Final Feasibility Study
Willow Creek Daylighting
Edmonds, Washington

December 18, 2015

SHANNON & WILSON, INC.

GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Excellence. Innovation. Service. Value.

Since 1954.

Submitted To:
Mr. Jerry Shuster
Stormwater Engineering Program Manager
City of Edmonds
1215 5th Avenue N.
Edmonds, Washington 98020

By:
Shannon & Wilson, Inc.
400 N 34th Street, Suite 100
Seattle, Washington 98103

21-1-12393-409

AUTHOR LIST (CREDITS AND ACKNOWLEDGEMENTS)

Overall Report, Alternatives, and Civil Design Plan and Recommendations

- David Cline, P.E., Shannon & Wilson, Inc.
- Katie Walter, P.W.S., Shannon & Wilson, Inc.

Fisheries Biology

- Paul Schlenger, Fisheries Biologist, Confluence Environmental Company

Tidal Hydraulics and Coastal Engineering

- Kathy Ketteridge, Ph.D., P.E., Anchor QEA LLC
- Adam Hill, Anchor QEA LLC

Hydrologic Data Collection, Existing Conditions Map, Concept Design Plans, and Cost Opinion

- Chris Helland, P.E., C.F.M, Shannon & Wilson, Inc.
- Eset Alemu, P.E., C.F.M., Shannon & Wilson, Inc.
- Brooke O'Neill, Shannon & Wilson, Inc.

Stormwater Modeling Coordination

- Mike Gisebert, P.E., Louis-Berger Inc.

Topographic Survey

- Doug Hartman, Doug Hartman and Associates

Cultural Resources Assessment

- Margaret Berger, Project Archaeologist, Cultural Resource Consultants, Inc.
- Glenn Hartmann, Principal Investigator, Cultural Resource Consultants, Inc.

Contaminated Soils and Alternatives Analysis

- Scott Gaulke, L.H.G., P.E., Shannon & Wilson, Inc.

Geotechnical Engineering and Geology

- Martin Page, P.E., Shannon & Wilson, Inc.
- Stephanie Williams, Shannon & Wilson, Inc.

Reviewers

- Keeley O'Connell, EarthCorps
- Jerry Shuster, P.E., City of Edmonds, Stormwater Engineering Program Manager
- Carrie Hite, City of Edmonds, Parks, Recreation, and Cultural Services Director

TABLE OF CONTENTS

Page

Page

TABLES

FIGURES

APPENDICES

WILLOW CREEK DAYLIGHTING
FINAL FEASIBILITY STUDY
EDMONDS, WASHINGTON

1.0 INTRODUCTION

Willow Creek is a tributary to and outlet of an estuarine tidal marsh (Marsh) complex located within the City of Edmonds (City) (Figure 1). Upper Willow Creek, a 393-acre basin, and Shellabarger Creek, a 378-acre basin, are the primary freshwater tributaries to the Marsh (SAIC], 2013).[1] The present Marsh is connected to the Puget Sound via a 600-foot-long channelized ditch known as Willow Creek. The creek enters twin culverts under BNSF Railway (BNSF) railroad tracks and then travels 1,600 feet through a series of pipes, manholes, and a floodgate system leading to an outfall in Puget Sound. The outfall is located approximately 200 feet offshore of the City's Marina Beach Park. The ditch, pipe, and floodgate system severely limit fish passage and tidal flows into and out of Willow Creek and the Marsh. This feasibility study evaluates the potential to daylight the piped portion of Willow Creek for the purpose of restoring tidal flows, habitat connectivity, and fish passage between Puget Sound through Willow Creek and the Marsh.

At present, the rough borders of the Marsh are 3rd Avenue South to the east, the Port of Edmonds (Port) Harbor Square property and the City's wastewater treatment plant to the north, BNSF railroad tracks to the west, the Union Oil Company of California (Unocal) property, the City's Willow Creek Fish Hatchery property, and the City Park to the south (Figure 2). Unocal is a wholly owned indirect subsidiary of Chevron Environmental Management Company (Chevron).

This feasibility study has been performed in two phases. The first phase was an Early Feasibility Study sponsored by the City's Public Works Department, Engineering Division, the Washington State Recreation and Conservation Office (RCO), and the Salmon Funding Recovery Board (SRFB) with Puget Sound Acquisition and Restoration (PSAR) funding (Prism Project Number 11-1553N) (Shannon & Wilson, Inc. [S&W], 2013). The second phase is this Final Feasibility Study report associated with RCO/SFRB/PSAR grant 13-1107P. As suggested by the RCO

[1] In this document, "Marsh," refers to the wetland complex made up of the 27-acre parcel (Edmonds Marsh) owned by the City of Edmonds plus the non-channelized wetland areas upstream and downstream of Edmonds Marsh. In this document, Willow Creek upstream of the Marsh is noted as, "Upper Willow Creek," and downstream of the Marsh is noted as, "Willow Creek."

Grant Manager, the draft version of this report was sent to the Lake Washington/Cedar/ Sammamish Water Resource Inventory Area 8 (WRIA 8) Technical Committee for review. The comments from the Technical Committee and the City's response to those comments are appended to in this report in Appendix M.

Concurrent with the present Willow Creek daylighting project, the City's Parks, Recreation, and Cultural Services Department has been undertaking a master planning process for Marina Beach Park. The master planning process involves developing a park plan that accommodates the Willow Creek daylighting, as well as reconfiguration of the park to meet multiple objectives and stakeholder concerns. The Willow Creek daylighting and the Marina Beach Park master planning projects include a public outreach component and a comprehensive landowner outreach process involving the Port, Washington State Department of Transportation (WSDOT) Ferries, BNSF Railway, and Chevron/Unocal. As of August 2015, a preferred park plan reflecting a daylighted Willow Creek channel through Marina Beach Park was under consideration by the City; it is being prepared for presentation for approval to City Council in fall 2015.

The City's Engineering Division is also performing stormwater studies to reduce flooding near the WSDOT ferry terminal cueing lanes along State Route 104 (SR-104), Harbor Square, and the intersection of Dayton Street and SR-104 (SAIC, 2013). The Dayton Street stormwater plans will reduce stormwater flows from the intersection to the Marsh. The daylighting of Willow Creek has been incorporated into the stormwater studies. Four specific elements of the stormwater study relate to the daylighting effort:

- A pump station for the Dayton Street stormwater flows.
- Improvements to the inlet conditions of the Shellabarger Creek culverts under SR-104.
- Channel improvements for Shellabarger Creek in the Edmonds Marsh just west of SR-104.
- Local storm drainage curb, gutter, and berm improvements to control flow on the east side of SR-104.

Of the several daylight alignments for Willow Creek evaluated in the Early Feasibility Study (S&W, 2013), the preferred alignment proceeds southwest on Unocal property adjacent to the BNSF railroad, under the BNSF railroad bridges, and across the City's Marina Beach Park.

Implementation of this alignment would support potential fish use in the daylighted channel and the Marsh, as well as reduce flooding at the Dayton Street/SR-104 intersection.

This Final Feasibility Study provides information on outstanding technical issues related to fish passage, fish habitat, soil contamination along the Unocal property, and design coordination for the BNSF. It also updates each of the key technical issues presented in the Early Feasibility Study, identifies a final preferred restoration plan, and offers recommendations for the design and permitting phases of the project.

1.1 Study Objectives

The objectives of the early feasibility phase of study were to:

- Document the existing conditions, topography, and hydrology of the Marsh and Willow Creek.
- Screen and evaluate three daylight alignments based on:
  - Fisheries functional and biological response.
  - Coastal hydrodynamics.
  - Engineering, cost estimates, infrastructure, property constraints, and political constraints.
- Evaluate the preferred alignment:
  - Develop a conceptual plan and cost estimate of the recommended alternative alignment.
  - Perform hydrodynamic modeling of the recommended daylight alternative alignment to evaluate flood and stormwater effects and fish passage conditions.
  - Quantify and characterize future juvenile Chinook use of the daylighted channel and the Marsh rearing habitat areas.
  - Provide information and recommendations for future phases of restoration design and permitting.

The objectives of the final feasibility phase of study were to:

- Undertake a cultural resources assessment of the geotechnical field explorations and daylighted channel plan.
- Perform a topographic survey along the proposed daylighted channel and Marsh restoration areas.
- Perform a beach outlet evaluation to inform the City of daylighted channel alignments across the Marina Beach Park beach.
- Use hydrodynamic modeling and analyses of the daylighted channel to generate a more detailed evaluation of fish passage and stormwater flood conditions.

- Perform a geotechnical assessment of daylighted channel conditions along the Marina Beach Park beach areas and evaluate proposed daylighted channel and design options for areas along steep slopes at the southern end of the Unocal property near the BNSF bridge(s) crossing.
- Review documents relating to Unocal's cleanup of contaminated soils, evaluate residual soil contamination risks along the daylighted channel route on the Unocal property, and offer recommendations for final design.
- Participate in property owner and stakeholder outreach meetings with Unocal/Chevron, WSDOT Ferries, the Port, and BNSF.

1.2 Ecosystem Restoration Context

Historically, the Marsh was a pocket estuary, a partially enclosed body of marine water intermittently connected to a larger estuary and diluted by freshwater tributary runoff or groundwater sources (Pritchard, 1967). It sat behind a sand-spit barrier that formed from south-to-north sediment shoaling patterns at Point Edwards (Washington State Department of Ecology [Ecology], 2003). The sand spit protected the Marsh from coastal wave and wind forces.

Pocket estuary habitats have been characterized as invaluable resting, feeding, and physiological transition zones for the smallest life history types of migrating salmonids, including juvenile Chinook (Redmond and others, 2005). The early marine life stage is a crucial transition time, in that salmonids attaining larger sizes during their first spring and summer are more likely to return as adults (hypothesized by Beamish and Mahnken [2001] and documented in hatchery fish by Duffy and Beauchamp [2011]). However, an estimated 40 percent of pocket estuaries throughout the Puget Sound have been lost (Fresh, 2011). As noted in Section 2.1, local loss of pocket estuary habitat is even greater.

Although often not considered to be Chinook salmon habitat because they do not support spawning, small streams provide rearing habitat for Chinook fry originating from nearby rivers (Beamer and others, 2013). For example, juvenile Chinook, coho, chum, and pink salmon have been observed in non-natal tidal streams of the Hood Canal (Hirschi and others, 1999) and of the Whidbey Basin (Beamer and others, 2013). Factors that influence whether juvenile Chinook salmon are present within small streams include distance to nearest Chinook-bearing river, stream channel slope, watershed area, and presence and condition of culverts at the mouth of the stream (Beamer and others, 2013).

Juvenile Chinook were found in small streams as far as 15 miles from a Chinook-producing river, although numbers were quite low in streams more than 6 miles distant (Beamer and others, 2013). Edmonds is approximately 9 miles from the Cedar River outlet from Lake Washington at

Shilshole Bay and 17 miles from the Snohomish River, the nearest salmon-bearing rivers. Despite the distance between the Marsh and large salmon-bearing rivers (e.g., Snohomish, Stillaguamish, and Skagit), juveniles have migrated to City beach areas (Figure 3 – Adapted from King County, 2004). It is likely that juvenile Chinook migrate from these rivers to the Edmonds Marsh area. The stream slope (<6.5 percent), watershed size (>100 acres), and anticipated Willow Creek outlet configuration (tidally backwatered) for the preferred daylight alignment would promote use of the restored Marsh and creek habitats.

The small coastal stream deltas and shoreline drift zones that provide habitat for migrating juvenile fish between the Snohomish River and Edmonds are limited by the blockages created by the BNSF railroad, the Port, and the City's stormwater infrastructure. A daylighted Willow Creek and Marsh restoration project would represent a rare nearshore habitat resource and a prime restoration and habitat connectivity opportunity within Water Resource Inventory Area (WRIA) 8. The Willow Creek daylight project is currently on the three-year habitat work schedule of WRIA 8 (identification - M233) and is listed as a Tier 1 project (i.e., the highest quality remaining habitat and the greatest Chinook use) (Water Resource Inventory Areas [WRIA] 8, 2013).

2.0 HISTORICAL AND EXISTING SITE CONDITIONS

Historical conditions of the Marsh have changed significantly since it was originally mapped in 1870. Since that time the railroad, sawmill industry, forestry, farming, and city urbanization have changed the landscape of the Marsh. A brief historical change analysis is provided here for reference purposes. Photographs of the site existing conditions are included in Appendix A.

2.1 Historical Physical Conditions

The historical Marsh area has been estimated to have been more than 100 acres in size (Gersib, 2008), extending from Point Edmonds (the southern tip of the Marina Beach Park) north to Brackett's Landing, which today is the Main Street/SR-104 intersection near the Edmonds WSDOT ferry terminal (Figure 4). The current Marsh area west of SR-104, and fed by Willow Creek, is estimated at 27 acres and the Marsh area east of SR-104, sometimes referred to as Stella's Marsh and fed by Shellabarger Creek, is estimated at 5 acres, corresponding to a 70 percent loss from historical conditions. The historical extent of the sand spit was likely from Point Edmonds to what is today the center of the Port marina. The historical outlet of the Marsh tidal channel was likely north of the N-dock, near the Port's administration office.

2.2 Anthropogenic Impacts to the Marsh

Like other urbanized areas throughout the Central Basin of Puget Sound (Collins and Sheikh, 2005), development of the City has resulted in hydrologic modification of streams and tidal systems, loss of freely available sediment sources, restricted fish access to small watersheds, restricted fish passage, habitat fragmentation, significant loss of historical backshore areas, and significant loss of pocket estuary marshes and lagoon complexes.

Edmonds was settled in the 1870s by George Brackett, considered the "founder of Edmonds" (History of Edmonds, 2012) and is the namesake of the Edmonds Ferry "Brackett's Landing" location. Brackett's arrival began the process of European settlement, port development, rail construction, industrial sawmill operations, oil and gas production, and commercial and residential development. The City was incorporated in 1890.

The Great Northern Railway reached the Edmonds shoreline the following year, established along the waterfront and western edge of the Marsh on the historical barrier sand spit. From the 1890s until 1951, the Edmonds waterfront was dominated by heavy industrial operations including sawmills and shingle mills. The last shingle mill closed in 1951.

The Unocal bulk fuel terminal facility was under construction as early as 1923 (Emcon, 1994). In the 1940s, the Marsh area was farmed and used for cattle pasture. Of note, in 1944 the Marsh had two large tidal channels (Figure 5), with the main tidal channel outlet flowing underneath a railroad bridge to the Sound. Today, there are twin culverts under the BNSF tracks that lead to the piped portion of Willow Creek.[2]

Beginning in 1924, Unocal distributed fuel in the area between Dayton Street and the present-day northwest corner of Edmonds Marsh adjacent to the railroad tracks. The property known then as the Dayton Street Depot is now the western portion of the Port's Harbor Square property (Figure 6) (Emcon, 1994). All Unocal petroleum operations were discontinued on the Depot site in the 1940s. In 1963, Unocal leased the Harbor Square property to a private party who likely added fill to the Marsh (Figure 7). With Unocal's permission, the area east of the Dayton Street Depot was filled with sands and silts from the Port's marina construction in the mid-1960s. In 1976, the Port purchased the Harbor Square property (including the former Dayton Street Depot) from Unocal (Emcon, 1994).

[2] The first 600 feet of pipe underneath Admiral Way is owned by the Port and leased to the City. The remaining piped portion, including the tide gate, out to the Sound is owned by the City.

In 1923, the first automobile ferry was established between Edmonds and Kingston. Private ferry services were operated through 1950, when the ferry was taken over by the State of Washington Ferry System. The ferry dock is now located at what was historically the northwestern corner of the Marsh. Long-term plans are under way to create a multimodal transportation facility; under the plan the existing ferry dock would be replaced by a new dock along the northern edge of the City's Marina Beach Park and over the Port's breakwater (Federal Highway Administration [FHWA], 2004). WSDOT Ferries, the U.S. Army Corps of Engineers (USACE), the Tribes,[3] and the City went through an Environmental Impact Statement (EIS) process for this "Edmonds Crossing" project (see Section 11.2 for status of the Edmonds Crossing project).

In 1962, the Port completed construction of the first phase of the Edmonds Marina. During this process, Willow Creek drainage was rerouted south (to its current alignment) through a pair of 36-inch concrete pipes underneath the BNSF railroad and Admiral Way, and outlets into a 48-inch corrugated metal pipe (CMP) that flows south towards Edmonds Marina Beach Park (Appendix A, Photograph 1). At the park, Willow Creek flows into a storm vault with a steel, top-hinge floodgate (Appendix A, Photograph 2). Currently, this floodgate is allowed full operation (closing on incoming tides) from late October through early March. In early March, the City opens the floodgate and keeps it open until the next fall. This protocol allows muted tidal flow into the Marsh. The configuration and operation of the pipe outfall system are described in Section 2.5.3.

After obtaining marsh land from Unocal in the early 1970s, WSDOT constructed SR-104. The road-building project divided the Marsh into two parts, with the newly constructed Shellabarger Creek culverts as the sole connection between them.

A stormwater line for SR-104 drains a watershed of approximately 870 acres. Heading west near Pine Street, the trunk line runs though the Unocal property along Union Oil Company Road and crosses underneath the BNSF railroad tracks near the Willow Creek outlet into to the Port's stormwater pipe. The WSDOT SR-104 pipe then parallels Port's Marina pipe that carries Willow Creek flows, and the WSDOT outfall to the Sound is just north of the Willow Creek outfall (Figure 2).

2.3 Union Oil Company of California (Unocal) Property

From 1923 to 1991, Unocal operated the Edmonds Terminal. Fuel would arrive by ship at the fuel dock formerly located at today's Marina Beach Park southern parking lot (Figure 6).

[3] Suquamish Tribe, Tulalip Tribe, Lummi Nation, Swinomish Tribe, and Port Gamble S'Kallam Tribe.

Transferred via pipeline over the railroad tracks to processing facilities and storage tanks on top of the adjacent bluff, fuel was then distributed via truck to the greater Seattle region. The Unocal site was also used for asphalt production for more than 25 years beginning in the 1950s. Operations and facilities also existed along the toe of the bluff in areas of fill over the historical Edmonds Marsh, as can be seen in Figures 6 and 7 from the 1960s. The north end of this area has a stormwater treatment pond that discharged to the Marsh and lower Willow Creek.

Residual contamination from historical operations is being cleaned up under Ecology regulations. In 1993, Unocal entered into an initial Agreed Order, DE 92TC-N328 Remedial Action for Unocal Edmonds Bulk Fuel Terminal, Edmonds Washington (Ecology, 1993). In 2001, Ecology approved an interim cleanup plan and Unocal initiated cleanup work on the "Upper Yard," which was the processing and storage tank area on top of the bluff. Approximately 125,000 tons of contaminated soil was removed from the yard. Ecology issued a letter confirming completion of the Upper Yard cleanup in 2003. Since that time, the Point Edwards residential condominium development has been built on the Upper Yard.

From 2001 through 2003, Unocal undertook several remediation actions on the 23-acre "Lower Yard." When Unocal assessed the extent of contamination in the Lower Yard in 2004, surface water and sediment in the Willow Creek drainage ditch adjacent to the site were found to be contaminated with polycyclic aromatic hydrocarbons (PAHs) and petroleum based contaminants including total petroleum hydrocarbons (TPH), light non-aqueous-phase liquid (LNAPL), and benzene, due in part to contaminants found in soils and sediments at the company's historical operations and stormwater outfall locations (Unocal, 2007).

In 2007, Unocal and Ecology entered into a second Agreed Order, DE 4460, for additional remediation at the Lower Yard. During 2007 and 2008, Unocal excavated more than 140,000 tons of contaminated soil and sediment (including sediment from Willow Creek), removed more than 9,000 gallons of petroleum product, installed a stormwater drainage system, regraded, and planted native species on the site. Since 2008, Unocal has installed 28 groundwater monitoring wells to evaluate whether residual hydrocarbon concentrations in the soil meet the remedial action cleanup criteria.

Groundwater monitoring revealed that a stretch of Willow Creek northeast of the stormwater pond required additional sediment cleanup action. Cleanup of this area and others is scheduled for 2016 (ARCADIS, 2015). A Cleanup Action Plan will be finalized sometime after August 31, 2015, when the public comment period has ended (South, 2013).

In 2005, WSDOT and Unocal signed an Agreement of Sale of Real Property and Escrow Instructions for the entire Lower Yard property. At that time WSDOT planned to use the property for the future Edmonds Crossing ferry terminal. Transfer to WSDOT will not be executed until Unocal meets the cleanup requirements specified in the Agreed Order DE 4460.

2.4 BNSF Railway (BNSF) Railroad

The tracks of the historical Great Northern Railway, now the BNSF railroad, run parallel to the existing Willow Creek channel and along the proposed Willow Creek daylighted channel alignment. Currently, portions of the existing lower Willow Creek channel encroach upon the BNSF right-of-way. The proposed Willow Creek daylighted channel is located on the Unocal property, and parallels the BNSF right-of-way. Two pre-constructed bridges exist at the downstream end of the proposed daylighted channel that will allow Willow Creek to cross under the double tracks at this location. BNSF constructed the bridges in 2010 as part of a separate Sound Transit mitigation project (Appendix A, Photograph 3).

2.5 Existing Watershed Conditions

Located in an urban and suburban watershed, the Marsh is fed by two freshwater streams (Upper Willow Creek and Shellabarger Creek) and by stormwater runoff from SR-104. Upper Willow Creek drains a basin of approximately 393 acres, Shellabarger Creek drains a basin of 378 acres, and SR-104 drains 833 acres (SAIC, 2013). Smaller basins, such as Harbor Square, the Point Edwards condominium development, Unocal property, and the BNSF railroad, also drain into the Marsh and Willow Creek.

2.5.1 Freshwater and Stormwater Inputs

The Upper Willow Creek headwaters originate in both Edmonds and the town of Woodway. The Edmonds portion originates southeast of the Marsh near 224th Street SW and 97th Avenue W. The Woodway portion begins south of Algonquin Rd (Figure 1). Both subbasins are zoned residential. Upper Willow Creek flows in an open stream channel, with some stormwater pipes in the upper portions of the Edmonds subbasin. After flowing through a culvert at Pine Street, Upper Willow Creek passes a fish hatchery located on City property and operated by Trout Unlimited before entering the Marsh (Appendix A, Photograph 4). Minor restoration and native revegetation activities have been completed along Upper Willow Creek near the hatchery, north of Pine Street.

Located northeast of the Upper Willow Creek basin, the Shellabarger Creek basin is bounded by SR-104 on the west, Main Street on the north, 9th Avenue N on the east, and Upper

Willow Creek basin on the south. North of Walnut Street, the creek is mostly piped. South of Walnut Street, it is mostly an open channel, except between 5th Avenue S and 4th Avenue S. The creek then enters the Marsh's freshwater wetland east of SR-104 and flows beneath SR-104 in two 48- by-72-inch steel pipe arches south of the Dayton Street/SR-104 intersection (Appendix A, Photograph 5). During flood events, however, part of Shellabarger Creek overtops and flows north along the SR-104 ferry queuing lanes towards the Dayton Street/SR-104 intersection (Appendix A, Photograph 7). This flood pattern may be due to sedimentation in the culverts under SR-104, which pose an ongoing maintenance challenge to WSDOT. On the west side of SR-104, there is no distinct channel and the stream flows in an unconfined flow pattern through the Marsh freshwater emergent cattail vegetation (Appendix A, Photograph 6).

