per Section 106 of the National Historic Preservation Act, including consultation, determination of eligibility,
and application of criteria of adverse effect. The proposed project would require relocating several NRHP-eligible structures, including the stone fire pit circles (c. 1935), the day use area fireplace (c. 1934), the day use comfort station 7 (c. 1934), and the Saltwater State Park foot bridge. In addition, Alternative 1 proposes to move the ranger (caretaker’s) residence 1 (c. 1935) and the secondary ranger building (NRHP eligibility not yet determined). Moving the buildings and fire pits would affect the resources’ integrity of location. However, the setting would be essentially the same, and no other aspects of integrity would be affected assuming strict adherence to the Secretary of Interior’s standards. Therefore, moving the buildings will not likely result in an adverse effect to the historic properties. Appendix E details the additional relocation and construction costs associated with moving the historic structures located on top of the bluff.

However, in order to evaluate potential effects to historic properties in compliance with Section 106 of the National Historic Preservation Act, the following procedural framework should be observed:

A. **Consultation**

Project proponents should consult with the King County Historic Preservation Program and the Washington State Historic Preservation Officer to solicit and consider their views on treatment of the historic resources. Initial consultation should also include determination of a project Area of Potential Effects (APE).

B. **Determination of NRHP eligibility**

Although the above-referenced resources were recommended eligible for the NRHP, it does not appear that a formal determination was made. A formal NRHP eligibility determination would be made for all resources within the APE. We anticipate that the eligibility determinations will mirror the recommendations made in 2009, and these recommended NRHP resources meet the criteria for inclusion in the NRHP, both individually and as a district.

C. **Application of criteria of adverse effect**

The project – in particular, moving the resources – would be formally evaluated to determine whether the integrity would be diminished to a degree that would constitute an adverse effect to the historic property. That appears unlikely if the Secretary of Interior’s standards are strictly adhered to during the planning and implementation of moving the buildings.

8 **REFERENCES**


Gregersen, C. unpublished data. Email from Chris Gregersen, King County DNRP, to Jennifer Vanderhoof, King County DNRP, summarizing forage fish egg survey results at Saltwater State Park. February 4, 2016.


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