Little Squalicum Shoreline Restoration Study
Final, 100% Design Technical Memorandum for New Estuary

To: City of Bellingham Public Works Dept.,
Ms. Renee LaCroix

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

March 8, 2010

Introduction

Coastal Geological Services, Inc (CGS) is working under contract to the City of Bellingham for the Little Squalicum Shoreline Restoration Study, which provides a feasible shoreline habitat enhancement project that will be brought to final design. The first major phase of the study consisted of feasibility analyses, which was completed in August 2009. That effort included documenting and analyzing coastal processes, site history, and relevant biological and habitat data for the future Little Squalicum Park shore and adjacent Mount Baker Plywood Peninsula area, located on the northern shore of Bellingham Bay near the west side of the City limits. The Final Feasibility report contains much more detail on site background, environmental conditions, project selection process, and anticipated benefits. The Feasibility report recommended development of the design for the creation of an estuary in the southeast portion of Little Squalicum Park that would be connected by a short tide channel under the BNSF railway, described herein.

This brief technical memo is intended to summarize results of the progressive phases of the estuary design process. These included the preliminary (30%) step, followed by the draft (90%) design phase, and subsequent refinement of the final (100%) design phase. CGS has been in consultation with City of Bellingham (COB) Public Works and Parks Departments, Little Squalicum Park Master Plan project consultants, fisheries biologists and others in preparation of the various stages of the design process.

The 100% design drawings are the major deliverable for this phase of the project and are attached. This memo summarizes the design assumptions, design features, wetland issues, excavation totals, and created habitat areas. Overall, this brief memo is a revised and updated version of the 30% design memo, dated Oct. 14, 2009, and the 90% design memo, dated Dec. 14, 2009. The final design drawings and this design memo reflect changes made to address comments from the COB Public Works and Parks Departments, WA Dept. of Ecology, WA Dept. of Fish and Wildlife

Assumptions and Understanding of Constraints

CGS understands the following to be the specific goals and guidelines for the proposed shoreline enhancement project at Little Squalicum site, as first stated in the 30% design memo:

1. Creation of an intertidal estuary with connection to Bellingham Bay that maximizes habitat benefits to nearshore species.
2. The estuary will be designed to incorporate the pre-existing topography of the existing wetland in the far southeast portion of the Park, without excavating into the majority of the existing wetland, but instead connecting into the exiting wetland basin to minimize disturbance to the extent possible.
3. The estuary will be placed close to the toe of the slope near the eastern Park boundary, but not so close as to pose slope stability issues to adjacent properties.
4. The estuary and adjacent grading will be located east of the proposed Park walking trails as designed in the Approved Master Plan Alternative of early January 2010.
5. Grading will be designed starting at the eastern edge of the eastern trail and include the southeast area of the Park where the estuary would be located only.
6. The eastern edge of the eastern trail was altered slightly in terms of elevation from existing site elevations to make it suitable for ADA access in this design. However trail design in not a specific deliverable for this work; instead the elevations were adjusted slightly in an attempt to meet anticipated future slope needs.
7. No grading plan will be developed for the former lower creek area as the needs and details for this area are subject to change pending environmental cleanup and detailed Park design process (still to come).Bridge and boardwalk design for trails is not included in this effort. One area for a future bridge design is included in the approximate location where the eastern trail crosses the creek upstream of estuary.
8. The BNSF trestle and supports are to remain and not be negatively impacted.
9. The Little Squalicum Creek reach upstream of the estuary and trails was not designed at this time as the creek enhancement design for the Park north of Eldridge Avenue needs to be developed first (which we understand may have a new longer course), in order to try to provide correct elevations, CGS has assumed that the creek thalweg (deepest portion) will be lower than at present where it enters the current design project area.
10. General habitat areas were designed into the drawings in terms of elevation bands relative to tidal information with more detailed planting and log elements incorporated into this final design.

Overview of 100% Design Components

Enhancement approach and design recommendations were reached based on the site visits, historic analysis, review of aerial and ground photos, and professional experience with numerous restoration projects around the Puget Sound region. These elements were described in the Final Feasibility report, completed in August 2009. The site topographic survey by White Shield from 2008 was used for determination of ground elevations and slopes. The goal of this work was to outline the maximum habitat benefit through habitat creation using realistic approaches based on geomorphic and physical elements of the site.