Stormwater also enters the Marsh from Harbor Square, Unocal, WSDOT stormwater conveyance systems, the Point Edwards condominium development, and possibly railroad properties (Figure 2). The Harbor Square development discharges to the northern end of the Marsh through three outfalls, one 21-inch CMP and two 24-inch reinforced concrete pipes (RCPs). Stormwater from a lined detention pond on the Unocal property Lower Yard area enters the channelized length of Willow Creek under industrial stormwater discharge permit SO-002953C (Jolitz, 2013) (Appendix A, Photograph 8); S&W observed discharge from the pond into the creek on April 13, 2012 (Appendix A, Photograph 9).

WSDOT maintains a separate stormwater conveyance system that follows SR-104 south to Pine Street and then east near the old Union Oil Company Road. The southern extent of this basin is approximately the border between Snohomish and King Counties near Highway 99. The WSDOT pipe crosses under Pine Street near the Upper Willow Creek culvert, travels along the north side of Union Oil Company Road across the Lower Yard, and crosses beneath Willow Creek just upstream (north) of the Port of Edmonds pipe inlet location (see further description below). At the Willow Creek outfall to the stormwater pipes beneath Admiral Way, the WSDOT pipe has been observed to overflow, dislodge the manhole cover, and discharge to Willow Creek (SAIC, 2013) (Appendix A, Photograph 10). Maximum overflows have been estimated at 10 to 15 cubic feet per second (cfs) (SAIC, 2013). Stormwater runoff from the portion of SR-104 between Pine Street and Dayton Street directly discharges into the Marsh.

Stormwater from the Point Edwards development, located on the former Unocal Upper Yard, passes through a water quality treatment facility (i.e., treatment pond; Appendix A, Photograph 11) before entering lower Willow Creek near the BNSF Railroad culverts and the Port of Edmonds pipe at the downstream (south) end of the channelized Willow Creek. The stormwater is discharged through a 36-inch corrugated polyethylene pipe with a trash rack on the pipe outlet.

Possible stormwater inflows from the BNSF railroad tracks and rail yard west of the channel have not been specifically identified for this study. Design of the BNSF embankment along the daylight alignment will need to consider these potential inputs.

Major inflows from only Upper Willow Creek, Shellabarger Creek, and Point Edwards were assessed in this study. The following recommendations are offered:

- Acquire and evaluate more detailed information on inflows from the Unocal, Harbor Square, and BNSF properties.
- Continue to coordinate the Willow Creek Daylighting study with the Dayton Street stormwater study and the Marina Beach Park Master Plan study.
- Refine stormwater inputs throughout the design phases of work.

2.5.2 Marsh Vegetation

The existing Marsh vegetation and habitat estimates include 3.2 acres of mudflats, 5.9 acres of low saltmarsh vegetation, 11.4 acres of freshwater marsh, and 6.1 acres of forested wetland. The transition between freshwater and salt-tolerant plant species occurs midway in Edmonds Marsh, between the Harbor Square tennis courts and the eastern edge of the Unocal stormwater detention pond. Figure 2 shows the freshwater emergent, and mudflat and saltmarsh vegetation areas midway through the Marsh.

The freshwater marsh is dominated by cattails (*Typha latifolia*), reed canary grass (*Phalaris arundinacea*), and other freshwater species including skunk cabbage (*Symplocarpus foetidus*) and red alder (*Alnus rubra*) near the areas where Willow Creek enters the marsh. The density of the cattail "thicket" presents challenges to the restoration design. Currently, no tidal or stream channels exist through the freshwater cattail thicket on the southeast area of the marsh (Appendix A, Photograph 6). This feasibility study identifies restoration actions and plans that will consider methods for reconnecting tidal and freshwater streams, described in later sections of the report.

Compared to other salt marshes in Puget Sound, the emergent saltmarsh plants in the Marsh are restricted to lower elevations. This phenomenon has been attributed to the constriction of tidal flow through the pipe and culvert system; in this "tidal muting," conveyance losses in the stormwater pipes, vaults, and confined ditch allow only a portion of saltwater tidal flow into the Marsh. As a result, the distribution of estuarine emergent plants is limited to tidal elevations that are lower than those observed in other comparable salt marshes in Puget Sound (Pentec, 1998). Operation of the floodgate near the entrance to Marina Beach Park in winter

months imposes further limits on Puget Sound inflow and tidal exchanges, and thus allows for larger areas of freshwater inundation.

Despite the tidal muting, saltwater vegetation, tidal channels, and mudflats are present in the downstream (western) port of the Marsh (Appendix A, Photograph 12). Distinctive tidal channels run adjacent to the Unocal stormwater detention pond on the south side of the Marsh, and larger tidal channels originate at the northern edge of the Marsh near the Harbor Square tennis courts.

Where Willow Creek flows through the channelized ditch along the BNSF embankment (Appendix A, Photograph 13), Unocal replanted a 420-foot-long area with native vegetation, likely along the downstream portions of the existing channel. However, during field reconnaissance in May 2015, S&W observed little native vegetation. Invasive Scot's broom (*Cytisus scoparius*) has colonized areas along the upstream (north) sections of the existing channel. Otherwise, the channel currently has little to no overhanging vegetation or riparian cover.

2.5.3 Existing Marsh Discharge to Puget Sound

At the downstream end of Willow Creek adjacent to the Unocal property and the BNSF railroad tracks, an embankment with two stormwater pipes spans the channel. Both pipes are fitted with flow control gates. The east pipe is a 36-inch CMP with a circular slide gate that was partially closed when surveyed in 2012 (Perteet, 2012), and appears to be locked or rusted in that condition. The west pipe is a 22-inch steel pipe that was fully closed when surveyed, but may leak because of corrosion (Perteet, 2012). The City owns the pipes, gates, and other drainage structures, and has a maintenance easement to access the structures. Unocal owns the property on which the pipes are located (Unocal, 1981).

These pipes and gates, particularly if they remain closed, can severely limit tidal flow into and drainage from the Marsh. They can also contribute to the flooding of SR-104 by backing up the entire Willow Creek system. *It is recommended that the City coordinate with Unocal to open the gate structures to reduce backwater flooding along SR-104.*

Willow Creek then discharges westward through two 42-inch concrete pipes beneath the BNSF railroad into a small pond between the railway and Admiral Way (Appendix A, Photograph 14). Willow Creek then enters the Port's 48-inch CMP and flows 600 feet southwest along Admiral Way and the BNSF railroad towards Marina Beach Park. This pipe likely contributes to the significant hydraulic losses and reduction in upstream tidal prism inflow and drainage (SAIC, 2013). The City recently performed video inspection of the pipe, and found it

to be in need of maintenance (Shuster, 2015). The City is negotiating with the Port regarding the future need for and use of the Port's stormwater pipe as it relates to this project.

At the southeast corner of the Marina Beach Park parking lot, the 48-inch CMP connects to a City storm vault (MH-11-124) fitted with a 48-inch, top-hinge steel floodgate leading to a 60-inch high-density polyethylene (HDPE) pipe (Appendix A, Photograph 15). The City's Public Works Storm Division operates the gate for flood protection between late October and early March, allowing the gate to open and close with the tide; the gate closes, but is not watertight (Moles, 2012). In early March, the City hoists the flap gate open at a 90 degree angle to the flow line allowing tidal inflow to the stormwater pipes, the lower portions of Willow Creek and the Marsh.

The 60-inch HDPE pipe is connected to a second vault (MH-11-119) located approximately 50 feet to the south near the Marina Beach Park grassy area, between the north paved and south parking lots. The pipe outfall system, constructed in 2004, extends approximately 1,000 feet to the west and discharges offshore into Puget Sound with an approximate pipe invert elevation of -9 feet North American Vertical Datum of 1988 (NAVD88) (Appendix A, Photograph 15). The depth and design of the outfall are not conducive to fish and severely limit upstream fish passage to Willow Creek and the Marsh.

The Marina Beach Park and pipe outfall are located in an area that is part of the historical sand spit at Point Edward (Appendix A, Photograph 16). The site lies at the northern end of a 5-mile-long drift cell, identified as SN-3 (Shipman and others, 2010). Within this drift cell, sediment is collected from feeder bluffs and stream deltas along the Puget Sound shoreline. Wind and wave action move the sediment north along the shoreline to the Edmonds Point area.

In anticipation of a daylighted Willow Creek, BNSF built two bridges as mitigation for Sound Transit rail improvements on the system; the bridges are located just east of the gated entrance to the Marina Beach Park off-leash dog area (Appendix A, Photograph 3). It is expected that the newly improved creek will pass under the tracks at this location. One bridge accommodates the current track and the other accommodates a proposed second track. At some unknown time in the future, BNSF may plan a third track through the area to the west side of the existing tracks.

Marina Beach Park is a potential host site for the daylighted channels and discussed in Section 3.1 (Appendix A, Photographs 15 through 20).

2.5.4 Tidal and Stream Hydrology Data Collection

Data on tidal hydrology, water surface elevations, temperature, and salinity were collected for the feasibility study from September 2012 through June 2015, as reported in Appendix B and summarized below (monitoring locations are shown in Appendix B, Figure B-1):

- Tidal conditions recorded at the LTC-1A data logger, installed in the Port of Edmonds Marina, are very similar to those recorded at the National Oceanic and Atmospheric Administration (NOAA), Elliott Bay Tide Gauge 9447130.
- During several tidal events at the LTC-1B data logger, installed in the WSDOT manhole, water elevations were above the manhole and discharged to Willow Creek, and possibly at times water pressures were higher than the manhole elevation when the manhole remained closed. It is recommended that a manhole riser pipe be added to the manhole to reduce future stormwater overflows into Willow Creek.
- At the LTC-2 data logger, installed in the Willow Creek channel near the Unocal lined detention pond, water elevations ranged from 6 to 10.5 feet (NAVD88). Observed high water elevations appear to be a mix of high tide and freshwater creek inflow. The lowest water elevations were controlled by the bed of the channel and pipes beneath the BNSF railroad. Tidal flows were significantly muted on the order of 1 to 2-feet. Maximum recorded temperatures (i.e., 22 degrees Celsius) would be lethal for juvenile salmonids. It is recommended that temperature mitigation measures, such as densely vegetated riparian areas, be put in place along the daylighted channel.
- At the LTC-3A data logger, located in lower Shellabarger Creek, water elevations were steady at 10 feet (NAVD88), and nearly 4 feet higher than that in the Willow Creek channel. This differential likely indicates clogged or blocked culverts, or backwater control from the downstream cattail thickets, and a low level of connectivity between the west and east sides of Edmonds Marsh across SR-104.
- Flow patterns at LTC-3B (Upper Shellabarger Creek) and LTC-4 (Upper Willow Creek) were similar, with Shellabarger Creek being flashier than Upper Willow Creek, likely due to channel confinement at the gauge and its more urbanized watershed.

The tidal datum for this study is NAVD88. Elevations in tidal environments (and from NOAA tidal stations) are often reported in mean lower low water (MLLW) datum. NOAA's VDatum v3.1 computer program (National Geodetic Survey and others, 2015) was used to convert elevations to NAVD88; MLLW datum elevation – 2.09 feet = NAVD88 elevation. For example, elevation 0.0 foot MLLW converts to -2.09 feet NAVD88. The tidal range at Edmonds is approximately 11 feet between mean lower low (elevation -2.09 feet) and mean higher high

tides (9.09 feet) (NAVD88). The mean higher high water (MHHW) for the Elliott Bay, Seattle, NOAA tidal station 9447130 is 9.3 feet (NAVD88).

2.6 Existing Fish Habitat Conditions

Fish species documented in existing Marsh habitats include coho salmon (adult and juvenile), the occasional chum salmon (adult), resident and sea-run cutthroat trout, three-spined stickleback, and sculpin (Pentec, 1998; CH2M Hill, 2004; O'Connell and others, 2009; Rice, 2014; Schlenger, 2012). The Willow Creek Fish Hatchery historically raised coho and Chinook salmon, with annual releases of 2,000 to 8,000 coho fry into Upper Willow Creek (Pentec, 1998). Prior to the early 2000s, it was estimated that approximately 20 to 40 adult coho returned to the creek each year (CH2M Hill, 2004). More recently, no adult coho have been observed in Upper Willow Creek (Thompson, 2012). At present, the hatchery produces only coho fry, none of which are intentionally released into Upper Willow Creek (CH2M Hill, 2004; Thompson, 2012). The following paragraphs describe existing habitat conditions for fish, in particular salmonids, in the Marsh, starting with downstream areas.

2.6.1 Connectivity to Puget Sound

The fish habitat conditions in the Marsh are significantly impacted by the restricted connectivity of the Marsh to the Puget Sound. For example, the submerged outlet pipe does not encourage free access, the pipe and culvert system poses physical challenges, and the floodgate mutes tidal exchange. Until recent years, a small number of adult coho salmon and an occasional adult chum salmon or sea-run cutthroat trout have found the submerged outlet pipe and migrated upstream through 1,600 feet of pipe to enter the Marsh system (Stay pers. comm., 1995; Pentec 1998; Thompson, 2012). Other salmonid life stages and other fish species are not known to enter the Marsh from Puget Sound.

The presence of macroalgae and eelgrass beds near the Marina Beach Park shoreline (CH2M Hill, 2004) indicates the potential availability of forage fish (e.g., surf smelt spawning habitat is present) and habitat for both juvenile and adult salmonids (Pentilla, 2007; Beamer and Fresh, 2012). *It is recommended that future study phases confirm nearshore macroalgae, eelgrass, and forage fish spawning conditions on the beach for purposes of habitat condition assessment, environmental documentation, and permitting.*

Salmonids migrating up the pipe from the low intertidal zone to the railroad tracks encounter Willow Creek, the 600-foot-long confined channel that leads to the Marsh. Since the mid-2000s, no adult salmonids have been documented to enter the creek and migrate to the Willow Creek Fish Hatchery (Thompson, 2012). It remains possible that adult salmonids

entered the Marsh during this time, but did not migrate into Upper Willow Creek. Lacking instream structure and overhanging riparian vegetation, the straight channel upstream of the outlet pipes offers poor salmonid habitat. In 2004, the confined channel bottom was characterized as "exclusively muck and the water is uniformly shallow, warm, and exposed" (CH2M Hill, 2004). Since then, Unocal has remediated this section of the stream and backfilled it with gravel; S&W and Confluence field staff observed a sandy, gravelly substrate with occasional gravels in the confined channel in summer 2012 and spring of 2015.

2.6.2 Existing Marsh Habitat Conditions

In the main body of the Marsh, habitat conditions range from freshwater to brackish, marked by a fairly abrupt transition. The extent of saltwater inundation, the vegetation communities along the salinity gradient, and the overall shape of the Marsh are controlled by the tidal exchange through the floodgate and stormwater pipe system, freshwater inputs from the surrounding watershed, and development that has encroached on the Marsh's historical footprint of nearly 100 acres. The filling of drainage channels in the freshwater wetland due to siltation from the upper watershed has further limited saltwater inundation and enabled the freshwater portion of the Marsh to expand to the west (City, 2010).

The distinctly estuarine area extends across approximately the western third, with freshwater wetlands in the remaining portion. Evidence that juvenile Chinook salmonids have recently used the Marsh could not be found.

Higher-salinity areas support native plants such as seashore saltgrass (*Distichlis spicata*) and pickleweed (*Salicornia virginica*), while lower-salinity areas support native plants such as saltmarsh bulrush (*Scirpus robustus*) and Lyngby's sedge (*Carex lyngbyei*) (Pentec, 1998). The more salt-tolerant plant species occur primarily along the drainage channels in the estuarine portion (O'Connell and others, 2009). The estuarine portion of the Marsh also includes unvegetated areas and shallow tidal channels, as well as an open channel along the margin of the Unocal property to the south of the marsh. This saltwater plant community resembles the vegetation in other pocket lagoon marshes that provide feeding and rearing for juvenile salmonids (Beamer, 2006).

The remaining two-thirds of the Marsh area, on both sides of SR-104, support freshwater vegetation. Dense stands of cattail, along with purple loosestrife (*Lythrum saclicaria*) and climbing nightshade (*Solanum dulcamara*) are reported (Pentec, 1998). Biological controls and intentional removal have nearly extirpated purple loosestrife, but nightshade appears to be advancing significantly in the Marsh east of SR-104 (O'Connell, 2015). Due to the density of

cattails and presence of invasive species, juvenile salmonid use and benefits would be limited. *It is recommended that invasive species in the southeastern area of the Marsh and in Shellabarger (Stella's) Marsh be removed or treated.*

Direct channels connecting the streams (Willow and Shellabarger creeks) with the saltwater tidal channel sections are not apparent (Perteet, 2012), potentially making it difficult for fish to move between the lower Willow Creek open channel, the estuarine marsh, and the upstream Willow and Shellabarger creeks. This navigational challenge may account for the absence of reported adult coho migration into Upper Willow Creek.

Fish habitat quality in the estuarine portion of the Marsh has been characterized (Pentec 1998) as "marginal to fair [for]rearing," given a lack of instream structure along the channelized section of the stream and marginal water quality (i.e., high water temperatures, low dissolved oxygen) in summer months. The estuarine portion of the Marsh provides some rearing habitat for juvenile salmonids and other saltwater-tolerant small fish. If productivity of the estuarine portion of the Marsh were typical (i.e., high) an abundance of prey items could be expected.

Fish access to the freshwater portion of the Marsh appears limited, except in the approximately 600-foot-long, historical Upper Willow Creek channel along the southern margin of the Marsh. The open channel habitats along lower Willow Creek between the Marsh pipe outlet and the upper extent of the Unocal property have been characterized as having "poor" or "very poor" quality (CH2M Hill, 2004).

During high tide, fish that navigate the pipe and lower Willow Creek can move throughout the Marsh's inundation area. During low tides, the channel along the Unocal property, and the Marsh's tidal channels are available; dense vegetation and sediment deposits preclude fish access to shallow freshwater flow in channels along Upper Willow and Shellabarger creeks. Because of sedimentation and the establishment of dense stands of cattails in the upper Marsh, the Willow Creek channel is no longer fully connected with the confluence of Upper Willow and Shellabarger creeks. Water depths vary substantially in this area, ranging from a few inches to more than 4 feet (Pentec, 1998). Fish habitat in this portion of the Marsh has been characterized as suitable for winter and spring rearing by salmonids, but with potential summer water quality limitations due to high water temperatures and low dissolved oxygen (Pentec, 1998).

2.6.3 Upstream Creek Channels

Upper Willow and Shellabarger creeks provide habitat suitable for some fish rearing and spawning for several hundred feet upstream form the marsh before obstructions block further

upstream passage. Fish habitat in Shellabarger Creek is fair to good for rearing and offers "good spawning potential for salmonids" (Pentec 1998). In Upper Willow Creek, fish habitat is excellent for rearing (Pentec, 1998) downstream from Pine Street, but only fair for rearing upstream from Pine Street. Spawning in Upper Willow Creek is characterized as poor (Pentec, 1998) or fair to good (CH2M Hill, 2004) for spawning. Given the barriers upstream from Pine Street, it is unlikely that adult salmon will spawn in the upper reaches of Willow Creek without restoration of fish passage.

2.6.4 Contaminant and Pollutant Impacts to Habitat

Given the industrial, urban, and suburban land uses of the Marsh, Shellabarger and Willow Creek watersheds, stormwater pollutants and chemical contaminants could be present in the water and sediments. These substances could reduce habitat productivity; this includes contamination of the salmonid prey base and bioaccumulation in the fish.

The stormwater pollutants that may enter the Marsh are likely the typical ones found in urban and roadway runoff (e.g., petroleum products, heavy metals, bacteria from animal waste, and sediments). Neither the Upper Willow nor Shellabarger Creek drainage basin contains industrial development. The City is under an Ecology Phase II Municipal Stormwater Permit, and the City is executing a series of programs to improve stormwater quality in all its drainage basins.

Additional pollutant sources to the current open lower Willow Creek channel and the future daylighted channel include contaminated surface and groundwater from the Unocal site, WSDOT manhole overflows, and nonpoint stormwater runoff from operations and maintenance of the BNSF railroad tracks. Runoff from the Point Edwards stormwater outfall also enters this portion of the Creek; its detention pond is regularly inspected by the City for compliance with maintenance standards.

Little to no quantitative water quality data is available to characterize the stormwater runoff entering the Marsh and Willow Creek. Groundwater from the Unocal site has been extensively sampled (see Section 10). Sediment contamination in Willow Creek within to the Unocal property and along lower Willow Creek was documented, remediated, and is considered "mostly" clean by Ecology and Unocal.

Stormwater pollutants and chemical contaminants may have had adverse effects on the productivity and habitat quality of the Marsh and Willow Creek. However, there is no information to characterize any such effects.

It is recommended that a stormwater and sediment sampling and analysis plan be developed to evaluate the potential effects of stormwater and chemical contaminants on fish. As discussed in the next section, the proposed tidal channel excavations for the recommended restoration plan should be targeted in the sampling and analysis plan as these will be the locations attracting fish and will have sediment disposal requirements during construction.

3.0 DAYLIGHT ALTERNATIVE ALIGNMENTS

Three alternative daylight alignments between the tidal marsh and Puget Sound were identified during the early feasibility phase of the project (Figure 8 and Appendix C). From south to north, the three alternative alignments evaluated are:

- Alternative 1 – Marina Beach Park
- Alternative 2 – Port of Edmonds Marina
- Alternative 3 – Sunset Beach

Each alternative alignment was evaluated on the basis of fish habitat, coastal hydrodynamics and Marsh drainage, infrastructure, property, and project costs.

3.1 Alternative 1 Alignment – Marina Beach Park Area

The Alternative 1 Alignment at Marina Beach Park would involve constructing a new channel across Marina Beach Park downstream from the pre-constructed BNSF railroad bridges. The upstream section of the new daylighted channel would be constructed north of the BNSF railroad bridges along the Unocal property. Of the three alternatives, the Marina Beach Park alignment would provide the largest area of natural beach conditions and largest restored area for fish habitat.

Juvenile Chinook salmon and adult salmonids, such as coho salmon, sea-run cutthroat trout, and possibly chum salmon, would be able to move into the Marsh. The fish would have to pass under three overhead crossings (two pedestrian and maintenance crossings in the park and the pre-constructed BNSF railroad bridges), but the fish should be able to navigate these crossings. To reduce eddies that could impede fish passage, the daylighted channel will need to be modified into a natural curvature at the BNSF railroad bridge abutments.

The Marsh outlet in the Marina Beach Park would be exposed to the wind and wave conditions of Central Puget Sound. Depending on outlet configuration, the tidal channel may shift or temporarily block fish passage, although any such blockages would be reversed by drainage outflows from the Marsh. Periodic channel maintenance by City staff may be necessary.

The Alternative 1 daylight alignment would pass through the pre-constructed BNSF railroad bridges and then northeast along the Unocal property, with a fence along the BNSF right of way, to lower Willow Creek. Exclusion fencing from the Marina Beach Park dog area would be needed, as would modification of the southern parking lot; these changes are being addressed in the park master planning process. Although new water supply and fiber-optic lines may be required, Alternative 1 would have the least impact on existing infrastructure. The primary property owners involved would be the City, BNSF, and Chevron/Unocal or, after property transfers are made, WSDOT Ferries.

3.2 Alternative 2 Alignment – Port of Edmonds Marina

The Alternative 2 Alignment at the Port Marina would involve constructing a new channel from the current Port stormwater pipe inlet along a new alignment across Admiral Way, through the Port parking lot, and daylighted into the Marina near Dock F. The existing culverts beneath the BNSF railroad would need to be replaced with new bridges similar to those pre-constructed near Marina Beach Park.

Relative to a Marsh outlet through a beach (i.e., Alternatives 1 and 3), a Marsh outlet in the marina would attract somewhat fewer juvenile Chinook salmon because of its low habitat value. The alignment would have extensive overwater coverage, deeper water, modified shoreline, potential exposure to petroleum contaminants, and boat and human-related noise and movement of the marina. These conditions would reduce foraging opportunities, diminish prey base quality, and increase predation risk.

A Marsh outlet alignment through the marina would provide the shortest daylighted length into the Marsh, which would suggest improved fish access. However, this benefit would be offset by a difficult migration path: through a series of structures including a culvert or bridge at the seawall entrance; through a daylighted channel along the parking lot; through culverts, pipes, and bridges under Admiral Way and the BNSF railroad; and finally into Willow Creek. This alternative would require a combination of hardened channel and pipe system

Shoreline drift would be less at the Marina outlet than at the park outlet of Alternative 1. Additional sediment delivery from the Marsh to the marina would result in increased maintenance dredging by the Port. The Alternative 2 Alignment would require modifications to roads, parking areas, and seawalls owned by the Port. The Port does not support a Willow Creek daylight alternative with an outlet in the marina (McChesney, 2012).

3.3 Alternative 3 Alignment – Sunset Beach

The Alternative 3 Alignment into Sunset Beach would involve constructing a series of new daylighted channel segments and pipes to the northwest, through the Port overflow gravel parking and boat maintenance area, and into a pipe under Admiral Way near the Sunset Beach access ramp to the Port fishing pier. The existing culverts beneath the BNSF railroad would need to be replaced with new bridges similar to those near Marina Beach Park. The alignment would have a combination of open channel along the gravel parking lot area, and pipe or culverts underneath Admiral Way and the seawall near the fishing pier.

Although fish could pass through this alignment, fewer would be likely to reach the Marsh relative to Alternative 1 because of the need for pipes. The Sunset Beach alignment of the Marsh outlet would offer a slightly more protected location than the Marina Beach Park alignment and can therefore be expected to experience fewer incidents of drift-related outlet closure; shoreline drift in this area is designated as "no appreciable drift" (Shipman and others, 2010). However, a November 2014 northwesterly storm fetch resulted in significant wave action on the Sunset Beach shoreline, which is evidence of periodic shoreline erosion and deposition at the Alternative 3 outlet.

The proposed outlet is located along at Sunset Beach where a small intertidal beach is backed by shoreline riprap and concrete bulkhead armoring. The nearshore area at this location is significantly smaller than that of Alternative 1. Expected sediment transport and deposition from the Marsh at the outlet would be minor, improving the likelihood that the outlet would remain open.

A Marsh outlet at Sunset Beach would be located in a sand and gravel beach and favorable foraging area. Also, the prey items carried to the beach via the Marsh outflow could attract fish. The Marsh outlet may need to be engineered to prevent it from migrating into the breakwater.

The Alternative 3 Alignment at Sunset Beach would encounter Port and City road, drainage, and utility infrastructure, and likely require a pipeline in the lower ends of the alignment. South of the Admiral Way street corner, the stream channel would flow into the Port overflow gravel parking lot.

Property owners along Alignment 3 are the City, the Port, and BNSF. A significant amount of the project is located on Port property. The daylighted channel would require an easement or purchase of the current gravel parking lot area on the corner of Admiral Way and Dayton Street. Alternative 3 is probably not viable because of property ownership constraints.

3.4 Preferred Alignment

The Alternative 1 Alignment along Marina Beach Park and the Unocal property was selected as the preferred alignment. The rationale for this preference is as follows:

- The Marina Beach Park beach provides quality forage fish habitat that would attract juvenile fish.
- The daylighted channel through the park would be an environmental amenity.
- The existing BNSF railroad bridges provide benefits and cost savings to the project.
- With the least impact on existing road and drainage infrastructure and properties, Alternative 1 is likely less costly than the other alignments.

In addition, the daylight options consider and will accommodate the future Edmonds Crossing project (Figure 13). The Willow Creek daylight options follow the alignment presented and described in the preferred alternative for the Edmonds Crossing EIS, per the guidance and coordination with WSDOT Ferries.

4.0 PREFERRED DAYLIGHT PLAN

An expanded description, figures, and cost estimates for the Willow Creek daylight plan (Figures 9 and 10) are presented in this section. Supporting technical studies and analyses of the preferred daylight plan were conducted for tidal and flood hydraulics (Section 5), fish habitat (Section 6), topography (Section 7), cultural resources (Section 8), geotechnical engineering (Section 9), and contaminated soils (Section 10).

4.1 Marina Beach Park Area

Three options for the alignment through Marina Beach Park were evaluated. In this Willow Creek Daylighting Feasibility Study, Options A, B, and C described below. Options A and B were developed early on in the Willow Creek Daylighting study. These Options were then shared and presented in the Marina Beach Park Master Plan project.

- Option A – A south alignment through the off-leash dog area (Figures 9 and 11).
- Option B – A north alignment through the park, including the south parking lot and possibly the treed and grassy knoll and beach areas (Figures 10 and 11).
- Option C – A central alignment between Options A and B; this alignment emerged during the park master planning process (Figure 12).

The Marina Beach Park Master Plan process presented Options A and B to the public for feedback. Option A through the off-leash dog area was removed from consideration early on in the public planning process. The Master Plan process then revised the options described below:

- Option 1 – This is a hybrid between the previous Options A and B with the Willow Creek Daylight channel running mid-way through the park, described as Option C above to remain consistent with the naming in this feasibility study report.
- Option 2 – The channel alignment is the same as Option B, north alignment through the south parking lot, treed and grassy knoll and beach areas described above.

On the basis of hydrodynamic modeling results, fish passage and habitat technical information, regulatory buffer requirements, parking, environmental effects, recreation, and public input, the Marina Beach Park Master Plan identified Option C as the preferred daylight alignment. The following park modifications would be required:

- A central daylighted channel alignment allowing for preservation of a fenced dog area while maximizing beach and passive recreation areas,
- Relocation of the south parking area into the north parking lot,
- Reconfiguration of the open grassy areas and pathways,
- Relocation of the children's play structure towards the east and south, nearer the parking lot, and
- Construction of two pedestrian bridges (one with light vehicle maintenance access) across the daylighted channel.

It is noted that Option C (Option 1 in the Marina Beach Park Master Plan) is an option developed as an outcome of the Marina Beach master planning process that seeks to balance a variety of park uses. Field explorations and a separate hydraulic and fish habitat analysis for Option C were not included in this final feasibility study scope of services. Option C, is however, a viable fish habitat restoration option considering expected coastal geomorphology and tidal hydrodynamics conditions. The Option C channel provides similar shoreline and tidal channel habitat to
Options A and B, albeit slightly shorter in length. The Option C channel outlet on the beach area has the potential to shift and migrate short distances to the north, along the beach, due to geomorphologic conditions related to predominate shoreline sediment drift and wave directions. This dynamic nature of the outlet will provide beneficial habitat use for salmon, and it does not pose significant risks to structures and Marina Beach Park Master Plan use areas and functions.

4.2 BNSF Railway (BNSF) Railroad Bridges

At the upstream end of the proposed Marina Beach Park daylighted channel, Willow Creek would cross underneath the pre-constructed BNSF bridges (BNSF, 2010). The bridge plans show 38-foot bridge spans with 1.5 Horizontal to 1 vertical (1.5H:1V) side slopes and a channel bed protected by riprapped bank, toe, and bed areas. The channel invert elevation below the BNSF bridges is 4.26 feet (NAVD88).

The nature of erosion protection measures installed along the bridge channel, banks, and abutment areas has not been determined. Erosion protection structures are shown in the plans, but there is no photographic evidence or other documentation that these structures were installed with the bridge construction. Hydrodynamics modeling performed for this phase of the feasibility study indicates that water velocities and depths in the proposed channel would be adequate for fish passage and would not create problematic scour and erosion conditions, if erosion and scour protection measures are in place at the BNSF bridges. Channel erosion protection will likely be needed between the park pedestrian bridge and the corner on the east side of the BNSF railroad.

The alignment and geometric configuration of the channel depicted in the conceptual design plan in this report (Figure 12) accommodate future expansion of the BNSF system to include a third rail west of the existing bridges along Admiral Way (Wagner, 2015). The costs of a future third bridge over the proposed daylighted channel are assumed to be BNSF's responsibility and are not included in the project cost estimates (Section 4.5 and Appendix D).

4.3 Daylighted Channel Area

The proposed daylighted channel would extend 750 feet upstream (northeast) from the existing BNSF railway bridges, on the Unocal property and adjacent to the BNSF right-of-way. WSDOT Ferries is expected to assume ownership of the Unocal property for the multimodal Edmonds Crossing project. The proposed daylighted channel in this area follows the conceptual alignment proposed in the Edmonds Crossing Final EIS (WSDOT, 2015).

The proposed channel configuration has a bottom width of approximately 15 feet, side slopes of 3H:1V downstream from the bridge and 2H:1V upstream from the bridge, and top widths ranging from 40 to 80 feet (Figure 12). The profile of the channel is 0.0012 foot/foot. The daylighted channel would travel along the Unocal property that is currently under an Agreed Order for soil cleanup (discussed in Section 10). It is assumed that the daylight excavations will encounter petroleum-related hydrocarbon contamination and that handling and disposal of the contaminated soil will be required. To protect the new channel from contaminated groundwater

(see Section 10), it is recommended that an HDPE liner be installed along the full length of the daylighted channel from the BNSF bridge to the north edge of the Unocal stormwater pond.

Currently, the existing channel experiences large temperature fluctuations, which are not observed in the Marsh wetland or tidal beach areas (Appendix B, Figure 4). It is recommended that dense plantings of native trees and shrubs be provided along the daylighted channel stream banks to provide shade and reduce the potential for high stream temperatures.

The existing floodgate would need to be replaced with a self-regulating floodgate to prevent tidal backwater flooding from storm surges and extreme tides that could inundate upstream roads, namely SR-104 (Appendix A, Photograph A-3). The location of the proposed floodgate is just south of the current Willow Creek channel outlet to the Port of Edmonds stormwater pipe where ground height is sufficient for tie-in of the floodgate structure (Figure 12). The floodgate would be engaged and operated annually by the City stormwater staff during the wet season (November through March). The floodgate would shut automatically at a designated elevation lower than the elevation at which SR-104 is overtopped. For the purposes of this study, a closure elevation of 9.5 feet (NAVD88), near the MHHW, was selected (Appendix E). Hydraulic modeling analyses indicate the floodgate structure would perform as planned and provide flood protection for the low-lying interior areas along SR-104 and Dayton Street. Fish passage would be blocked for up to 3 hours each day, but not during the key spring and early summer migration periods of interest (Appendix E). It is recommended that the floodgate structure be included in the future project design to prevent tidal backwater and storm surge flooding of SR-104 and the Dayton Street intersection.

4.4 Marsh Area

The proposed plan involves excavation of tidal channels in the main marsh area to support its reconnection with Upper Willow and Shellabarger creeks (Figure 8). Currently, the marsh and former channels are filled with sediment and cattails. Stream flow from the creeks disperses through the dense cattail vegetation without a direct connecting channel through the freshwater section of the marsh. Over time, increases in saltwater inflow would reduce the area of cattail growth. *It is recommended that the transition of freshwater to saltwater vegetation be accelerated by excavating tidal channels through the dense cattail stands. Cattail removal through mowing, herbicide applications and planting of native species should be considered as an adaptive management action if saltwater inundation does not reduce cattail density.*

4.5 Cost Estimate

The preliminary estimated cost for construction of the daylighted channel along the Unocal property through Marina Beach Park and for improvements in Edmonds Marsh is approximately $7.4 million (M) with a 25 percent contingency (Table 1 and Appendix D); real estate and property-related costs, design, and permitting are not included. An additional $1M is estimated for engineering design, permitting, and right-of-way agreement negotiations. Changes in the cost estimate presented in this final feasibility study compared to the early feasibility are for the following reasons:

- Removed costs for pedestrian and maintenance bridges that will be part of the Marina Beach Park Master Plan construction funds.
- The addition of a soldier pile retaining wall along the daylighted channel near the BNSF railroad and south end of the Unocal site near the steep hillslope that poses a potential landslide risk.
- An increase in the length and depth of the HDPE liner and clean backfill along the full length of the daylighted channel to mitigate risk of residual groundwater-to-surface water petroleum contamination (see Section 10); deeper excavations will provide protection for the HDPE liner and sufficient space for the riparian shrub and tree root zone.
- Increased costs associated with soils disposal for both contaminated soils above and below the cleanup level. This cost could be greatly reduced with a formal agreement from Ecology and WSDOT for contaminated soils below the cleanup criteria, reuse on the project site.
- Increases in costs for permits, engineering review, special insurance and bonding, and flaggers for work within the BNSF right-of-way.

Numerous uncertainties are associated with the cost estimate: property ownership and land transfer, extent of soil contamination, handling and disposal requirements for contaminated soil, BNSF railroad permits, condition of railroad bridge abutments and foundations, stormwater inflows, need for protection and realignment of stormwater structures, need for relocation of utility infrastructure, and need for preservation of cultural and archaeological resources.

Given the $1.5M incremental cost for the longer, deeper HDPE liner, it is recommended that uncertainties regarding potential contamination be reduced. *Specifically, it is recommended that soils be further characterized for the proposed design and that onsite soil management and disposal options be evaluated. This additional information could help refine and reduce the project construction cost estimate.*

In light of the other uncertainties, it is recommended that a 20 percent contingency be carried forward through design and construction project phases.

The basis of cost is 2015 dollars using data sources from RS Means (2014) and recent bid tabs for similar types of salmon habitat restoration projects, escalated to 2015 dollars. *For planning and future construction funding purposes, it is recommended that the cost estimates in this feasibility study be escalated to the funding year associated with the construction project.* For example, if the project construction is planned in fiscal year 2018, the project construction cost should then be escalated from 2015 dollars to 2018 dollars, based on expected annual inflation and cost escalation rates for the Edmonds, Washington, area.

5.0 TIDAL HYDRAULICS ASSESSMENT OF THE PREFERRED PLAN

A tidal hydraulics assessment was performed for existing and proposed conditions to evaluate effects on fish habitat and flood conditions (AnchorQEA, LLC, 2013 and 2015). Findings are detailed in Appendix E and summarized in this section.

5.1 Tidal Hydraulics Modeling Setup

A one-dimensional, unsteady flow hydraulic model was used to evaluate tidal inundation, water depths, and in-channel velocities for the beach, daylighted channel, and Marsh under existing and future proposed conditions. The USACE Hydrologic Engineering Center River Analysis System (HEC-RAS) (USACE, 2010) was run for typical low-flow (tidal) conditions and for the approximate 100-year flood flow condition.

Tidal inflow and elevation data for the model include NOAA tidal data from the Seattle, Elliott Bay Station (NOAA Station 9447130). As noted in Section 2.5.4, the tidal data from the Elliott Bay station and the project's Edmonds Marina station (LTC-1) are very similar, with minor shifts in tidal cycles (on the order of minutes) and elevations (on the order of tenths of a foot). The NOAA Seattle Elliott Bay Station 9447130 tidal data were used for modeling downstream boundary conditions of tidal water surface elevations for time periods not otherwise reflected in data collected for this feasibility study.

The typical spring tidal flow condition selected was May 1 through 14, 2008. Fish trap and juvenile Chinook data indicate that juvenile migration from the Skagit and Snohomish river deltas peaks sometime in mid-April (Beamer, 2010). The two-week May period accounts for travel time from the larger river deltas to the Edmonds area, and includes both a spring and a neap tide. Hydrologic inflow modeling data were also made available for this study from the City's Dayton Street stormwater study for Upper Willow and Shellabarger creeks (SAIC, 2013).

Stream inflow data provided by the SAIC (2013) stormwater study were Hydrologic Simulation Program Fortran (HSPF) model outputs. Low flows selected for Willow and Shellabarger creeks were 0.3 and 0.5 cfs, respectively, based on representative low-flow modeling periods in the HSPF model.

The flood condition selected was an event in December 2007, when observations were made at SR-104 and the Unocal stormwater detention pond, both of which were flooded. Edmonds Marsh and Willow Creek overtopped their respective banks and flowed onto the Unocal property. All flood waters were contained onsite, and managed under a construction National Pollutant Discharge Elimination System (NPDES) permit. The NOAA tide station and HSPF modeling outputs (SAIC, 2013) were used as inputs for the HEC-RAS December 2007 event.

Modeling geometry for the existing conditions used a geographic information system (GIS) surface compiled by S&W from existing Light Detection and Ranging (LiDAR) and ground survey data. Additional bridge survey data were used to model the BNSF bridges based on as-built drawings provided by BNSF to the City. Modeling geometry for the preferred daylight and conceptual design plan used a similar surface, with modifications for the daylighted channel along the beach, Unocal property, and tidal channel excavations in Edmonds Marsh. Additional details regarding the modeling setup are provided in Appendix E.

5.2 Tidal Hydraulics Modeling Results

Based on results of spring salmon migration modeling, the area of inundation in the Marsh will increase moderately from 16.8 to 19.2 acres (Appendix E.1, Figures 1 through 9). The boundary of the inundation area coincides with the dense cattail areas on the southeastern portions of the Marsh. The inundation area mapping is somewhat limited by uncertainties in topographic survey data, LiDAR data, and the predicted inundation depths within the dense cattail thickets.

Figures 10 through 17 in Appendix E.1 show the potential future changes in channel velocities. Relative to current conditions, channel velocities in the upper Marsh area decrease because the excavated tidal channels are enlarged and the resulting peak velocities drop from 1.3 feet per second (fps) (existing) to 0.6 fps (proposed). In lower Willow Creek, the peak velocities drop from 4.8 fps (existing) to 0.7 fps (proposed).

These reductions in stream velocity result from elevated backwater conditions, which in turn are caused by the increase in tidal inundation elevations. Reduced velocities in the lower end of the stream channels indicate that fish will use less energy in navigating the channels. Reduced velocities also indicate potential increases in sedimentation. Over time, sedimentation could

reduce channel connectivity and require maintenance excavation to maintain upstream fish passage.

Immediately downstream from the confluence of Upper Willow Creek and Shellabarger Creek in the central areas of the Marsh, the channel velocities increase from 0.1 fps (existing) to 0.4 to 0.6 fps (proposed). Farther downstream in lower Willow Creek (channelized), the velocities increase from 0.2 fps (existing) to 0.6 fps (proposed). In the proposed daylighted channel near the railroad bridges, peak velocities can be as high as 1.5 to 2.0 fps (in either flood or ebb direction). Along the beach channel, tidal peak velocities can be 0.5 to 1.0 fps for flood tide, and as high as 5.0 to 6.0 fps for ebb tide. Increased sediment transport conditions are thus expected for downstream areas along the primary daylighted channel, compared with the Marsh and upstream tributary channels to the Marsh.

The project also improves flood conditions in the Marsh, daylighted channel, and adjacent areas. Figure 19 in Appendix E.1 shows the results of the hydraulic modeling output for the December 2007 flood event. A 2-foot reduction in peak flood water surface elevation is predicted—from an estimated 12.7 feet (NAVD88) to an estimated 10.7 feet (NAVD88). This is a significant reduction in flood water surface elevations, likely resulting from improved drainage and flow along the daylighted channel compared to the confinement, losses, and flow obstructions of the existing stormwater pipes and floodgate.

Additional modeling was performed during the final feasibility phase of study, as described in Appendix E.2. The primary purpose of the additional modeling was to gather additional inflow information from the Dayton Street stormwater study, add these flows to the model, evaluate tidal channel configurations and different alignment options on Marina Beach Park, and evaluate the performance of the floodgate.

The Willow Creek Daylight HEC-RAS model was updated to include stormwater flows from the Point Edwards stormwater system. In addition to revising flood flow estimates, channel alignment Options A and B were evaluated along the Marina Beach Park as described above in Section 4.1.

The dimensions and elevations of the Marina Beach outlet channels were derived from a review of seven similar lagoon and marsh outlets discharging to the Puget Sound. Based on this review, the depth and connection elevation of the outlet tidal channel was changed from -2.7 feet (NAVD88) in the early feasibility study to a tidal channel elevation of 4 feet (NAVD88), near the mean tide level. This change was made in part to create reasonable excavation limits for the

channel. An additional 6 to 7 feet of depth would cause wide excavation areas across the park and extend a fair distance out from the shoreline into subtidal areas.

The Marina Beach Park alignment Options A and B were evaluated for tidal hydrodynamics and fish habitat conditions (Appendix E). The configuration of the tidal channel had an invert elevation of 4 feet (NAVD88) near the mean tide elevation, with a bottom width of 15 feet, sideslopes of 3H:1V, and channel top width of approximately 80 feet.

The updated hydrodynamic modeling results indicate maximum tidal channel velocities of 2 to 3 fps, and daily maximum tidal channel depths of 6 to9 feet. These depths may have public safety concerns. *It is recommended that the City evaluate tidal channel, public safety, and mitigation measures as part of future design phases of work.*

It is also recommended that the City evaluate options for modifying the daylighted channel between the BNSF railroad bridge and the Edmonds Marsh by narrowing the channel and increasing roughness and vegetation, which may reduce the tidal exchange and hence channel velocities. This could offset the benefit of reducing flood elevations described above.

The hydrodynamic and fish passage analyses for Marina Beach Park daylight outlet Options A and B (Appendices E and F) resulted in the following general findings:

- The outlet channel hydraulics, depth, velocity, and fish passage conditions for Options A and B are very similar. Option C identified in the Marina Beach Park master planning process would have similar tidal channel hydraulic conditions.
- The Option B daylight outlet channel would create incrementally more fish habitat because the channel is slightly longer.
- The Option B daylight outlet channel is oriented to the northwest, similar to the original lagoon and sand-spit outlet channel. The alignment is positioned away from the predominantly southerly wind fetch, resulting in fewer anticipated problems associated with channel sedimentation, erosion, migration, and blockage.
- The depth of the tidal channel is sufficient to merit additional evaluation of tidal hydraulics, public safety, and warning signage around the tidal channel along Marina Beach Park.
- Future modeling should consider revised stream bank slopes in the park area, and a low flow (inset) tidal channel for potential improvement of tidal flow hydraulics for fish and public safety.