Design Elevations and Slopes

The elevations of saltmarsh vegetation were investigated at the nearby Post Point Lagoon site in South Bellingham. This was the site of a recent saltmarsh enhancement project designed by CGS for City of Bellingham Public Works. The site offers natural recolonization of saltmarsh areas with excellent elevation control based on new survey monuments. The saltmarsh zone was generally found to extend from +7.5 to +9.2 ft MLLW. The elevation band of +7.5 to +9.5 ft MLLW was used for low marsh and the bank from +9.5 to +11.0 ft MLLW high marsh, also allowing for some sea level rise. Design slopes were lowest for the low marsh area such that the coverage would be increased relative to other higher slope areas of the estuary. Also, the elevation just above the high marsh areas was kept gradual to allow for a moderate amount of sea level rise in the coming decades.

For the estuary design at Little Squalicum Park typical design slopes for the marsh elevations were generally 10:1 (horizontal:vertical). The high marsh area was at this gentle slope and the upland areas were at somewhat steeper slopes. Steeper slopes were designed into the area vertically above the high marsh in order to make enough area for the estuary and provide adequate tidal prism to maintain the inlet (which was discussed in detail in the Feasibility Report). The typical design slopes for the various elevation bands are listed in Table 1. However, slopes were smoothed in different areas to prevent abrupt changes in slope and slopes varied in a number of areas to logically connect features and work around constraints.

Table 1. Typical design slopes for different elevation bands.

Elevation Band (ft MLLW)	Typical Design Slopes (horizontal:vertical)
+12 and higher	3:1
+10 to +12	5:1
+7.5 to +10	10:1
Below +10	Varies
Trail	20:1 or less

The existing topography is presented in Sheet 1, with all of the data from the White Shield Inc. topographic survey completed for the Environmental Protection Agency (EPA). The proposed site plan for the estuary area is presented in Sheet 2, showing all proposed areas of change in topography. Note that only the area east of the eastern trail alignment, as taken from the final Master Plan, is included in design work. The Preferred Alternative from the Master Plan work in 2009 was created in collaboration with Public Works and the estuary feasibility and design process, such that the estuary and the trail layouts all fit together. Approximate locations of trails are included on the proposed site plan which will be designed in more detail by others as funding allows. The proposed estuary contours extend down as low as approximately +2.5 ft MLLW in the southern center of the basin. The basin was designed to have curved shores with several small peninsulas to maximize shore length and habitat benefits, as well as to add to aesthetics.

Issues Pertaining to Surrounding Areas

A key element of the design is where the proposed estuary receives Little Squalicum Creek channel and flow. The clean-up plan for the north portions of the Park is still in process and no final designs are available, but it is anticipated that the creek will be reconfigured to some extent. Moving the creek back into its historic channel upstream of Marine Drive and remeandering

(lengthening the channel) more than its present straightened course have both been discussed. The proposed estuary design would benefit from these actions as the proposed design shortens the distance that the creek has to drop to intertidal elevations. Upstream creek habitat would also be enhanced through a longer channel with a pool and riffle configuration. An altered configuration would effectively lower the base level of the creek channel where it enters the proposed estuary area. Having the creek channel at a lower elevation further upstream would therefore minimize the steepness and severity of the transition from creek to intertidal estuary. An elevation of +9.5 ft MLLW was selected for the creek thalweg (deepest portion of channel) where it will cross under the new trail alignment.

The ecology block retaining wall that is located along the north-northeast side of the proposed estuary has a large volume of fill placed adjacent to it on the east side. Fill appears to have raised the ground surface up by 7-9 ft here. This wall has the lower 3 courses of ecology blocks in a near-vertical configuration (no batter) and the upper 2 tiers at a very slight up-slope batter. This wall does not appear to be built to modern engineering standards and may not be stable as is. Portions of the upper 2 tiers appear to be resting on wood. It is not clear exactly where the retaining wall is relative to the Park property boundary. The proposed topography was designed keeping a minimum setback from the face of wall of 10 ft for the edge of the excavation area.