6.0 FISH HABITAT ASSESSMENT OF THE PREFERRED PLAN

The following information is the assessment of fish habitat conditions that would be provided through the proposed restoration options in the City's Willow Creek Daylight project. The fish habitat assessment builds on the original alternatives presented in the Early Feasibility Study (S&W, 2013) and progression of alternatives and options in this final report. The detailed fish habitat assessments are included in Appendix F. The following is a summary of the key analyses, findings, and recommendations.

6.1 Beach Outlet Channel Evaluation

Three beach outlet channel alignments are considered in this evaluation: Options A and B, which were developed in the first phase of the feasibility study phase, and Option C, which emerged through the Marina Beach Park master planning process. All options are identical upstream of the railroad bridge, with a proposed channel bottom elevation under the railroad bridge at 4.26 feet NAVD88 (6.2 feet MLLW).

Option A would turn the beach outlet channel sharply to the south after flowing under the railroad bridge. The channel traverses the park's existing dog off-leash area and its length downstream of the railroad bridge is approximately 450 feet.

Option B would be oriented north of Option A and avoids sharp turns downstream from the railroad bridge. In this option, the channel alignment extends through the existing south, gravel parking lot, which was the former Unocal Oil Pier alignment, and the park's open lawn area. The channel downstream of the railroad bridge in Option B is approximately 600 feet long.

Option C lies between Options A and B across Marina Beach Park. In this option, the channel alignment extends across the existing south parking lot, which was the former Unocal fuel pier alignment. The Option C channel downstream from the railroad bridge is approximately 400 feet long.

The beach outlet channel would provide habitat for juvenile salmonids originating from within the Upper Willow Creek and Shellabarger Creek systems, as well as an entrance corridor to the Marsh system and habitat for non-natal fish originating from other river and creek systems.

The beach outlet channel will provide two main functions for juvenile salmon: (a) entrance corridor to the entire Marsh system and (b) habitat for species using the Marina Beach Park shoreline and lower Willow Creek daylight areas of the project. A comparison of how the two beach outlet channel options provide these functions is described below.

In considering juvenile salmon utilization of the overall restoration project, the beach outlet channel is particularly important because it forms the entrance point for juvenile salmon access into the channel and Marsh system. Fish access from Puget Sound into the restored habitats will be dependent upon the extent to which the outlet channel stays open. As described below, Option B offers better fish access and habitat than Option A.

- With its more northerly outlet alignment, Option B is less likely to be affected by the net south-to-north sediment drift along this stretch of the Puget Sound, making for a more stable channel with less accumulated sediment and fewer log masses.
- Lacking the sharp turn downstream of the bridge of Option A, Option B is likely to require less rock armoring of the channel banks, therefore having longer streambanks with natural vegetation versus rock lining.
- Option B's longer channel length would provide more estuarine habitat for juvenile salmonid use.
- The Option B alignment would create less dog-induced disturbance (physical presence and pet waste) because it is not immediately adjacent to the park's off-leash dog area.
- Potential disturbance due to people and dogs in the channel is equally likely for both options, but would typically occur during the warmer summer months when fewer juvenile salmon are present.

Option C has less channel length than either Option A or B. However, the differences in channel length and orientation offered by Option C as identified during the park master planning process are minor, and Option C provides habitat benefits similar to those provided by the other options analyzed above. For Option C, it is anticipated that with shoreline drift and sediment deposition, the channel may migrate towards the north.

6.2 Juvenile Salmon Access to Edmonds Marsh

Because of the local semi-diurnal tidal cycle (i.e., two daily high tides and two daily low tides), nearshore water surface elevations are constantly changing, with corresponding changes in flow velocities and water depths along the Marsh system. In systems with substantial freshwater sources, such as the Willow Creek and Edmonds Marsh, additional depth and flow variability results from input of upland runoff. These combined variations result in naturally intermittent access by juvenile salmon migrating along marine shorelines.

On rising tides, water flows into these barrier estuary systems, allowing both active and passive fish migration to the Marsh. In contrast, falling tides require fish to swim actively upstream to access the marsh habitats. As a result, juvenile salmon move into marshes more often during the

rising tide as fish move with the water; approximately 80 percent of juvenile salmon movements in a tidal channel are in the direction of tidal currents (Hering and others, 2010).

Fish passage requirements are less clear in tidal areas compared to freshwater streams (WDFW, 2013; Barnard and others, 2013). The law requires fish passage at manmade barriers, such as water crossings (Revised Code of Washington (State) [RCW] 77.57.030), but does not specify how efficiently or continuously passage needs to be provided for tidal systems (Barnard and others, 2013). In tidal environments, access to or through intertidal habitats is naturally intermittent.

Maximum allowable velocities for fish passage range between 2 and 4 fps, depending on culvert length (Table 2). Maximum velocities as low as 1 fps may be more appropriate for small fish such as juvenile salmon (Barnard and others, 2013). Allowable depth and velocity criteria for juvenile salmon in tidal systems have not been explicitly developed by WDFW; criteria for adult trout (i.e., greater than 6 inches long) established in Washington Administrative Code 220-110-070 are the most applicable. The fish passage maximum velocity criteria are presented in Table 2. The minimum depth criterion is 0.8 foot.

Because the water crossings for the Willow Creek Daylight project (i.e., at the railroad bridge and at the seasonally operated floodgate 700 feet upstream) are much shorter than 100 feet, the maximum allowable velocity would be 4 fps.

The suitability of passage conditions for juvenile salmon moving from Puget Sound into the Marsh was evaluated using depth and velocity predictions from a one-dimensional hydrodynamic model prepared for the project (Appendix E). The hydrodynamic model was prepared for a two-week spring period (May 1 through 14, 2008) representative of conditions during the spring rearing period and long enough to encompass one spring and neap tide cycle. The model was run assuming combined flow from Upper Willow and Shellabarger creeks of 0.8 cfs. Throughout the analysis period, depths and velocities were calculated at 15-minute intervals.

The analysis was conducted for a scenario with a floodgate in the Willow Creek channel and for a scenario without a floodgate. The floodgate scenario is described fully in Appendix E. Located approximately 700 feet upstream of the railroad crossing (Station 1402), the floodgate would consist of three culverts, one at 4 feet NAVD88 and two at 5.5 feet NAVD88, to allow more fish passage during low flow conditions. The floodgate would be open when water levels are below 9.5 feet NAVD88 (11.7 feet MLLW) during winter period operations. The floodgate

closure at those water levels is intended to protect SR-104 and Dayton Street areas from tidal flooding during extreme tide and storm surge conditions.

The analysis indicated that during 26 percent of the time (equivalent to 3 hours per tidal cycle), water will be flowing into the Marsh with the rising tide, with a minimum depth of 0.8 foot throughout the entire route (Table 3). Flows throughout the daylighted channel will thus allow for passive fish migration into the marsh (i.e., they will not have to swim upstream). Minimum depths of greater than 0.8 foot will be available during all times considered fish passable.

In the no floodgate scenario, maximum velocities of 4 fps or less will be provided 65 percent of the time. Fish will be able to access the Marsh without encountering a velocity higher than 2 fps 57 percent of the time. The percentage of time drops to 38 percent at a maximum velocity of 1 fps.

Suitable conditions for fish passage can also be provided with a floodgate, although the percentage of time is reduced compared to the no floodgate scenario. Constriction of flow through the floodgate results in an increase in upstream water surface elevations and increases in velocities through the gates. For the 4 fps maximum velocity criterion, the difference for with and without the floodgate is minimal: fish passage criteria are met 63 percent of the time with the floodgate compared to 65 percent without the floodgate. However, more substantial reductions occur at the 3 fps maximum velocity criterion (65 percent without floodgate compared to 47 percent with the floodgate) and for the 2 fps velocity criterion (57 percent without floodgate compared to 36 percent with the floodgate). The percentage of time in which maximum velocities are less than 1 fps is 30 percent with the floodgate scenario compared to 38 percent without the floodgate.

This analysis shows that depth and velocity conditions allowing juvenile salmon to move into the daylighted creek and Marsh will be regularly provided. It is thus reasonable to expect that some of the juvenile salmon migrating along the Puget Sound shoreline will enter the daylighted creek even if not all of them reach the Marsh. The additional rearing habitat and prey resources provided for fish entering the daylighted creek areas would also benefit the fish.

6.3 Puget Sound Shoreline Function

The proposed daylighting of Willow Creek is expected to improve rearing conditions along the Puget Sound shoreline for juvenile salmon. A restored surface water connection between the Marsh and Puget Sound will allow the entry of the brackish marsh water with its prey items and detritus (decaying plant and animal material) into the marine nearshore. Currently, all of these inputs enter Puget Sound via a subtidal pipe, where they are largely undetected or unavailable to

the surface-oriented juvenile salmon rearing and migrating along the shoreline. Regardless of whether the fish enter the Marsh system, these inputs can be expected to improve the habitat conditions for juvenile salmon. More prey items, including insects that offer particularly high caloric content and foster rapid fish growth, will be available in the upper portion of the water column near the shoreline. The brackish, lower salinity water will also provide a physiological refuge while the juvenile fish continue their acclimation to the marine environment.

6.4 Habitat Structure in the Marsh

As described in the existing conditions section of this report, the western third of the Marsh supports salt-tolerant vegetation that transitions abruptly to a dense thicket of cattails; discernible surface channels from Upper Willow and Shellabarger creeks are not present. The conceptual restoration design expands the extent of saltmarsh vegetation and extends accessible fish habitat into the creek systems draining into the Marsh. The daylighting of Willow Creek to Puget Sound would restore a more natural volume of tidal exchange with the Marsh. The daylighted creek would allow high tide inundation elevations similar to the water surface elevations along the Puget Sound shoreline, thus reducing the tidal muting observed at present. This increased tidal exchange and restored channel connections in the marsh will promote the expansion of the area of salt-tolerant vegetation species, and reduce freshwater cattail thickets blocking fish passage in the Marsh.

Anticipated water elevations in the Marsh were used to predict the vegetation community that can be supported in different areas of the Marsh. General saltmarsh vegetation zones based on elevation were applied using observations from the Snohomish River system (Rice and others, 2012) and other Puget Sound locations.[4]

Areas with elevations between the mean tide level and mean high water (MHW) are likely to support low-marsh vegetation species such as Lyngby's sedge, three-square bulrush (*Scirpus americanus*), pickleweed, and seashore saltgrass. High-marsh vegetation will be supported in elevations from about MHW to above MHHW. Common high-marsh plants include tufted hairgrass (*Deschampsia caespitosa*), Puget Sound gumweed (*Grindelia integrifolia*), Pacific silverweed (*Potentilla anserina*), American beachgrass (*Elymus mollis*), and common cattail (*Typha latifolia*).

[4] Additional saltmarsh vegetation observations were used from the Skagit River estuary. See: Hood, 2009; Shannon & Wilson, Inc. [S&W], 2010), Duwamish River (Hummel, 2013), Nisqually River (Belleveau, 2012), and Commencement Bay (Thom and others, 2000).

Based on the NOAA tidal data for Edmonds (Station 9447427), the project site's approximate range for low-marsh vegetation is between 4.4 and 7 feet NAVD88 (6.5 and 10.1 feet MLLW). By this approach, the high-marsh range is between 7 and 9.2 feet NAVD88 (10.1 and 10.9 feet MLLW).[5] Available Marsh elevation data indicate that much of the western two-thirds of the Marsh area could support low-marsh species. Compared to existing conditions, this is a substantial expansion in saltmarsh area. As a result of this anticipated expansion in the low Marsh, an equivalent contraction of the high Marsh can be anticipated. Some of the existing vegetated low Marsh would likely transition to unvegetated tideflat. Overall, the Marsh can be expected to shift from a freshwater, cattail-dominated system to a more diverse saltwater-tolerant vegetation assemblage.

The anticipated changes in Marsh vegetation structure would induce a shift in prey species (e.g., insects and invertebrates) in the Marsh, the daylight creek, and the Puget Sound nearshore at the outlet. Total prey production under existing and proposed conditions would likely be similar, but available across larger shoreline, tidal channel and marsh areas (Cordell, 2013).

It is recommended that plans for cattail removal be confined to the westernmost extent of the existing cattail thicket, or that intentional removal be considered as an adaptive management measure if the salt marsh does not develop as expected.

6.5 Access to Upper Willow and Shellabarger Creeks

The conceptual restoration design for the Marsh includes the excavation of tidal channels to provide direct connections between the freshwater creeks and the Marsh. In the absence of well-defined channels at present, this action is expected to improve fish access to the creeks. With the expected increase in tidal exchange and flushing of the Marsh, the new Marsh tidal channels are expected to be self-sustaining over a shorter period of time, likely on the order of 5 to 10 years, depending on the size of the excavation and the rates of sedimentation. The next phase of design could evaluate the anticipated excavated tidal channel sedimentation rates. Sedimentation will likely occur at the new tidal-freshwater interface, eventually limiting fish passage under certain flow conditions and possibly requiring future maintenance.

It is understood that City and its community partners hope to incrementally improve upstream fish passage, flow regimes, water quality, and connectivity in the Upper Willow Creek and Shellabarger Creek watersheds. Plans for these actions are in progress and will likely occur over a period of decades. The beneficial effects of the daylighting efforts described in this report will be maximized when upstream watershed restoration actions are completed in the future.

[5] Upper end of range approximated as 1 foot above the mean high water mark.

6.6 Potential Contaminant and Pollutant Impacts to Restored Habitats

As described previously, sediment and water quality in the Marsh and Willow Creek may have been adversely affected by adjacent industrial and railroad operations, Unocal site remediation, and stormwater runoff. Ongoing sources of pollution could reduce the quality of the restored fish habitat within the Marsh, but such effects on habitat quality were not considered in detail in this Final Feasibility Study. *It is recommended that additional sampling and analysis for stormwater pollutants and chemical contaminants be conducted as baseline monitoring during the design, permitting and construction project phases.*

7.0 TOPOGRAPHIC SURVEY

The City continues to compile baseline survey information of the project area at each phase of study. Topographic surveys have been completed for the Marina Beach Park area, the BNSF railroad bridges and railroad corridor near the bridges, the Willow Creek channel, the Shellabarger Creek culverts, and proposed tidal channel connection locations near SR-104 (Appendix G).

A topographic survey is recommended along the Unocal property from the BNSF bridges to the upstream end of the Willow Creek channel near the Unocal stormwater pond to complete the base map of the project design and construction areas. Limited historical surveys exist along this area and need updating. These areas were not surveyed in this phase of study because Unocal did not grant right-of-entry to the study team.

8.0 CULTURAL RESOURCES ASSESSMENT

To ensure that no cultural resources are disturbed during construction of the proposed project, a cultural resources assessment was undertaken at locations where geotechnical and contaminated soil field explorations involved earth-disturbing activity along the route of the preferred daylight alignment on Unocal Property and through Marina Beach Park (Appendix H).

The archaeologist developed the cultural resources assessment as a component of preconstruction environmental review with the goal of evaluating the potential for any as-yet unrecorded cultural resources within the project area. The work was intended, in part, to assist in addressing state regulations pertaining to the identification and protection of cultural resources (e.g., RCW 27.44 and RCW 27.53) and compliance with the National Environmental Policy Act (NEPA), and Section 106 of the National Historic Preservation Act, as amended, and implementing regulations (36 Code of Federal Regulations [CFR] 800) the State Environmental Policy Act (SEPA), Executive Order 0505 as would be required for projects using state allocated

funds from the RCO/SRFB. Under Section 106, agencies involved in a federal undertaking must take into account the undertaking's potential effects on historic properties (36 CFR 800.16(l)(1)). Under SEPA and NEPA, agencies must consider the environmental consequences of a proposal, including impacts to cultural resources, before taking action.

As part of the assessment, the archaeologist contacted cultural resources staff at Muckleshoot Indian Tribe, Snohomish Tribe, Snoqualmie Nation, Stillaguamish Tribe, Swinomish Tribe, Suquamish Tribe, and Tulalip Tribes to inquire about project-related cultural information or concerns.

The assessment utilized a research design that considered previous studies, the magnitude and nature of the undertaking, the nature and extent of potential effects on historic properties, and the likely nature and location of historic properties within the area of potential effect, as well as other applicable laws, standards, and guidelines (per 36 CFR 800.4 (b)(1)).

Based on the findings of the cultural resources assessment, no previously recorded cultural resources are in the project disturbance locations for this phase of study, and the probability that the overall project would impact archaeological sites is low.

Additional subsurface investigations are recommended in the eastern part of Marina Beach Park for areas historically positioned at the base of the sand spit.

9.0 GEOTECHNICAL EVALUATION

The purpose of the geotechnical evaluation summarized here was to examine the potential effects of proposed channel excavations on adjacent property and structures, and to develop conceptual level design recommendations for mitigation of geotechnical and geologic hazards. Field explorations were performed in the Marina Beach Park area and geotechnical data on the BNSF railroad bridges and adjacent hillslope were reviewed. Full details are provided in Appendix I.

Two borings and five test pits were completed at Marina Beach Park. One of the borings was advanced to a depth of 20 feet below ground surface (bgs) and the second was advanced to a depth of 45 feet bgs. Depths of the test pits ranged from 8 to 14 feet bgs.

Soil samples were screened onsite for contamination based on visual, olfactory, or other indicators. Samples were collected near the water table, where encountered, and screened for volatile organic compounds using a photoionization detector. No indications of hydrocarbon contamination were observed in the test pit or boring samples.

Geotechnical laboratory tests were performed on selected samples retrieved from the explorations to characterize the index and engineering properties of the subsurface soils at the project site. Laboratory testing included visual soil classification, moisture content determinations, and grain size analyses (Appendix I).

Geologic units were identified for the sediment and soil types encountered in the project explorations. The geologic unit descriptions are described herein and are shown in the boring logs presented geotechnical report (Appendix I).

The subsurface conditions encountered in explorations in the project area generally consist of a fill (Hf) layer overlying beach deposits (Hb) locally interlayered with a 0.5- to 1-foot-thick marsh deposit (Hm). These units are further described as follows:

- Fill (Holocene fill - Hf) – Explorations encountered 6 to 8 feet of fill soil with variable properties. Hf generally consists of silty sand with gravel and cobbles to clayey sand with gravel and cobbles to 6 feet bgs at TP-4 at the Marina Beach Park lawn area. This fill may be associated with a glacial till source. Hf encountered in Marina Beach Park outside of the lawn area consists of poorly graded sand with gravel to 8 feet bgs, and may be derived from a nearby excavation in a similar beach environment. Based on the historical land uses in this area, some deposits resembling beach deposits have been interpreted as fill.
- Beach Deposits (Holocene beach - Hb) – Explorations encountered more than 20 to 46.5 feet of Hb below the fill unit. Hb generally consists of medium dense, poorly graded sand with silt to poorly graded sand and gravel with variable amounts of silt and wood fragments. Below about 35 feet bgs, Hb becomes dense.
- Marsh Deposits (Holocene marsh - Hm) – Test pit explorations locally encountered a thin 0.5- to 1-foot-thick layer of silty sand laminated with sandy silt and peat between 6 and 8 feet bgs. Metal debris was found on top of, and in, the marsh deposits in TP-2 and TP-3. Traces of iron-oxide staining were found in marsh deposits in TP-5.
- Near the adjacent hillslope, Hb and Hf are present at the base of the slope, and mapped Whidbey Formation underlies the slope.

Groundwater was encountered between 8 and 9.5 feet bgs, and is likely close to the mean tide level.

At the proposed Marina Beach Park channel, the soils that will form the channel side slopes consist of loose to dense sand and gravel fill over beach sands. The proposed channel cross sections indicate that the creek will consist of a 15-foot-wide low-flow channel and a 20- to 40-foot-wide bankfull (at MHHW) channel. These soils will generally form stable 2H:1V side slopes, steeper than the proposed 3H:1V side slope shown in the conceptual design plans.

According to BNSF bridge design drawings (Sheet 1 of 3, 90 percent submittal by AECOM, dated December 8, 2008), the bridge was designed for a future 6-foot bottom width, with a channel invert elevation of 4.26 feet (NAVD88), with 1.5H:1V slopes extending down from the top of the bridge piers to the channel bottom. The geometry of the bridge (span is 37 feet long) is such that 2H:1V sloping side channels will not allow for a bottom channel 6 feet wide as shown. Thus, a steeper slopes (1.5H:1V) will be required underneath the bridge. The steeper slope is acceptable if armored or reinforced at the surface to limit erosion- and scour-mediated undermining and sloughing.

Geotechnical boring logs for the BNSF bridge project (borings BH-1 and BH-2 by HWA) indicate the presence of loose to medium dense sand and silty sand to 18.5 feet bgs, followed by dense, slightly gravelly, silty sand and sand with gravel to the bottom of the boring at 41.5 feet bgs. The driven steel piles that support the BNSF bridge appear to derive their bearing from soils below a depth of 18 feet bgs. Thus, the proposed excavation that would remove soils from beneath the bridge would not have an adverse effect on foundation bearing capacity of the existing bridge.

For the proposed new pedestrian bridges, the results of boring B-1 indicate that the medium dense soils between 9 and 14 feet bgs (below the groundwater level) at the proposed bridge location are susceptible to liquefaction during a design level seismic event. Thus, the upper 14 feet of soils at the proposed bridge site would be susceptible to settlement during a seismic event and shallow spread footing foundations are not suitable. *For this reason, it is recommended that the proposed pedestrian bridge be supported on deep foundations that derive their capacity from medium dense to dense granular soils below 14 feet bgs.*

Potential geologic hazards that may affect the site include slope failure of the steep slope; liquefaction and associated effects (lateral spreading, differential settlement, and reduced bearing capacity foundations); and fault rupture. The review of these hazards is based on historical mapping and results of subsurface explorations.

Based on the Washington State Coastal Atlas (Ecology, 1979), the project site is mapped as unstable due to the steep slope east of the railroad tracks. The closest mapped landslide occurred about 0.5 miles south of the site, along the shoreline. Surficial sloughing of loose colluvium on the surface of the slope is possible. The potential for this type of movement is low to moderate over most of the hillside but high in some areas where local topography is steeper.

During an earlier data acquisition site visit, the presence of a large, older concrete structure extending along the toe of this steep slope was noted. The structure may have been constructed

as a retaining wall. Given the close proximity of the proposed channel to the toe of the slope, it is possible that the proposed channel excavation could undermine the structure at the toe of the slope and thereby cause slope instability. This proposed excavation over a distance of about 50 to 100 feet will likely require construction of a retaining wall at the toe of the slope (Figure 14). The retaining wall would likely consist of a soldier pile and lagging wall. To protect the base of the wall from scour, it may be necessary to construct a reinforced soil slope in front of the wall.

Additional site investigations are recommended to collect data on the slope, concrete structure, and condition of soils at this location. Site-specific slope stability analysis should then be performed to determine if mitigation measures are required.

10.0 CONTAMINATED SOILS EVALUATION

The purpose of the contaminated soils assessment was to evaluate the potential effects on fish habitat from residual contamination, and the likelihood of encountering contaminated media during construction of the future Willow Creek channel on the Unocal site. A detailed contaminated soils assessment report is included in Appendix J. Appendix K contains comments on the contaminated soils assessment from Department of Ecology and ARCADIS U.S., Inc., on behalf of Chevron Environmental Management Company (CMEC), dated November 18, 2015. [6]

The report in Appendix J and the comments in Appendix K include information provided by Chevron for the Unocal Site under a Draft Interim Action Work Plan (IAWP) for the Former Unocal Edmonds Bulk Fuel Terminal, released in July 2015 (Chevron, 2015). The IAWP was submitted to comply with the Washington State Department of Ecology Agreed Order No. DE 4460.

This feasibility study assessment relies on information provided in the IAWP and other supporting Unocal site cleanup documents to evaluate the potential effects both during the construction of the proposed channel, as well as the long-term effects on the daylighted channel. Possible design mitigations are also presented to reduce or eliminate the potential risks. Results of the contaminated soils review are summarized in this section.

The existing channel along BNSF and Unocal property would connect to the proposed daylighted channel on the Unocal property, pass underneath the pre-constructed BNSF railroad bridges, traverse Marina Beach Park, and enter into Puget Sound. Conceptual design for this alignment includes about 700 feet of daylighted channel excavations along the western boundary

[6] The Contaminated Soils Assessment Report in Appendix J was not revised based on the comments in Appendix K. The main text of the report does take into account the updated information from the Appendix K.

of former Lower Yard of the Unocal property and parallel to the BNSF railroad from the lower Willow Creek outlet to Marina Beach Park (Figure 8). The excavation is expected to be 5 to 10 feet deep with an average bottom width of 15 feet and an average top width of 40 to 50 feet, generating up to 17 cubic yards of soil per foot of channel.

The Lower Yard has undergone several phases of soil, sediment, and groundwater investigation and remediation. The contaminants of concern for the site are the total petroleum hydrocarbons (TPH) and their underlying constituents such as benzene and polyaromatic hydrocarbons (PAHs).

Cleanup to risk-based concentrations has been performed (Appendices J and K). Recent site monitoring identified two areas needing additional remediation (ARCADIS, 2015). As of fall 2015, Ecology and Unocal are finalizing an Interim Action Work Plan that is likely to be the final remedial action on the property. This plan includes remedial excavation of contaminated material from Detention Basin – 2, and a dual-phase extraction system along portions of the WSDOT stormwater line near Union Oil Road located on the west side of the Lower Yard. These actions will begin in the spring and summer of 2016 (South, 2015). Once remediation is deemed complete by Ecology, the Unocal property will transfer the property to WSDOT Ferries.

The cleanup may leave various areas in the site with residual contamination. The cleanup was performed on a statistical basis; therefore select areas of the site may have residual contamination in excess of the calculated cleanup criteria (South, 2015). Contamination encountered during construction that exceeds the calculated cleanup criteria will need to be disposed of at an off-site facility. Other areas having residual contamination may not exceed the calculated cleanup criteria, but have levels high enough to have staining or odors needing special consideration for on-site reuse, or special disposal locations if on-site reuse were not allowed. Ecology reassured the Willow Creek daylight team at the October 2015 meeting, that contaminated soil on-site reuse was permissible, provided contaminate concentrations are below cleanup levels (South, 2015). Additional measures may be needed for soil reuse to manage odors during construction, including special handling during construction such as covering the exposed soils, and soil capping in its final disposition.

In addition to soil reuse, capping and handling measures, an HDPE protective liner is recommended along the entire length of the daylight channel. This recommendation is to provide an additional level of protection to aquatic resources along the daylight channel, and to account for uncertainties associated with the site cleanup. The cost for the HDPE liner installation is included in the project cost estimates (Section 4.5 and Appendix D). The use of a liner will necessitate over-excavation to account for placement of ballast and topsoil over the

liner to resist buoyancy forces, and to allow for tree and shrub rooting. Costs for spoils requiring special handling, characterization, and disposal are reflected in the project cost estimates. *Groundwater modeling is recommended to evaluate the effects of a barrier to groundwater migration and avoid unforeseen negative consequences.*

During construction, residual contaminated soils disposal will likely be necessary, even though contaminated soils have been removed from much of the daylight alignment and replaced with clean fill. This feasibility study assumes that 50 percent of all soils to be excavated from the channel are contaminated with petroleum products. This conservative estimate results in a $1.1M cost for handling and disposal of contaminated soils. As part of the preliminary design process, it is recommended that additional soil samples be collected along the daylight alignment, if Unocal were to provide access, and perform testing to allow for characterization of the soil excavation areas, and refinement of the soil handling and disposal estimates. Otherwise, the testing, handling and disposal quantities will have higher uncertainty on the disposal quantities until later phases of design or construction.

In Marina Beach Park area, the two channel alignments (Options A and B) through the park into Puget Sound were evaluated; as noted earlier, a separate Option C was added during the Marina Beach Park master planning process but not fully evaluated during this phase of the feasibility study. Field explorations along channel alignment options A and B were conducted to characterize materials and evaluate geologic and environmental conditions present at Marina Beach Park. No evidence of contamination was identified in the geotechnical explorations performed for either alignment in the park. However, treated wood piles and other industrial debris may be present in the subsurface, within the park boundaries, in particular along the previous Unocal fuel transfer pier alignment. The Unocal fuel pier alignment follows the Option C (preferred) alignment, which is the current day south parking lot. *As part of the preliminary design process, it is recommended that additional soil samples be collected along the daylight alignment Option C in Marina Beach Park, and tested to allow for refinement of the soil handling and disposal estimates. In addition, ground penetrating radar could also be used along the Option C alignment to survey for timber pile obstructions that may be in the area.*

11.0 PROPERTY OWNER OUTREACH AND COORDINATION

The City is currently engaged in outreach and coordination with Chevron, WSDOT Ferries, and BNSF. The Port of Edmonds, which owns property adjacent to Marina Beach Park, was engaged during the park master planning process. The following is a brief status update of property owner coordination activities. A property, real estate and land strategy detailing the outcomes of this coordination is provided in Appendix L.

11.1 Chevron/Union Oil Company of California (Unocal)

Chevron Environmental Management Company manages the Unocal site, the parcel of land south of the City's Edmonds Marsh property and east of the BNSF railroad. Formerly a tank farm and petroleum distribution facility, the site is undergoing a remedial cleanup under an Agreed Order with Ecology. Chevron/Unocal also has an agreement with WSDOT Ferries to transfer the property for the Edmonds Crossing project when site cleanup is complete (South, 2012).

The City has engaged with Chevron on multiple occasions. A two-year site access agreement had been in place for collection and sharing of surface water data by S&W for the Early Feasibility Report; that agreement has now expired. The City provided an opportunity for Chevron to comment on both the Early and this Draft Final Feasibility Report(s), and is coordinating updates on site cleanup status. Ecology held a public meeting on August 20, 2015, to present Chevron's remediation plans for 2016. Chevron and Ecology are preparing responses to public comments made for the 2016 remediation plans.

The City of Edmonds and S&W met with Chevron/Unocal, Chevron's consultant ARCADIS, and Ecology on October 7, 2015, to discuss and understand the IAWP and better understand cleanup criteria and current monitoring results for the site described in this report. Both Ecology and ARCADIS, on behalf of Chevron, provided comments to the report (Chevron, 2015; Ecology, 2015) (Appendix K).

11.2 Washington State Department of Transportation (WSDOT) Ferries

The City has been actively engaged with WSDOT Ferries since the 2004 publication of the multimodal Edmonds Crossing EIS (CH2M HILL, 2004). The City met with WSDOT Ferries and Ecology in July 2014 to discuss the status of the Unocal site cleanup. Ecology (South, 2013) indicated that the remedial site cleanup was nearly complete. At this same meeting, WSDOT Ferries stressed the importance of keeping the daylight alignment as close as possible to the alignments shown in the EIS.

The City met with WSDOT Ferries twice in 2015. The first occasion was at a stakeholder interview for the Marina Beach Master Plan, during which the WSDOT Ferries representative explained that the record of decision for Edmonds Crossing EIS allows them to proceed with the project whenever it is funded (Fodor, 2015). WSDOT Ferries is also starting to update their long-range plan; it may include some form of the Edmonds Crossing project since ridership is up.

WSDOT Ferries requested a meeting with the City to further discuss the Edmonds Crossing project. At this early June 2015 meeting, WSDOT Ferries expressed concern that the conceptual drawing of park alternatives did not include Edmonds Crossing. The City agreed to show the Edmonds Crossing, Marina Beach Park fly-over structure leading to the proposed ferry terminal in future public documents and meetings. The City and WSDOT Ferries intend to explore a joint development agreement allowing both institutions to implement their projects in a mutually satisfactory manner. The ferry fly-over easement has been considered in the Marina Beach Park master plan. The easement would likely affect the park's future parking areas and certain lookout points on the north edge of the park near the Port of Edmonds breakwater structure.

11.3 BNSF Railway (BNSF) Railroad

To date, City staff has met twice with BNSF representatives. During the February 2015 stakeholder's interviews for the Marina Beach Park master planning process, BNSF stated they worked with Sound Transit on design and construction of the pre-constructed bridges explicitly for the daylight project. All track crossings (including the proposed daylighted creek under the pre-constructed bridges) need to be reviewed and approved by BNSF. Adequate site distance to tracks and safety signs are required, as are safety barriers to deter unauthorized access to tracks by the public.

The City also met with BNSF on May 27, 2015, to discuss possible daylighted channel cross-section options adjacent to the BNSF right-of-way. Issues discussed include fencing, channel liner and anchoring, and BNSF permit process and review timelines. A process was set up for submittal of future project deliverables to BNSF. BNSF offered to begin a draft permit and construction maintenance agreement for daylighting the creek under the pre-constructed bridges; this action is expected to strengthen future grant applications for the project.

12.0 PROJECT FUNDING AND SCHEDULE

The City is tracking a number of grant opportunities, and plans to match these grants with capital improvement funds. Potential funders include NOAA, U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, USACE, WDFW, Ecology, and the Washington State Recreation and Conservation Office. Other private grant and funding organizations may also be interested. The project is likely to be funded through a series of smaller grants and incrementally work towards the daylight, restoration, and master plans referred to in this report.

The current Willow Creek daylight project schedule is listed below:

- Marina Beach Park Master Plan – October 2015
- Willow Creek Daylight Final Feasibility Study – November 2015
- Willow Creek Daylight Preliminary Design – June 2016
- Willow Creek Daylight Final Design and Permitting – 2017
- Marina Beach Park Design and Permitting – 2016 - 2017
- Construction – 2018 – 2020

The schedule is subject to change as real estate agreements and easements could take time to complete.

13.0 PERMITS

The following permits that will likely be required for project:

- Clean Water Act (CWA) Section 404 USACE permit (likely an individual permit)
- CWA Section 401 Water Quality Authorization (likely an individual permit)
- Endangered Species Act Section 7 Consultation
- National Historic Preservation Act Section 106 Consultation
- WDFW Hydraulic Project Approval
- SEPA Checklist
- City of Edmonds Permits
  - Shoreline Substantial Development Permit
  - Coastal Zone Management Consistency
  - Fill/Grade Permit
  - Edmonds Building Permit
  - Stormwater Approval
- BNSF Permits/Agreements
  - Temporary Right-of-Entry
  - Construction Maintenance Agreement
  - Engineering Review

The following documents will also need to be submitted:

- Joint Aquatic Resource Permit Application
- Biological Assessment –The project environmental site assessment (ESA) determinations are expected to be "May Affect," with "Not Likely to Adversely Affect," and "No Effect," for species with special status.
- ESA Section 7 – Limit 8 form for approved salmon habitat restoration projects
- Section 106 – Archaeological Review

14.0 PROJECT RECORDS AND IMPORTANT INFORMATION

Key project records have been provided in Appendix N for reference.

15.0 FINDINGS AND RECOMMENDATIONS

Overall, the feasibility study demonstrates that the Willow Creek daylight project preferred restoration plan would improve fish passage to the Marsh, would improve salmon habitat along the Central Puget Sound shoreline, and is feasible. Findings and recommendations for the next phase of design and permitting are noted in this section.

15.1 Marina Beach Park

The beach outlet channel between the main portion of the Marsh and the beach provides important rearing habitat for juvenile salmon while also functioning as a migratory corridor for the fish. The outlet channel can provide highly functional habitat for rearing fish and is an important component of the overall benefits to juvenile salmon.

The proposed daylighting of Willow Creek will restore the connection between Puget Sound and Edmonds Marsh and provide conditions that will enable juvenile salmon, other fish, and other nearshore fauna to enter the Marsh system during portions of the tidal cycle.

The master planning process for the Marina Beach Park has progressed and identified a preferred alignment, Option C (see Section 4.1 and Figures 8 and 12), as well as added various infrastructure including a second pedestrian bridge to the Marina Beach Park site.

The beach outlet channel design will need to focus on alignment, channel geometry, and use of materials that support regular access to the daylighted channel and Marsh system, while providing productive juvenile salmon rearing habitat and minimizing or softening the use of riprap and hardened stream bank features.

To the extent possible given the park needs, the beach outlet channel could be designed to provide better habitat if space is available for channel movement over time and to have flatter side slopes than are shown in this Final Feasibility Study at 3H:1V.

Regardless of the beach outlet channel alignment, dogs should not be allowed to enter the channel. Restricting people from entering the creek would also benefit fish, ecological conditions in the creek, and, given the proposed channel depth, public safety.

A vegetated buffer along the outlet channel would reduce behavioral disturbance to fish and other animals in the park areas of the daylighted channel, and, provide prey inputs, shade, and separation from park visitors in upland areas along the beach channel in the park. The flow regime and riparian conditions along the mostly bare, existing daylight channel, will shift from a shallow, mixed tidal and stream flow condition, to a predominately tidal flow condition with dense riparian vegetation. The tidal inflows will have water temperatures similar to the Puget Sound, and in combination with dense riparian plantings and large woody debris will provide shade and habitat cover, and will have lower water temperatures than existing conditions. Future design phases will provide an analysis demonstrating the expected improvements in water temperatures along the proposed daylighted channel.

Preliminary design of the daylighted channel should further evaluate channel bottom widths, bank grading, tidal flow velocities and depths, vegetation plans, and bridge designs. This design refinement will involve additional hydraulic modeling runs with the revised plans and iterations of the channel geometry. One concern brought forth in the planning process and listed above is tidal flow velocities, depths, and public safety concerns, and their management in the park setting. The outlet of the daylighted channel, beach, and backshore areas need a design for grading, vegetation, and large woody debris; the design should be developed by a hydraulic or coastal engineer or coastal geomorphologist.

15.2 BNSF Railway (BNSF) Bridges

The design plans through the BNSF bridges will involve an independent permit and landowner construction and maintenance agreement process with the railroad. A separate set of design plans and permit applications should be developed specifically for BNSF. BNSF has already provided the City with a permit and drawing review submittal tracking sheet. Plans will focus on design of erosion protection, embankment stability measures in and around the railroad bridges, construction sequencing, and safety requirements while working in and around the railroad. A full description of rail operations, safety provisions, and construction methods will be required for development of a construction maintenance agreement between BNSF and the City.

15.3 Daylighted Channel – Union Oil Company of California (Unocal) Property

The daylighted channel conceptual design upstream of the railroad bridge has been located entirely on the Unocal property, paralleling the BNSF railroad right-of-way. The design will require coordination and design review with WDOT Ferries after Chevron/Unocal transfer the property.

Going forward, this study recommends developing a composite channel design, including a low-flow (inset) floodplain and marsh bench with dense riparian plantings on the bench and upper channel banks to provide habitat cover and shading along the daylighted channel. To the extent possible along the entire alignment, the design should include dense riparian vegetation that shades the channel. Overhanging vegetation will provide cover for the fish, reduce solar heating of the water, and separate the channel from activities on adjacent properties.

Refinement of the channel cross-section geometry to provide an inset channel would create more suitable fish habitat during the fall migration periods, tidal only, and low-flow periods. Such refinements should consider the resulting effects on depth and velocity to maximize fish passage and fish habitat within the channel over a range of flow conditions.

Instream wood should be included in the daylighted channel design to provide habitat structure, cover, and resting areas with lower velocities for migrating juvenile salmon. These elements will improve the fish passage conditions for the fish, as well as improve the rearing habitat quality in the channel.

If space allows, given other constraints, habitat in the outlet channel would be improved by adding sinuosity. If the channel is shifted to the east, or meandering within an inset channel, there could be more room to provide a vegetated riparian buffer.

Design of the daylighted channel will include the use of a liner to protect from the risk of residual petroleum product contamination. This will require soil and groundwater sampling (if allowed by Unocal), groundwater modeling and buoyancy calculations, and liner and backfill designs. The liner design depths will need to be integrated with plans for dense riparian zone rooting depths and large woody debris scour depths along the channel. Characterization of the quantities of residual soil contamination for off-site disposal and on-site reuse is needed. These studies will need to be coordinated with Ecology and WSDOT.

The floodgate is located in the Unocal property daylight section of the project. Additional modeling and flood operation scenarios are needed to finalize the floodgate operations schedule and criteria for the City and regulatory permit agencies. Additionally, the floodgate design includes a sheet pile wall, concrete headwall, and floodgate structure. The structure will need to be tied to high ground on both sides of the channel, which may include design coordination and an upstream construction easement with BNSF. The project also recommends a fence along the BNSF right-of-way to prevent BNSF employees from cutting riparian vegetation and disposing of trash and debris in Willow Creek. This will require design coordination and a permit with BNSF.

The progress of the Unocal remedial cleanup will ultimately dictate the transfer of property to WSDOT allowing for the daylighting of Willow Creek. Continued landowner coordination is recommended. If at all possible, it is recommended that the City work with WSDOT and Ecology to advocate for the Willow Creek Daylight project with Unocal. Actions by Unocal that could expedite the design include allowing completion of the topographic survey and subsurface explorations along the daylight alignment, sharing of groundwater monitoring data for the preliminary design phase of work, and confirmation of cleanup criteria assumptions as they relate to the daylighted channel.

15.4 Edmonds Marsh

The preliminary design of the Edmonds Marsh includes excavation of daylighted channels through the cattail thickets to the SR-104 culverts. Unvegetated mudflat and vegetated low-marsh areas will expand, while the vegetated high-marsh area (including cattails) will shrink, but the rates of change are unknown. If the transition is too slow, cattail mowing or treatment should be considered as an adaptive management action. Also, importing large woody debris into the marsh would allow a greater range of terrain development and nurse logs for vegetation establishment and use by birds, amphibians, and mammals.

There is a moderate risk that sediments and surface water quality within the Marsh may be degraded. Sediment and water quality sampling in the Marsh is recommended to refine the design of proposed excavations and future habitat conditions.

The hydrologic monitoring data indicate that the Shellabarger Creek portion of the Marsh is disconnected from the main Marsh, indicating a blockage between the two marshes at the SR-104 culverts or from the dense cattail thickets. WSDOT should be encouraged to fully clean the culverts, as they are likely contributing to SR-104 flooding.

Independent of the Willow Creek Daylight project, a number of actions are planned for Shellabarger and Willow Creeks. Proposed actions in Shellabarger Creek include rerouting of SR-104 stormwater overflows to the Dayton Street pump station, removal of invasive nightshade in Stella's Marsh, and ultimately salmon habitat restoration and upstream connectivity to Upper Shellabarger Creek. Proposed actions in Willow Creek include fish passage barrier removal, stream restoration, and low-flow enhancements. These future actions are not addressed in this feasibility study.

With restored habitat and connectivity in Shellabarger and Willow creeks and the Marsh, upstream restoration is likely to be more successful. Sedimentation of the creeks at their

connections with the Marsh is likely a future maintenance consideration indicating an adaptive management and monitoring program element.

Upstream fish passage in Willow Creek through existing culverts and blockages, such as Pine Street or 216th Street SW, would greatly expand the benefits of the downstream daylight project on watershed restoration.

Another upstream restoration action to consider on Willow Creek is low-flow augmentation to reduce historic Edmonds drain diversions. Increased summer and fall low-flow conditions in Upper Willow Creek could lead to sustainable conditions for coho rearing and resident cutthroat trout.

It is recommended that an integrated plan of habitat restoration, stormwater runoff, and flood protection action items be prepared to help the City and their stakeholders understand the various actions in the Willow and Shellabarger Creek watersheds, and to ensure that multiple objectives are being met.

16.0 LIMITATIONS

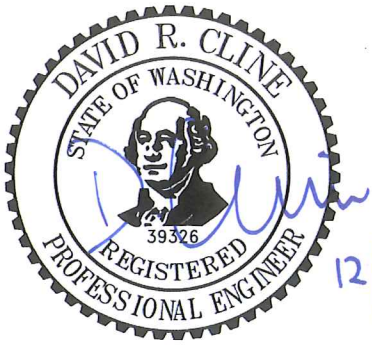
This feasibility study was prepared for the exclusive use of the City and their representatives for specific application to the Willow Creek Daylight project. Judgments, conclusions, and interpretations presented in the report should not be construed as a warranty of existing site conditions, nor of future estimated conditions.

The data presented in this report are based on limited survey and the current phase of the Final Feasibility Study. S&W is not responsible for conditions or consequences arising from relevant facts that were concealed, withheld, or not fully disclosed at the time the report was prepared. The facts and conditions referenced in this report may change over time, and the facts and conditions set forth here are applicable to the conditions as described only at the time of this report. The conclusions stated here are factual, but no guarantee is made or implied.

This report was prepared for the exclusive use of the City, and its representatives, and in no way guarantees that any agency or its staff will reach the same conclusions as S&W. The report was prepared within the limitations of the contract scope, schedule, and budget. The conclusions and recommendations presented in this report were prepared in accordance with generally accepted professional geotechnical and environmental engineering principles and practices in this area at the time this report was prepared.

Appendix O, "Important Information About Your Geotechnical/Environmental Report," is meant to help clients and others in understanding S&W reports.

SHANNON & WILSON, INC.



12/18/2015

David Cline, P.E., C.F.M.
Vice President

DRC:SWG:KK:PS:MM/drc

17.0 REFERENCES

Anchor QEA, LLC, 2013, Tidal marsh hydrodynamics report, Willow Creek daylight early feasibility study: Report prepared by Anchor QEA, LLC, Seattle, Wash., Project Number 120017-01.01, for Shannon & Wilson, Inc., Seattle, Wash., May.

Anchor QEA, LLC, 2015, Beach outlet and hydrodynamic evaluation report, Willow Creek daylight final feasibility study: Report prepared by Anchor QEA, LLC, Seattle, Wash., Project Number 140017-01.01, for Shannon & Wilson, Inc., Seattle, Wash., January.

ARCADIS, U.S., Inc. (ARCADIS), 2015, Chevron Environmental Management Company, public review draft interim action work plan, former Unocal Edmonds bulk fuel terminal, Edmonds, Washington: Report prepared by ARCADIS, Seattle, Wash., Project Number B0045362.0005, for Chevron Environmental Management Company, 11720 Unoco Road, Edmonds, WA, July.