The bridge supports for the BNSF rail trestle are located close to the proposed inlet. The inlet was kept an even distance between the concrete supports, but the placement may not be acceptable to BNSF for long-term structural support if the inlet moves laterally. The coordination process with BNSF is underway by the City of Bellingham. An engineering evaluation of trestle support stability will need to be completed prior to construction of the proposed estuary. The results of this evaluation may require that shore protection be designed and built for the BNSF trestle supports adjacent to the proposed new inlet.

A buried fiber optic cable runs along the northern edge of the BNSF ROW, and may cross into the Park property near the southeast corner of the Park. This is shown on a Larry Steele survey for the Coast Millennium Trail project. This will obviously need to be addressed prior to implementation.

Wetland Impacts

The Wetland Reconnaissance and Existing Conditions Report (NES 2009) identified 14 wetlands in the park. Wetlands 9, 11, 12, and 14 are within the immediate estuary area, 2 of which extended across the park property boundaries (Sheet 1). Wetlands 11, 12, and 14 were rated as category III wetlands, and are quite small (Table 2; NES 2009). Wetland 11 and 12 are located close to the center of the proposed estuary, and would be completely converted into the proposed large estuary. Wetland 14 is located under the BNSF rail line and lies outside the proposed tidal inlet, although work within the area is likely to impact it to some degree. The one wetland that would not be completely converted with the proposal is wetland 9, the only wetland of moderate size in the proposed estuary area. The standing water portion of this wetland (the southeast portion) would not be significantly altered. However the northwest portion of the wetland would be completely converted to estuary, while the area beneath the BNSF rail line would not be altered.

Table 2. Wetlands impacted by proposed estuary (from NES 2009).

Wetland #	Area (acres)	Wetland Score	Category
9	0.59	16	II
11	0.01	14	III
12	0.01	14	III
14	0.03	19	III
total	0.64	-	-

The estuary design will convert the isolated small wetlands into one, much larger estuarine wetland. The ponded water portion of wetland 9 will be maintained with the higher elevation (western) portions of the wetland altered. The new estuarine wetland area would be 61,930 sq ft (1.42 acres), not counting the remaining portion of wetland 9, as compared to the wetland total of 27,900 sq ft (0.64 acres). This represents approximately 6% of the total area of the proposed estuary. With such small size wetlands converted as compared to the large area of high-quality estuary proposed, the project clearly appears to be self-mitigating in terms of wetlands.

Excavation

Existing and proposed cross sections are shown on Sheet 3. The total amount of excavation in the estuary area was calculated using AutoCAD at approximately 27,800 cubic yards (cy; Table 3). Of that total cut 3,890 cy would be removed from below the plane of MHHW, with 750 cy of that being removed from below Mean Tide Level (MTL = +5.1 ft MLLW).

Table 3. Excavation (cut) volumes for creating the proposed estuary within certain elevations. MHHW is mean higher high water (+8.5 ft MLLW), MTL is mid tide level (+5.1 ft MLLW).

Elevation Parcel	Excavation (cubic yards, in the ground)
Total excavation	27,806
Below MHHW (+8.5 ft MLLW)	3,890
MTL to MHHW (+5.1-8.5 ft MLLW)	3,140
Below MTL (+5.1 ft MLLW)	750

The volume of soil that would be trucked or conveyed out of the estuary area would be larger than the volume of soil in the ground as the volume of excavated soil expands to between 1.3 and 1.5 times the volume of the soil in place. However, some of the soils at this site are very high in gravel content which should result in less expansion than with typical northwest Washington soils. The depth of cut for the proposed excavation area is shown in Sheet 4.

Exploratory test pits were augered by CGS as part of the initial design phase. These samples were intended to provide an indication of subsurface conditions within the design footprint with respect to sediment grain sizes, relative level of compaction, and the location of the ground water table. Test pit logs for the four test pits completed at the site and are included in Appendix A. One test pit (TP-3) was excavated twice over two days, and the second excavation produced what is believed to be diesel-range hydrocarbon contamination. No laboratory testing was performed on sediment samples as part of this study. This was the northern-most sample, which was located in the northern portion of the proposed estuary excavation area. Additional analysis of the potential

influences of environmental contaminants (which is still underway) and grading details for surrounding areas will have to be carried out prior to completion of an integrated final design for the entire lower Park area.