Barnard, R. J.; Johnson, J.; Brooks, P.; and others, 2013, Water crossings design guidelines: Olympia, Wash., Washington Department of Fish and Wildlife, 297 p., available: http://wdfw.wa.gov/conservation/habitat/planning/ahg/.

Beamer, E.M., 2010, Fir Island Farm estuary restoration, typical outmigration periods for the Skagit River: Personal communication (correspondence) between E. M. Beamer, Skagit River System Cooperative and Brian Williams, Washington State Department of Fish and Wildlife.

Beamer, Eric and Fresh, Kurt, 2012, Juvenile salmon and forage fish presence and abundance in shoreline habitats of the San Juan Islands, 2008-2009: map applications for selected fish species: La Conner, Wash., Skagit System Cooperative, 77 p., December, available: http://skagitcoop.org/wp-content/uploads/Beamer_Fresh_2012_Final.pdf.

Beamer, E. M.; McBride, Aundrea; Henderson, Rich; and others, 2006, Habitat and fish use of pocket estuaries in the Whidbey Basin and north Skagit County Bays, 2004 and 2005: La Conner, Wash., Skagit System Cooperative, 76 p., January, available: http://skagitcoop.org/wp-content/uploads/EB2207_Beamer_et_al_2006.pdf

Beamer, Eric; McBride, Aundrea; Henderson, Rich; and Wolf, K., 2003, The importance of non-natal pocket estuaries in Skagit Bay to wild Chinook salmon: an emerging priority for restoration: La Conner, Wash., Skagit System Cooperative Research Department, 9 p., available: http://skagitcoop.org/wp-content/uploads/EB1579_Beamer_et_al_2003.pdf.

Beamer, E. M.; Zackey, W. T.; Marks, D. and others, 2013, Juvenile Chinook salmon rearing in small non-natal streams draining into the Whidbey Basin: La Conner, Wash., Skagit System Cooperative, 74 p., December, available: http://skagitcoop.org/wp-content/uploads/EB2752_Beamer-et-al_2013.pdf.

Beamish, R. J. and Mahnken, Conrad, 2001, A critical size and period hypothesis to explain natural regulation of salmon abundance and the linkage to climate and climate change: Progress in Oceanography, v. 49, no. 1-4, p. 423-437.

Belleveau, L. J., 2012, Determining the influence of soil salinity and tidal inundation on the growth, distribution, and diversity of salt marsh vegetation implications for the restoration of the Nisqually delta, Washington: Olympia, Wash., Evergreen State College, M.E.S. Thesis, 91 p.

BNSF Railway Company (BNSF), 2010, Final design for Sound Transit Commuter Rail, Seattle to Everett, Washington, grading and structures, as-builts: Sheet 1 of 3.

Brennan, J. S.; Higgins, K. F.; Cordell, J. R.; and Stamatiou, Vasilia, 2004, Juvenile salmonid composition, timing, distribution, and diet in marine nearshore waters of central Puget Sound in 2001-2002: Seattle, Wash., King County Department of Natural Resources and Parks, 164 p., available: http://www.kingcounty.gov/environment/watersheds/central-puget-sound/nearshore-environments/juvenile-salmonid-report.aspx.

CH2M Hill, 2004, SR 104 Edmonds crossing final environmental impact statement and final section 4(f) evaluation: Report prepared by CH2M Hill, Bellevue, Wash., for Federal Highway Administration (FHWA); Federal Transit Administration (FTA); Washington State Department of Transportation (WSDOT); and the City of Edmonds, FHWA-WA-EIS-98-I-F, November.

City of Edmonds (the City), 2010, Edmonds Marsh channel improvements: Available: http://www.edmondswa.gov/images/COE/Government/Departments/Development_Services/Planning_Division/Plans/Final_2010_SWM_Comp_PLan_Text.pdf.

Collins, B. D. and Sheikh, A. J., 2005, Historical reconstruction, classification, and change analysis of Puget Sound tidal marshes: Olympia, Wash., Washington Department of Natural Resources, 1 v., June, available: https://salishsearestoration.org/wiki/Collins_%26_Sheik_2005_reconstruction_of_puget_sound_tidal_marsh.

Cordell, J., 2013, Shoreline prey production: Personal communication (telephone conversation) between Jeff Cordell, University of Washington School of Fisheries and Aquatic Sciences, and Paul Schlenger, Confluence Environmental Company, April 2.

Duffy, E. J. and Beauchamp, D. A., 2011, Rapid growth in the early marine period improves marine survival of Chinook salmon (Oncorhynchus tshawytsha) in Puget Sound, Washington: Canadian Journal of Fisheries and Aquatic Sciences, v. 68, no. 2, p. 232-240.

Edmonds-South Snohomish County Historical Society and Museum, 2015, Edmonds history: Edmonds, Wash., Edmonds-South Snohomish County Historical Society and Museum, available: http://www.historicedmonds.org/history/edmonds-history/, accessed June, 2015.

Emcon, 1994, Background history report, Unocal Edmonds bulk fuel terminal, Edmonds Washington: Report prepared by Emcon, Bothell, Wash. project 0324-035.01, for Unocal Corporation, Edmonds, Wash., February.

Fodor, Kojo, 2015, regarding Willow Creek daylight alignment: Personal communications at meeting between Kojo Fodor, WSDOT Ferries, and City of Edmonds, June, 3..

Fresh, K. L.; Dethier, M. N.; Simenstad, C. A.; and others, 2011, Implications of observed anthropogenic changes to the nearshore ecosystems in Puget Sound: Olympia, Wash., Puget Sound Nearshore Ecosystem Restoration Project, Technical Report 2011-03, 29 p., available: http://www.pugetsoundnearshore.org/technical_papers/implications_of_observed_ns_change.pdf.

Gersib, R. 2008, Edmonds Marsh "aerial" photograph interpretation (historical conditions): Internal memorandum by Dick Gersib, Washington State Department of Transportation.

Hering, D. K.; Bottom, D. L.; Prentice, E. F.; and others, 2010, Tidal movements and residency of subyearling Chinook salmon (Oncorhynchus tshawytscha) in an Oregon salt marsh channel: Canadian Journal of Fisheries and Aquatic Sciences, v. 67, no. 3, p. 524-533.

Hirschi, R. and Doty, T., 2002, Juvenile salmonid use of tidal creek and independent marsh environments in north Hood Canal: summary of first year findings, Port Gamble S'Klallam Tribe Natural Resources: Available: http://www.kitsapgov.com/dcd/lu_env/cao/bas/fw/PGST%20juv%20sal%20in%20HC%20small%20estuaries%203-5-03.pdf.

Hood, G., 2009, Estuarine habitat restoration with global climate change and rising sea-levels: Presentation at the 2009 Northwest Straits Commission Annual Conference.

Jolitz, Kim, 2013, Comments on draft early feasibility study for Willow Creek daylight: Personal communication between Kim Jolitz, Chevron Environmental Management Corporation and Jerry Schuster, City of Edmonds, May 6 and 7.

McChesney, B., 2012, Daylighting of Willow Creek through the Port: Personal communication (telephone conversation) between Bob McChesney, Port of Edmonds and David Cline, Shannon & Wilson, August 22.

Moles, Todd, 2012, Willow Creek flood gate: Personal communication (in person) between Todd Moles, City of Edmonds Stormwater Department and David Cline, Shannon & Wilson, August 31.

National Geodetic Survey; Office of Coast Survey; and Center for Operational Oceanographic Products and Services, 2015, VDatum (vertical datum transformation), v. 3.4: National Oceanic and Atmospheric Administration, available: http://vdatum.noaa.gov/.

O'Connell, K., Myers, D., and Owens, B., 2009, Biological condition of the Edmonds waterfront and preliminary feasibility considerations for nearshore ecosystem restoration: Prepared for The Maria Norbury Foundation, Edmonds, WA, Prepared by People for Puget Sound, January 31.

O'Connell, K., 2015, Increased nightshade establishment in the Lower Shellabarger Creek area of Edmonds Marsh, east of SR-104: Personal communication (telephone) between Keeley O'Connell, EarthCorps, and David Cline, Shannon & Wilson, Inc., May.

Pentec, 1998, Evaluation of habitat benefits and impacts associated with the proposed daylighting of the outlet from Edmonds marsh: Report prepared by Pentec, Edmonds Wash., Project Number 00393-002, for Port of Edmonds, December 18.

Pentilla, Dan, 2007, Marine forage fishes in Puget Sound: Puget Sound Nearshore Restoration Project, Report no. 2007-03, 23 p., available: http://www.pugetsoundnearshore.org/technical_papers/marine_fish.pdf.

Perteet, 2012, Survey for Dayton St. and SR 104 storm drainage alternatives study, City of Edmonds, Wash.: Report prepared by Perteet, Seattle Wash., for City of Edmonds, Wash.

Pritchard, D. W., 1967, What is an estuary: physical viewpoint, in Lauff, G. H., ed., Estuaries, Jekyll Island, Ga., 1964, Proceedings: Washington, D.C., American Association for the Advancement of Science, publication no. 83, p. 3-5.

Redman, Scott; Myers, Doug; Averill, Dan; and others, 2005, Regional nearshore and marine aspects of salmon recovery in Puget Sound: Report prepared by Puget Sound Action Team, for Shared Strategy for Puget Sound, 321 p., June 28, available: http://www.pugetsoundnearshore.org/supporting_documents/RegionalNearshore_with_Appendices.pdf.

Rice, C.; Chamberlin, J.; Zackey, T.; and others, 2014, Pre-project Monitoring of the Qwuloolt restoration in the Snohomish Estuary. Salish Sea Ecosystem Conference, Seattle, Wash., May 2.

Rice, C., 2012, Edmonds Marsh restoration and recent fish observations: Personal communication (telephone conversation) between Casey Rice, National Marine Fisheries Service, and Paul Schlenger, Confluence Environmental Company, August 31.

RSMeans, 2013, RS Means heavy construction cost data 2014 (28th ed.): Kingston, Mass, R.S. Means Co., 739 p.

SAIC, 2013, Final report, Dayton Street and SR 104 storm drainage alternatives study: Report prepared by SAIC, Seattle, Wash., Project Number: 001712 | 26512110002 city, state, job number, for the City of Edmonds Stormwater Division, Edmonds, Wash., July.

Schlenger, P., Pers. Obs., 2012, Personal field observations by Paul Schlenger, Confluence Environmental Company, of juvenile salmonids in Willow Creek during site visit on August 31.

Shannon & Wilson, Inc. (S&W), 2010, Vegetation assessment and wetland reconnaissance: Technical Memo prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-12318-001 for Washington Department of Fish and Wildlife, Laconner, Wash., November, 19.

Shannon & Wilson, Inc. (S&W), 2013, Willow Creek daylighting final - early feasibility study, Edmonds, Washington: Report prepared by Shannon & Wilson, Inc., Seattle, Wash., 21-1-12393-206, for City of Edmonds, Edmonds, Wash., May 10.

Shipman, Hugh; Dethier, M. N.; Gelfenbaum, Guy; and Fresh, K. L., 2010, Puget Sound shorelines and the impacts of armoring - proceedings of a state of the science workshop, May 2009: U.S. Geological Survey Scientific Investigations Report 2010-5254, 266 p.

Shuster, Jerry, 2012, Willow Creek pipe, floodgate and Washington State Department of Transportation overflow manhole conditions: Personal communication (phone call) between Jerry Shuster, City of Edmonds Stormwater Manager, and David Cline, Shannon & Wilson, August.

Shuster, Jerry, 2015, Willow Creek, Port of Edmonds pipe conditions: Personal communication (phone call) between Jerry Shuster, City of Edmonds Stormwater Manager, and David Cline, Shannon & Wilson, August.

South, D., 2012, Sediment quality sampling results and need for Willow Creek cleanup on section of stream along eastern edge of Union Oil Company of California stormwater pond: Personal communication (email) from David South, Washington State Department of Ecology to Kim Jolitz, Chevron Environmental Management Corporation, August 9.

South, D., 2013, Status of the Union Oil Company of California site cleanup, sediment and groundwater quality within Willow Creek, Edmonds Marsh: Personal communication (telephone and email) between D. South, Washington State Department of Ecology, and Jerry Shuster, City of Edmonds, May 8.

South, D., 2015, Status of the Unocal site cleanup, sediment and groundwater quality within Willow Creek, and reuse of soils on site meeting the calculated cleanup criteria: Personal communication between D. South, Washington State Department of Ecology, and Jerry Shuster, City of Edmonds, October 7.

Thom, R. M.; Borde, A. B.; and Woodruff, D. L., 2000, Tidal wetland plants distribution and primary control factors in Commencement Bay: Sequim, Wash., Batelle Marine Sciences Laboratory, 13 p., April.

TABLE 1
WILLOW CREEK DAYLIGHT
PRELIMINARY OPINION OF PROBABLE CONSTRUCTION COST

Item	Description	Quantity	Units	Unit Cost	Item Cost[1]	Subtotal
1.0	Mobilization and Demobilization	1	LS	$ 50,000.00	$ 50,000	
1.1	Contract Administration, Submittals, Closeout	1	LS	$ 100,000.00	$ 100,000	**$ 150,000**
2.0	**Marina Beach Park (Channel and Habitat Features)**					
2.1	Temporary Erosion and Sediment Control	1	LS	$ 50,000.00	$ 50,000	
2.2	Demolition and Removal (existing tidegate and water main)	1	LS	$ 50,000.00	$ 50,000	
2.3	Dewatering	1	LS	$ 100,000.00	$ 100,000	
2.4	Channel Excavation	8,000	CY	$ 10.00	$ 80,000	
2.4.1	Haul and Dispose Excavated Material (uncontaminated)	3,900	CY	$ 10.00	$ 39,000	
2.4.2	Haul and Dispose Excavated Material (50 percent contaminated)	3,900	CY	$ 95.35	$ 372,000	
2.5	Vegetated Reinforced Soil Slope	1,000	VSF	$ 81.50	$ 82,000	
2.6	Channel and Shoreline Habitat Features	1	LS	$ 50,000.00	$ 50,000	
2.7	Revegetation	1	LS	$ 50,000.00	$ 50,000	**$ 873,000**
3.0	**Daylight Channel Construction**					
3.1	Temporary Erosion and Sediment Control	1	LS	$ 50,000.00	$ 50,000	
3.2	Dewatering	1	LS	$ 250,000.00	$ 250,000	
3.3	Dewatering (Contaminated GW Treatment)	1	LS	$ 50,000.00	$ 50,000	
3.4	Channel Excavation	16,900	CY	$ 7.00	$ 118,300	
3.5.1	Haul and Dispose Excavated Material (uncontaminated)	13,520	TON	$ 50.00	$ 676,000	
3.5.2	Haul and Dispose Excavated Material (50 percent contaminated)	13,520	TON	$ 80.00	$ 1,082,000	
3.6	Demolition, Protection, Modification of Stormwater Structures	1	LS	$ 250,000.00	$ 250,000	
3.7	HDPE Channel Liner for Contaminant Protection	84,600	SF	$ 2.50	$ 212,000	
3.8	Self-regulating Tidegate	1	LS	$ 400,000.00	$ 400,000	
3.9	Import Clean Liner Backfill	9,400	CY	$ 16.20	$ 152,000	
3.10	Utility Relocations	1	LS	$ 25,000.00	$ 25,000	
3.11	BNSF Railroad ROW Work					
3.11.1	BNSF Permits and Construction Maintenance Agreement	1	LS	$ 50,000.00	$ 50,000	
3.11.2	BNSF Railroad Crossing Special Insurance	1	LS	$ 100,000.00	$ 100,000	
3.11.3	BNSF Railroad Flagger	30	EA	$ 2,000.00	$ 60,000	
3.11.4	Erosion Protection Rock Bedding Material	250	CY	$ 60.00	$ 15,000	
3.11.5	Erosion Protection Rock (12-inch Riprap)	500	CY	$ 60.00	$ 30,000	
3.14	Soldier Pile Wall	150	LF	$ 2,500.00	$ 375,000	
3.15	MSE Wall Facing	750	SF	$ 50.00	$ 37,500	
3.16	Daylight Channel Revegetation	1	LS	$ 50,000.00	$ 50,000	**$ 3,982,800**
4.0	**Marsh Improvements**					
4.1	Clearing and Grubbing (remove cattails)	1.4	AC	$ 10,000.00	$ 14,000	
4.2	Channel Excavation/Dredging	970	CY	$ 50.00	$ 49,000	
4.3	Haul and Dispose Excavated Material (uncontaminated)	485	CY	$ 10.00	$ 5,000	
4.4	Haul and Dispose Excavated Material (contaminated)	485	CY	$ 95.35	$ 46,000	
4.5	Marsh Habitat Features	1	LS	$ 25,000.00	$ 25,000	
4.6	Revegetation	1	LS	$ 50,000.00	$ 50,000	**$ 189,000**
				Equipment, Labor, and Material Costs	**$ 5,195,000**	**$ 5,195,000**
				Taxes (9.5%)	$ 494,000	
				Bonding & Insurance (5%)	$ 260,000	
				Contingency (25%)	$ 1,487,000	
				Construction Cost	**$ 7,436,000**	**$ 7,436,000**
				Real Estate Agreements, Easements, Real Property (TBD)	$ -	
				Engineering, Permits (15%)	$ 1,115,000	
				Project Costs	**$ 8,551,000**	**$ 8,551,000**

1 - Costs are rounded to nearest thousand.

TABLE 2
APPLICABLE FISH PASSAGE VELOCITY CRITERIA

Culvert Length (ft)	Maximum Velocity (fps)
10 – 100	4
100 – 200	3
>200	2

Note: Minimum depth criterion is 0.8 feet per Washington Administrative Code 220-110-070.

TABLE 3
PERCENTAGE OF TIME PROVIDING FISH PASSAGE

Criteria	No Flood Gate (%)	With Flood Gate (%)
Incoming tide and minimum depth > 0.8ft	26%	26%
Maximum velocity < 4fps and minimum depth > 0.8ft	65%	63%
Maximum velocity < 3fps and minimum depth > 0.8ft	65%	47%
Maximum velocity < 2fps and minimum depth > 0.8ft	57%	36%
Maximum velocity < 1fps and minimum depth > 0.8ft	38%	30%

Note: Most applicable criteria per Washington Administrative Code 220-110-070.

0 ½ 1

Scale in Miles

N
W E
S

Willow Creek Daylight Project
Edmonds Marsh
Edmonds, Washington

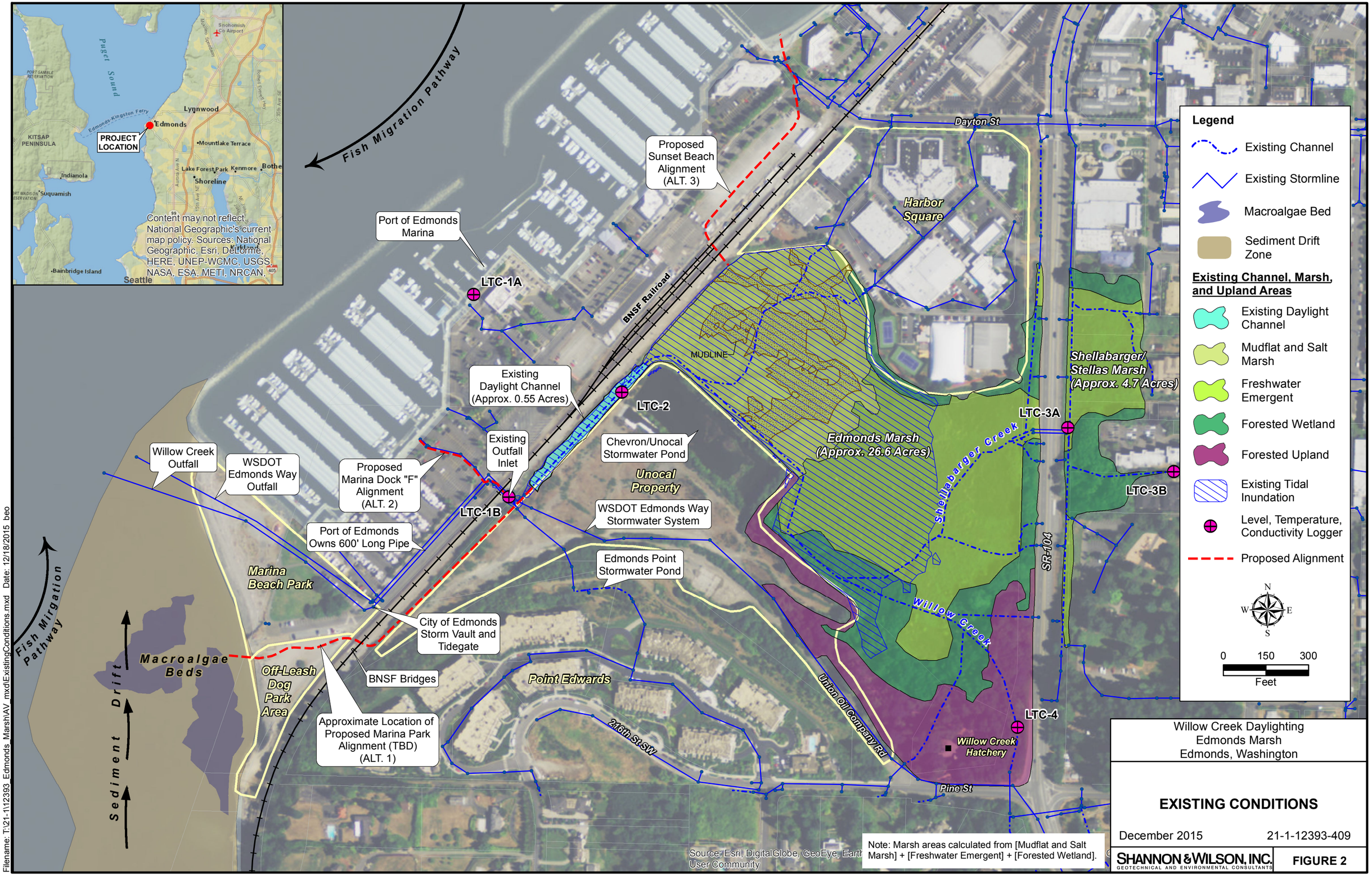
VICINITY MAP

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 1

Filename: I:\WIP\21-1\12393 Willow Creek Daylight\406. GEOTECH\Report\Figures\old\VicinityMap.mxd Date: 9/28/2015 beo



Note: Marsh areas calculated from [Mudflat and Salt Marsh] + [Freshwater Emergent] + [Forested Wetland].

Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

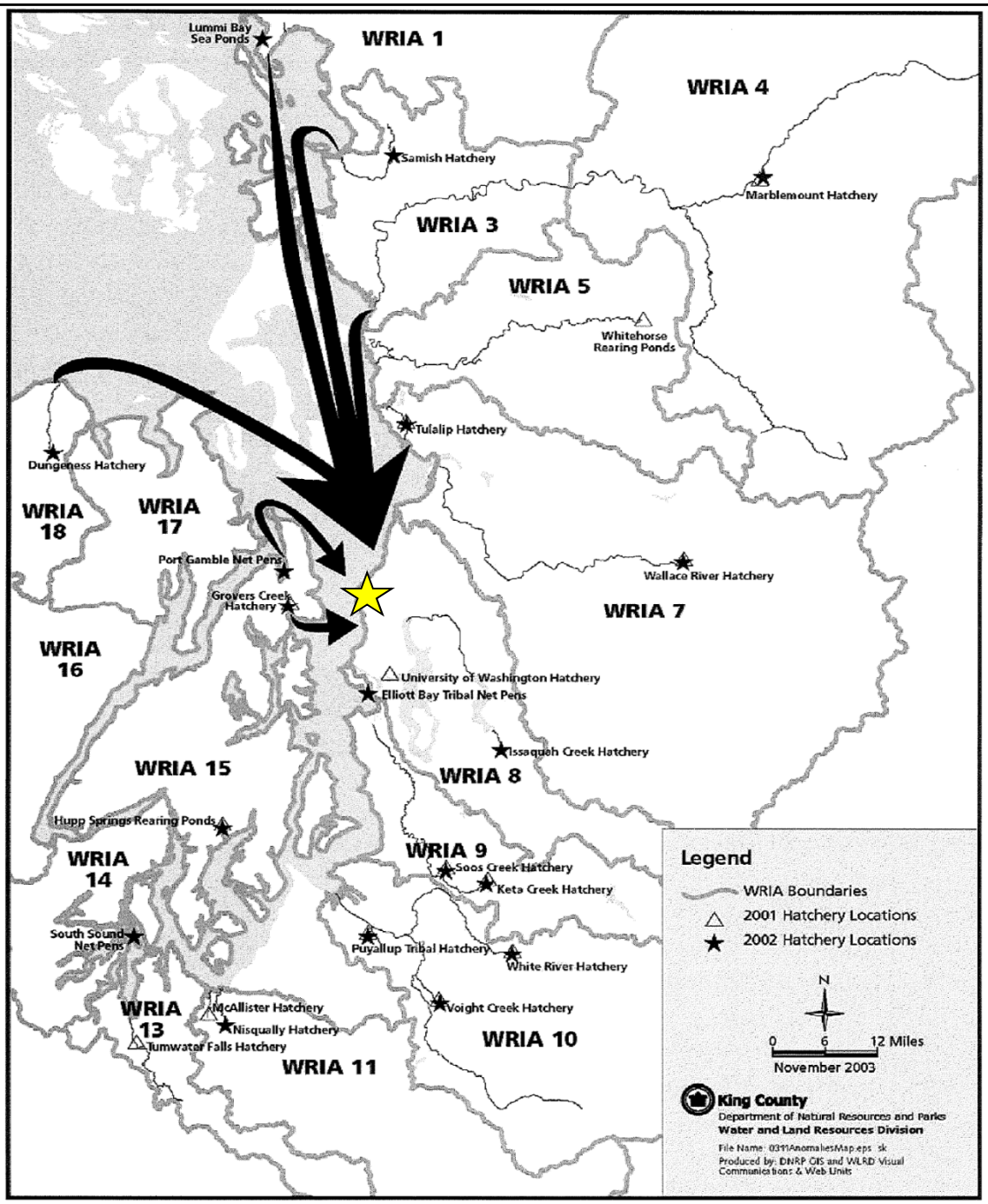
EXISTING CONDITIONS

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 2

Filename: T:\21-1\12393_Edmonds_MarshAV_mxd\ExistingConditions.mxd Date: 12/18/2015 beo



City of Edmonds

Willow Creek

Edmonds, WA

Juvenile Chinook Migration Patterns

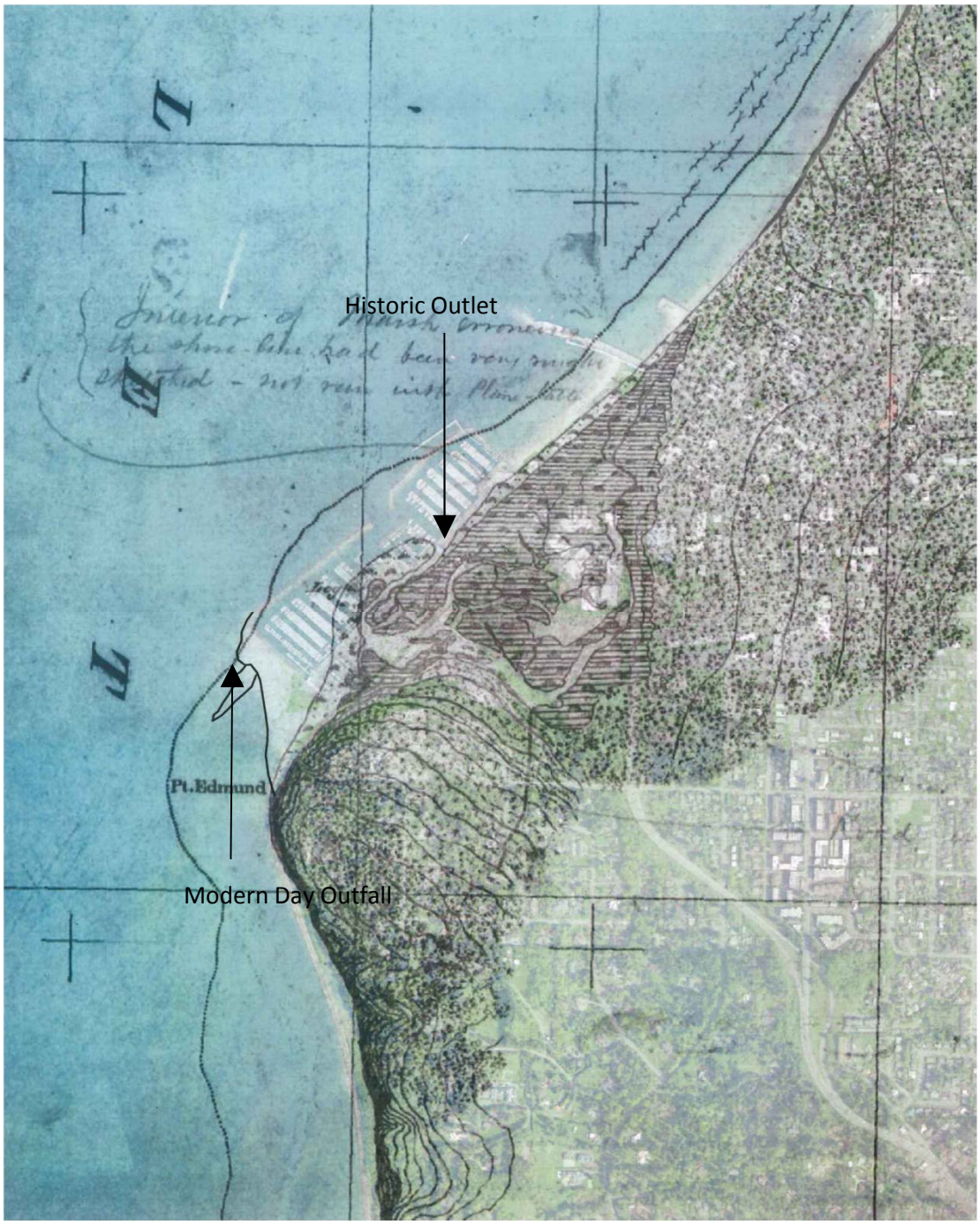
Source: King County 2004

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 3

FIG.3



Willow Creek

Edmonds, WA

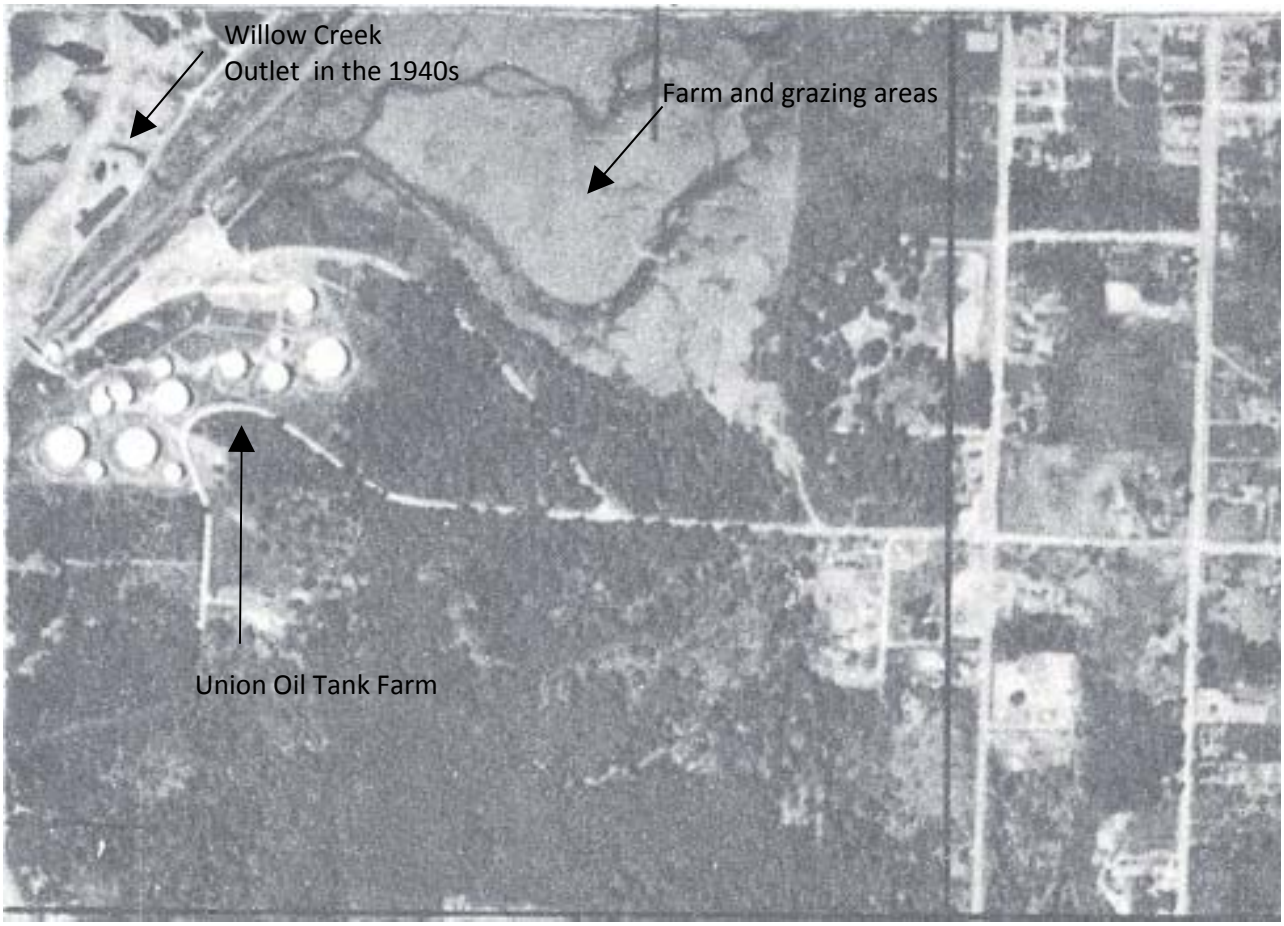
1870 HISTORIC MARSH

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 4

FIG. 4



Willow Creek

Edmonds, WA

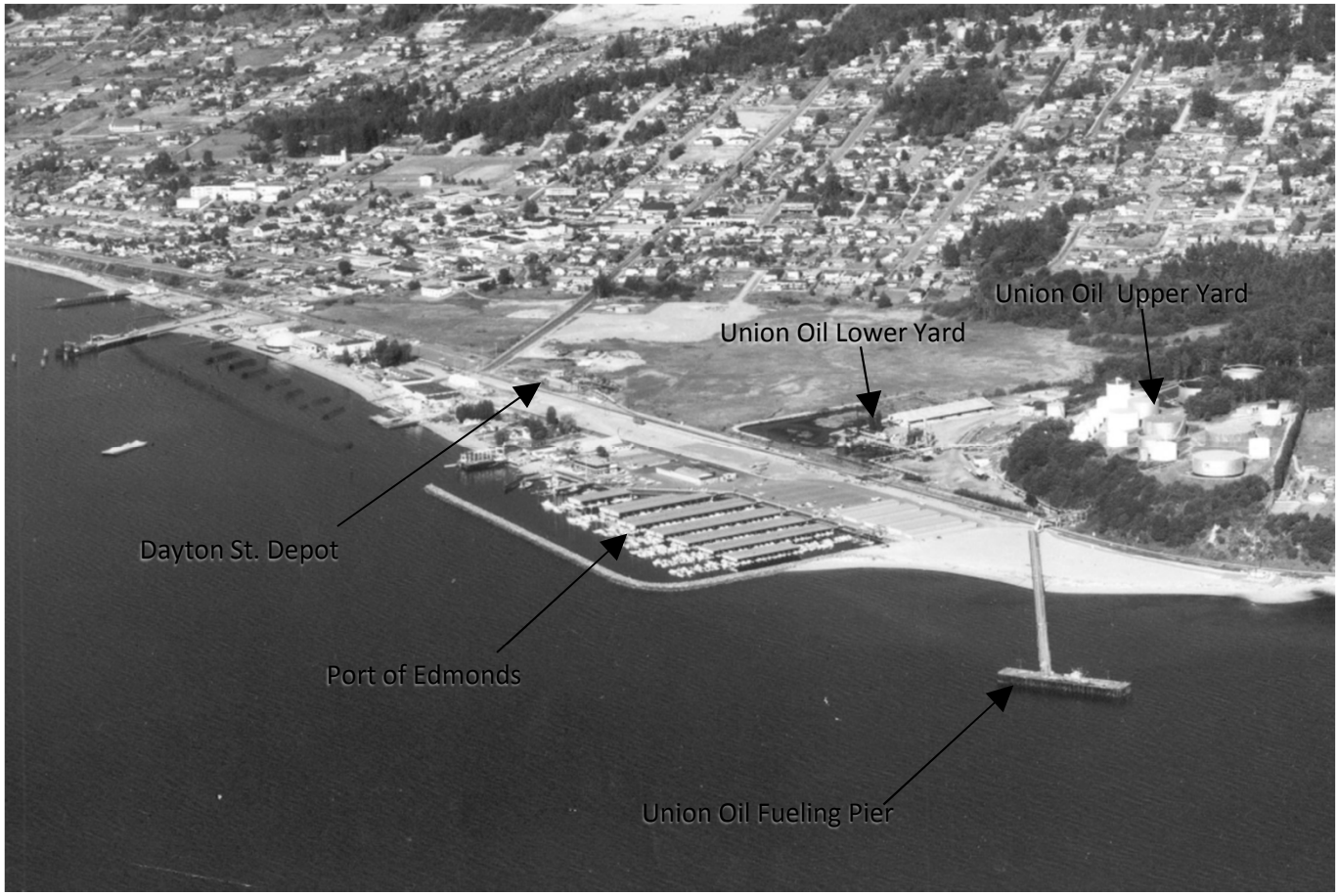
1944 Edmonds Marsh

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 5

FIG. 5



Willow Creek

Edmonds, WA

1967 Edmonds Marsh Oblique Aerial Photograph

Source: City of Edmonds, 1967

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 6

FIG. 6

Willow Creek

Edmonds, WA

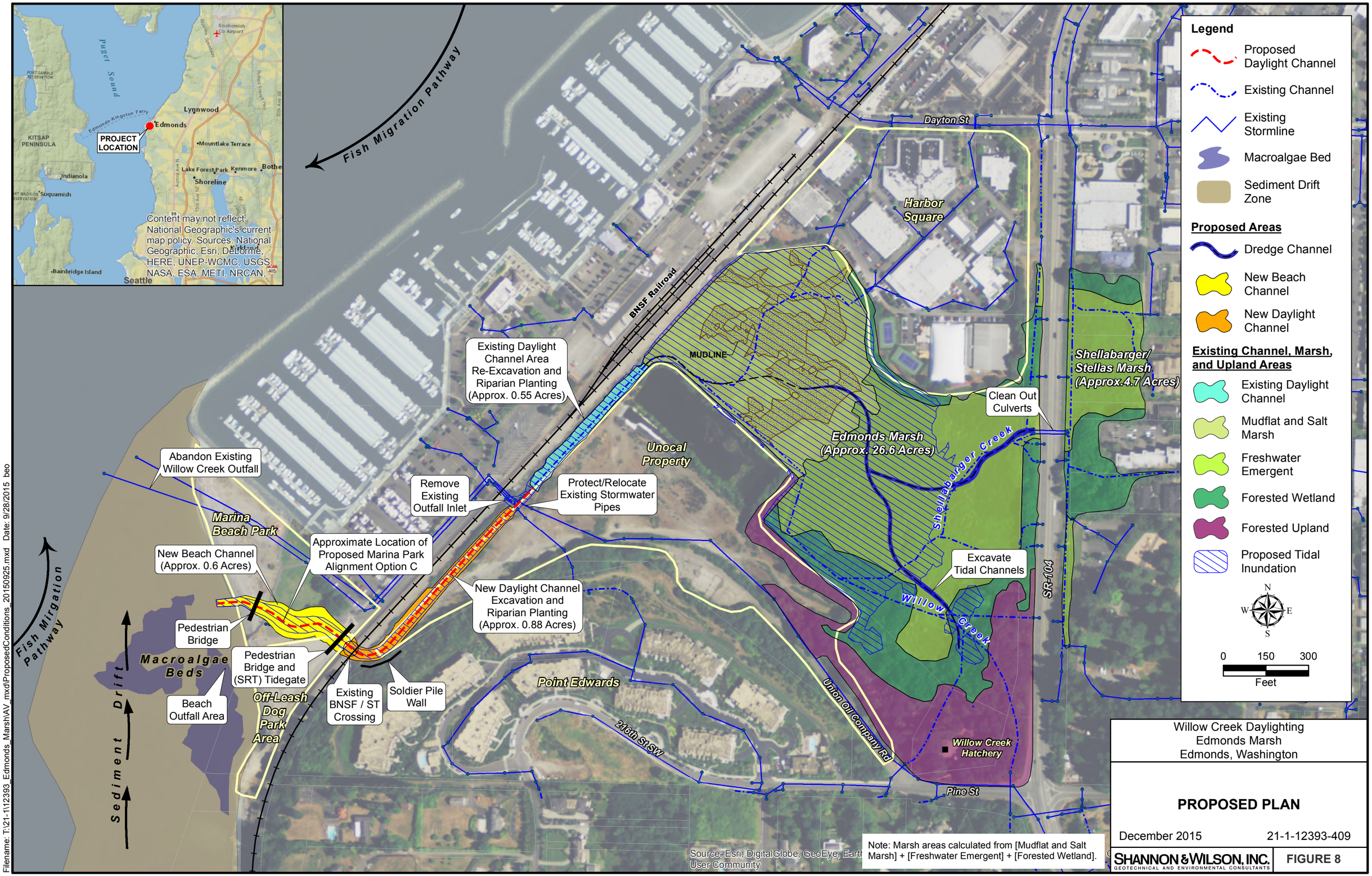
1964 Marsh and Unocal Site

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 7

FIG. 7



Note: Marsh areas calculated from [Mudflat and Salt Marsh] + [Freshwater Emergent] + [Forested Wetland].

Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

PROPOSED PLAN

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 8

Filename: T:\21-1\12393_Edmonds_MarshIAV_mxd\ProposedConditions_20150925.mxd Date: 9/28/2015 beo

Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

MARINA BEACH PARK OUTLET OPTION A

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 9

Filename: T:\21-1\12393_Edmonds_MarshAV_mxd\ExplorAndProposedChannelSurfaces.mxd Date: 9/28/2015 beo

Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

MARINA BEACH PARK OUTLET OPTION B

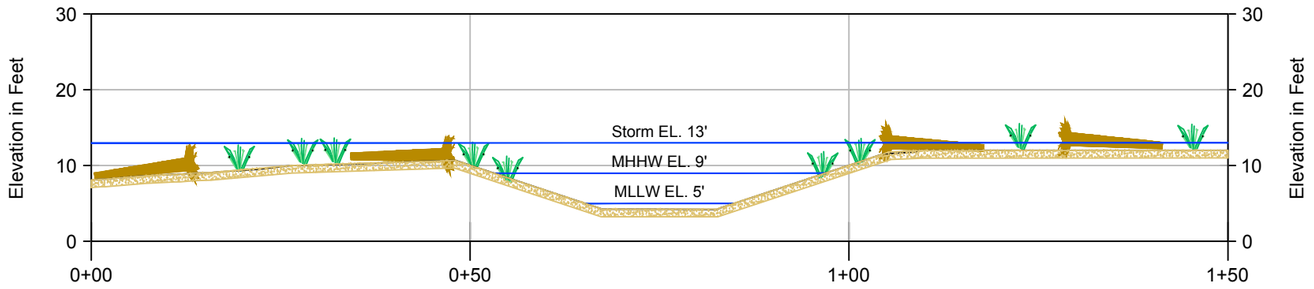
Decmber 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

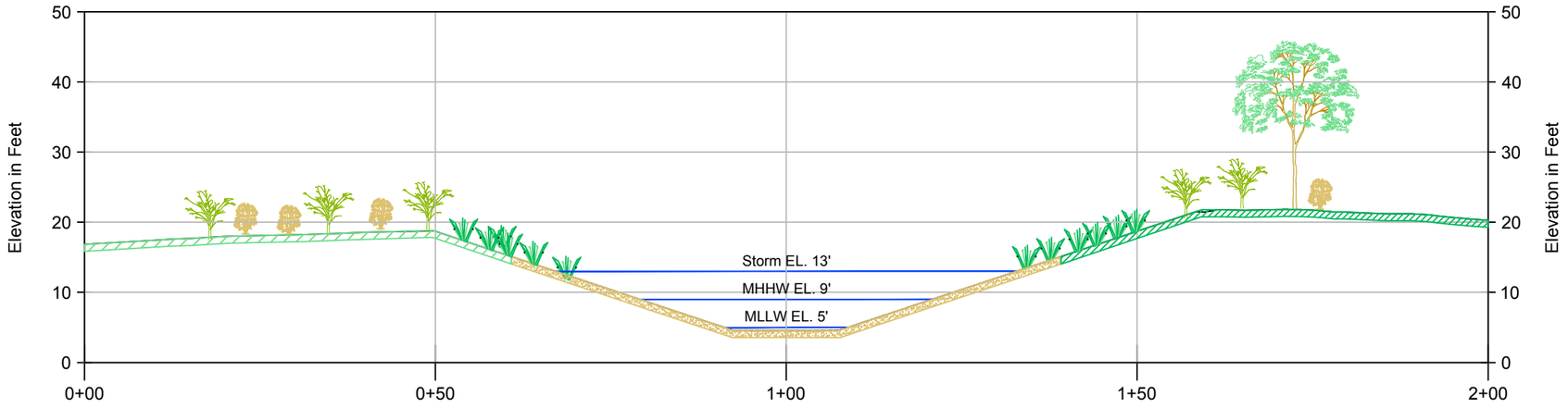
FIGURE 10

Filename: T:\21-1\12393_Edmonds_MarshAV_mxd\ExplorAndProposedChannelSurfaces.mxd Date: 9/28/2015 beo

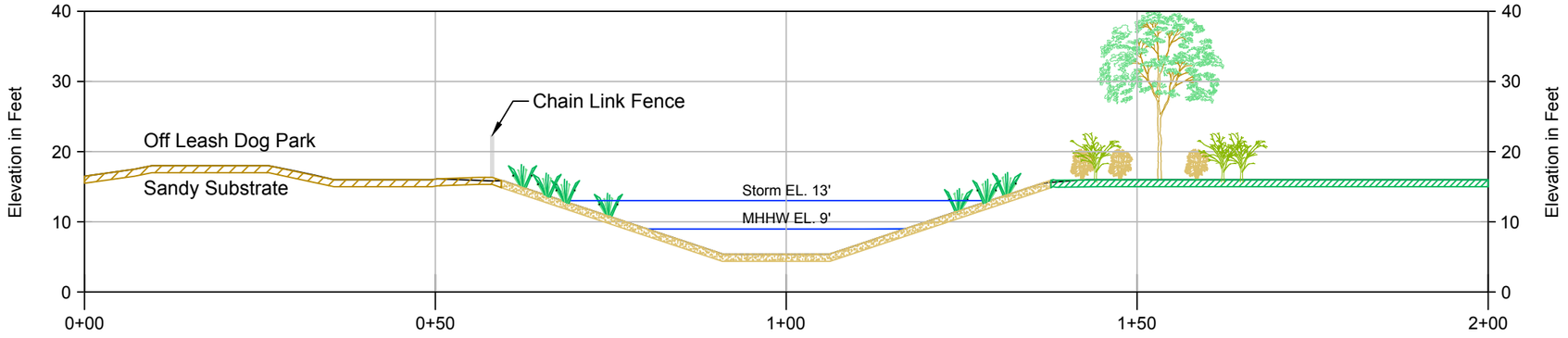
Section A-A

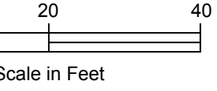


Section B-B



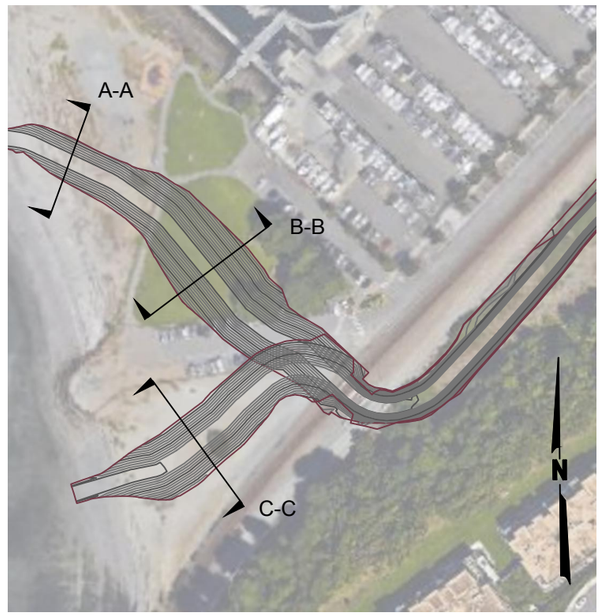
Section C-C





NOTE

Figure adapted from electronic files, *2004_Willow_Cr_Survey.dwg*, 2008_Marsh_Survey.dwg, *20120049 TOPO.dwg* and Basemap.dwg received 08-04-2014.
Aerial.jpg received 08-11-2014.



INSET MAP OF ALIGNMENT OPTIONS
SCALE:1"=200'

Willow Creek Daylight Project
Contaminated Soils Assessment
Edmonds, Washington

BEACH OUTLET DAYLIGHT ALIGNMENT OPTION SECTIONS

December 2015 21-1-12393-407

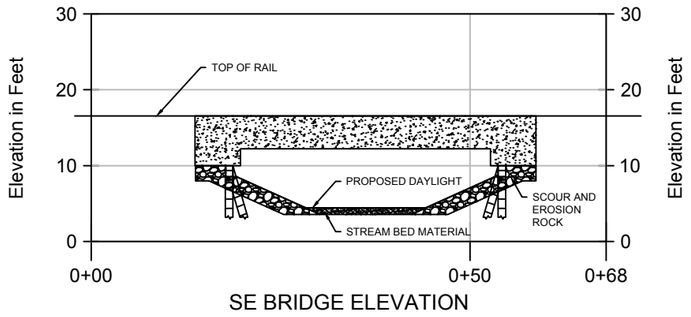
SHANNON & WILSON, INC. GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 11

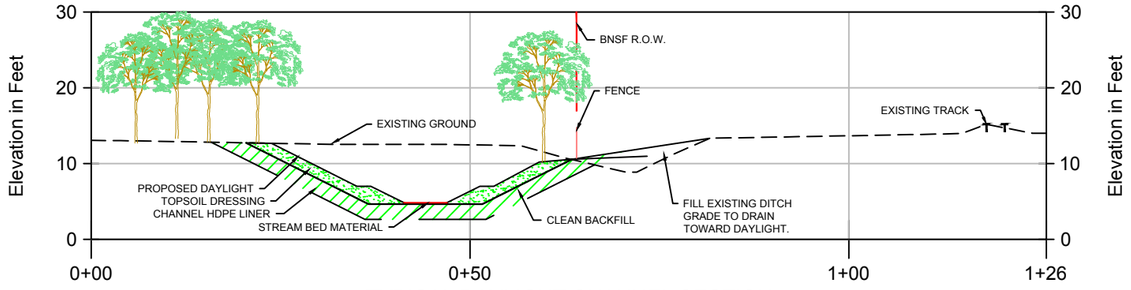
Filename: I:\WIP\21-1\12393 Willow Creek Daylight\CAD\03. BASE_DWG\Grading Base.dwg Date: 12-18-2015 Login: cmh

NOTES

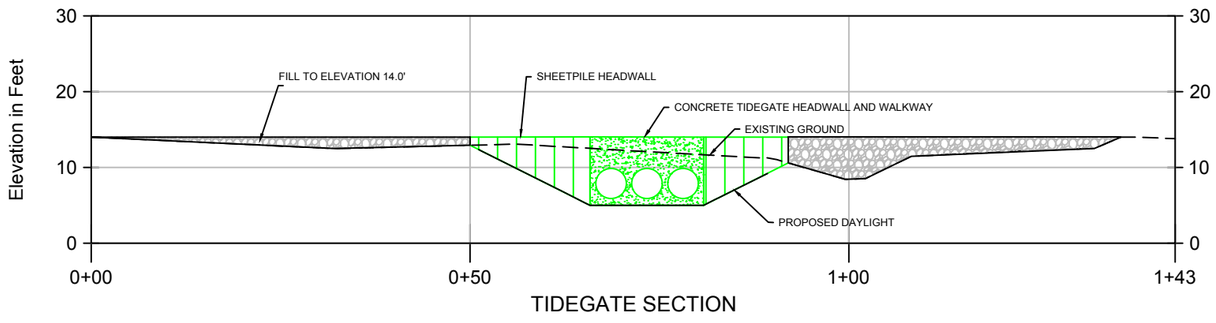
1. DAYLIGHT CHANNEL CHANNEL GRADING TO OCCUR SE OF BNSF RIGHT OF WAY.
2. ADDITIONAL GRADING REQUIRED TO MAINTAIN DRAINAGE PATTERNS.
3. REPLACE FENCE AT BNSF ROW.
4. BRIDGE PROFILE GENERATED FROM SURVEY AND 90% AECOM SUBMITTAL, NOT FOR CONSTRUCTION



SE BRIDGE ELEVATION

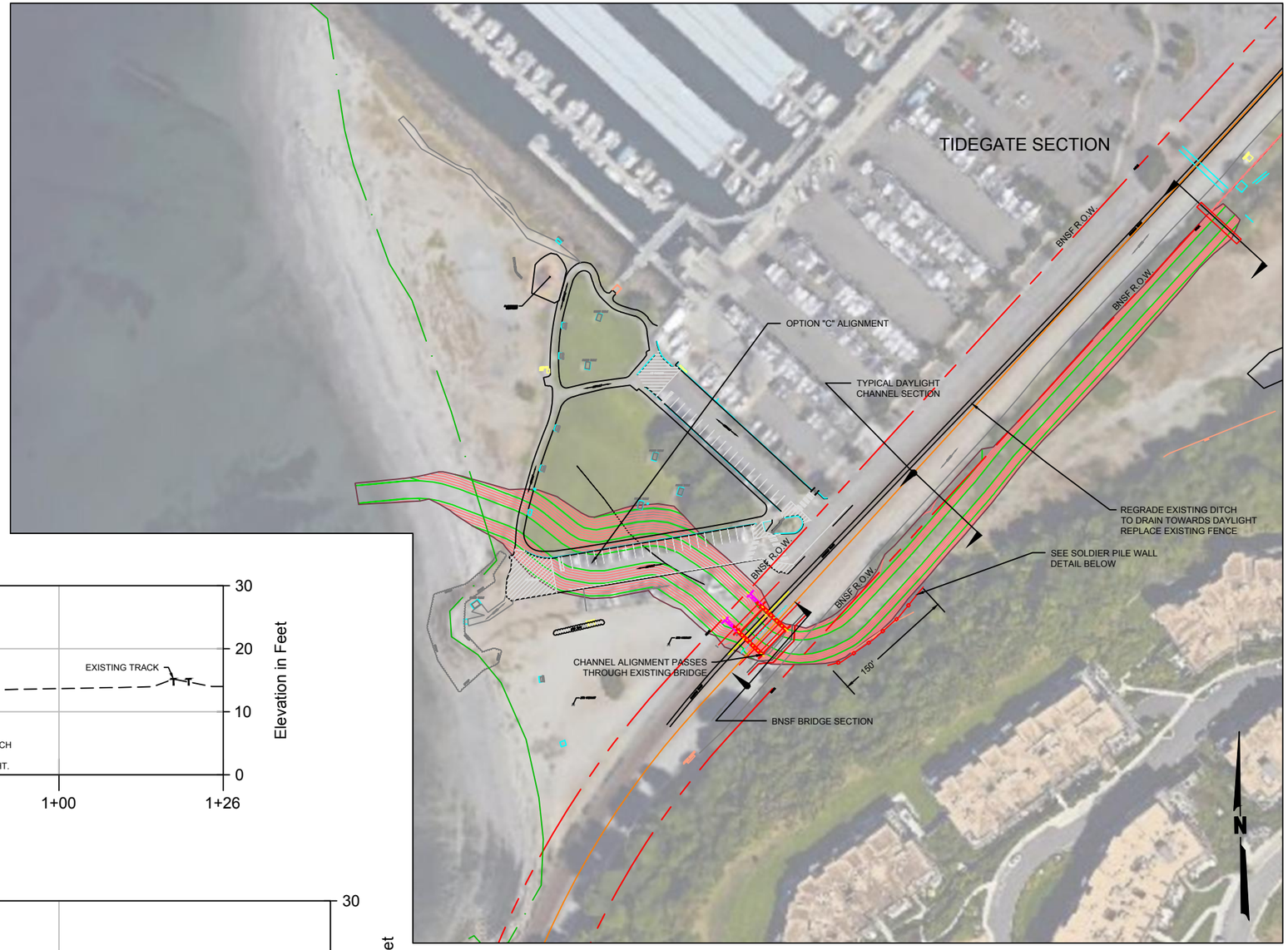


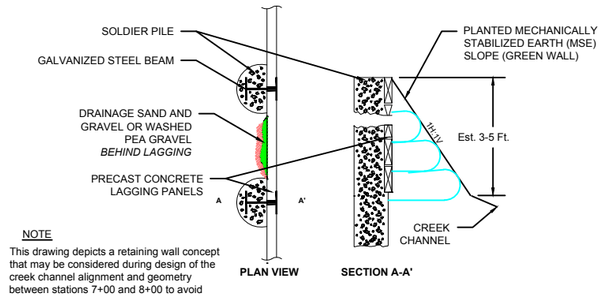
TYPICAL DAYLIGHT CHANNEL SECTION



TIDEGATE SECTION

Scale in Feet





NOTE

This drawing depicts a retaining wall concept that may be considered during design of the creek channel alignment and geometry between stations 7+00 and 8+00 to avoid excavation into the toe of the steep slope along the property boundary.

INSET MAP OF ALIGNMENT OPTIONS

Willow Creek Daylight Project
Contaminated Soils Assessment
Edmonds, Washington

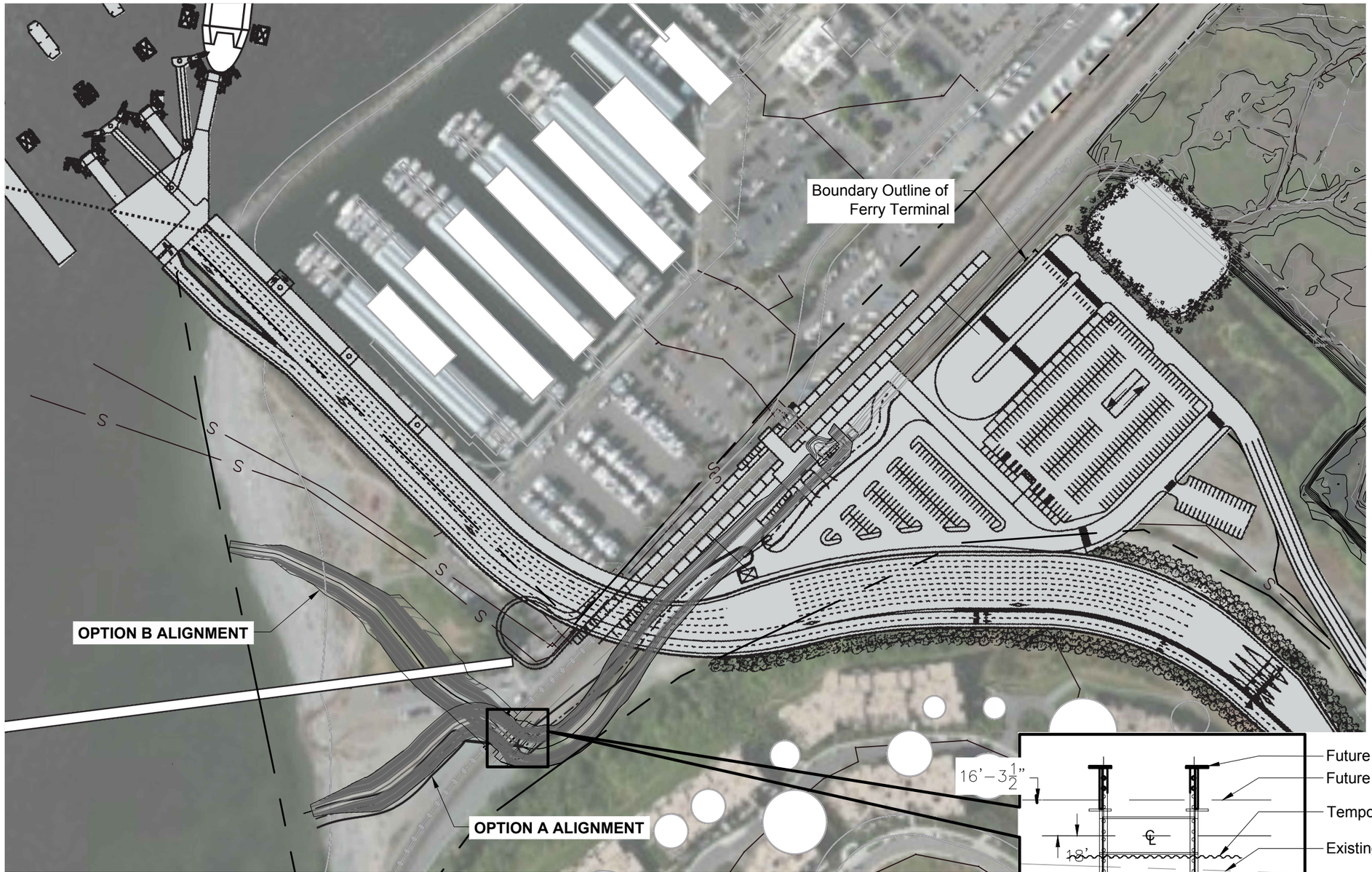
PREFERRED DAYLIGHT ALIGNMENT AND TYPICAL SECTIONS

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 12

Filename: I:\WIP\21-1\12393 Willow Creek Daylight\CAD\04. SHEET_DWG\Railroad Sections.dwg Date: 12-18-2015 Login: cmh

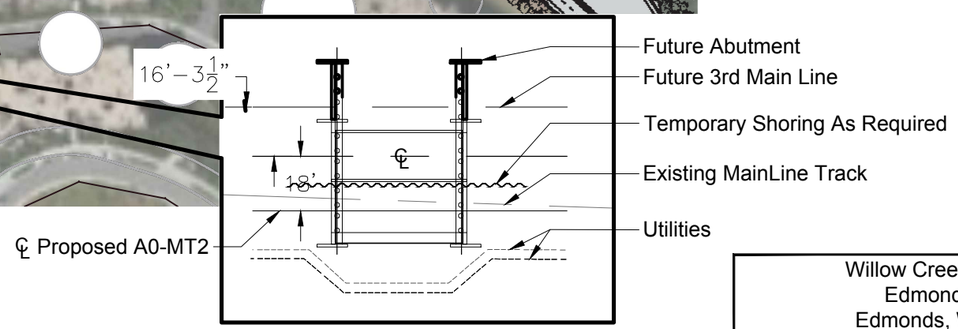


N

LEGEND

Existing

- Major Contour
- Minor Contour
- Finished Grade Contour
- Boundary Line
- Electric
- Fiber Optic
- S — StormWater



INSET MAP OF BRIDGE LAYOUT
SCALE:1"=50'

NOTE

Figure adapted from electronic files, *2004_Willow_Cr_Survey.dwg*, 2008_Marsh_Survey.dwg, *20120049 TOPO.dwg* and Basemap.dwg received 08-04-2014. Also aerial.jpg received 08-11-2014.

WSDOT Ferry preferred alternative location is approximate.

0 200 400

Scale in Feet
Contour Interval = 1 Foot

Willow Creek Daylighting
Edmonds Marsh
Edmonds, Washington

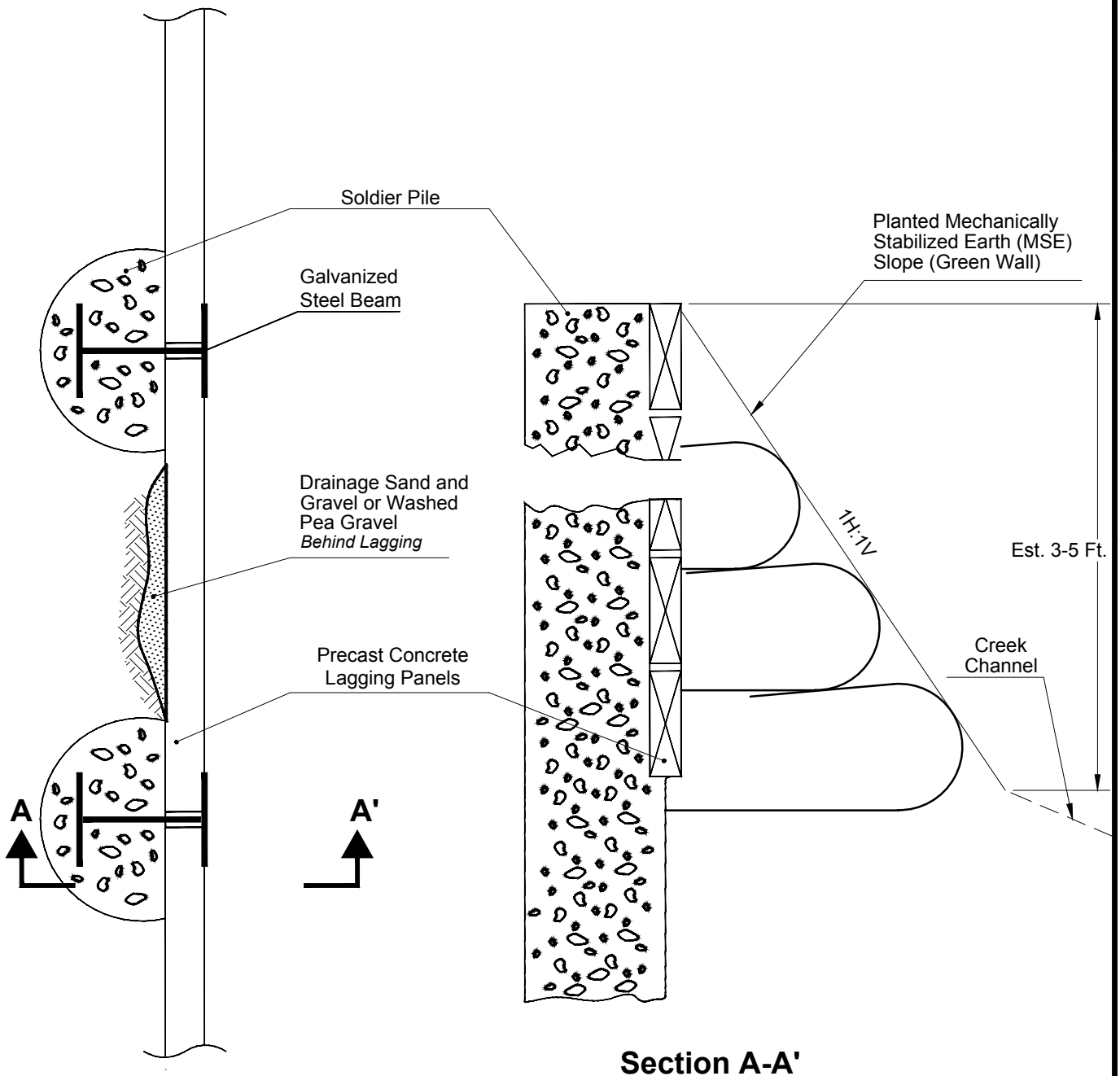
BEACH OUTLET DAYLIGHT ALIGNMENT OPTIONS A & B

December 2015 21-1-12393-404

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 13

Filename: I:\WIP\21-1\12393 Willow Creek Daylight\CAD\05. FIGURES_DWG\211-12393-404 Fig 1.dwg Date: 12-18-2015 Login: cmh



PLAN VIEW

Section A-A'

Not to Scale

NOTE

This drawing depicts a retaining wall concept that may be considered during design of the creek channel alignment and geometry between stations 7+00 and 8+00 to avoid excavation into the toe of the steep slope along the property boundary.

Willow Creek Daylight Project
Geotechnical Evaluation
Edmonds, Washington

SCHEMATIC
SOLDIER PILE WALL

December 2015 21-1-12393-409

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIGURE 14

File: Z:\12393-406\21-1-12393-406 Soldier Pile Wall Schematic.dwg Date: 12-18-2015 Author: cmh