Planting and Vegetation Zones

The location of the proposed vegetation zones are presented in Sheet 5. This sheet shows the spatial extent of general planting areas as defined by elevation. The 4 zones are presented in terms of elevation zones, with the associated appropriate vegetation communities, which are listed in Table 4.

Table 4. Surface areas for different elevation bands (areas of sloping surfaces).

Vegetation Community	Elevation Band (+ft MLLW)	Surface Area (sq ft)
Upland	11.0 - 15.0	19,037
High marsh	9.5 - 11.0	12,603
Low marsh	7.5 - 9.5	20,042
Tide flat/ mud flat	2.5 - 7.5	29,285

The uplands (+11.0 MLLW and higher) and portions of the marsh will be planted by the City to increase habitat value and preclude the establishment of invasive exotic species. All planting should be native species appropriate for this site. Vegetation installed adjacent to the high marsh band must also be salt tolerant such that it survives extreme high water or storm events. The development of a detailed planting plan was beyond the scope of this effort. Instead a general schematic of recommended distribution of trees and 2 size classes of shrubs is provided in Sheet 6. Suggested tree species include shore pine, western redcedar, and Douglas fir. The density of upland plants was increased in the final plan above previous quantities in order to provide enhanced riparian vegetation cover. Western redcedar is recommended for use especially along the east and northeast shore of the proposed estuary as there is minimal screening from the adjacent houses and road traffic. The south and west shore of the estuary should also be planted with coniferous and possibly deciduous species that will provide shade to the upper intertidal.

The high marsh area (+9.5 to +11.0 ft MLLW) will be inundated with salt water on a regular basis in most times of the year and all species for this zone must be highly salt tolerant. The high marsh zone (Sheet 5) will be planted with species to include those listed in Table 5. Planting at a sparse level is recommended as these plants are both hard to install successfully and colonize fairly well on their own. Also many of these species are difficult to obtain.

The low marsh area (+7.5 to +9.5 ft MLLW) is mostly intertidal and will be inundated by salt water routinely. This zone will likely not require planting as pickleweed (*Salicornia virginica*), salt grass (*Distichlis spicata*), and American searocket (*Cakile edemtula)* are best left to colonize on their own (which is well along the way at the Post Point Lagoon after 2 years). Seeds and plant material are delivered by tidal flow and deposited in the wrack after high tides.

Table 5. Recommended high marsh vegetation species list.

Abbreviation	Latin Name	Common Name
**DISP*	*Distichlis spicata*	Salt grass
**AMCH*	*Ambrosia chamissonis*	Silver burweed
ELMO	*Ellymus mollis*	Dunegrass
GRIN	*Grindelia integrifolia*	Pacific gumweed
TRMA	*Triglochin maritimum*	Sea arrow-grass
PLMA	*Plantago maritima*	Sea plantain
Achillea sp	*Achillea millefolium*	Yarrow
LEDE	*Lepedium densiflorum*	Prairie peppergrass

The tide flat will not be planted as conditions may not support vegetation in this generally ponded water area, with the possible exception of eelgrass. Eelgrass may become established in patches, similar to the situation at the Post Point Lagoon in the Fairhaven portion of Bellingham. How favorable for eelgrass the estuary will become is highly dependent on the minimum depth that the inlet becomes dynamically stable at, as well as water turbidity and salinity. It may be that the water is too fresh during winter to support eelgrass. This is very difficult to predict as the volume of sub-surface water (springs and seepage) that will flow into the proposed basin is not known with any accuracy. The area is generally rich in springs, which have been observed flowing with moderately high rates in November-December 2010, as well as with observable flow in summer. Eelgrass does not become established (nor can it be successfully transplanted) if salinities are too low.

LWD Placement

The intent of placement of large woody debris (LWD), typically in the form of logs, is two-fold. Log placement is intended to add habitat diversity and organic material to soils and the estuary, and secondly, log placement is intended to create as a barrier to people attempting to enter the estuary. Log placement is generally restricted to the upper west shore of the proposed estuary where one of the primary Park trails is to be located (Sheet 6). Logs would be installed approximately 2 high, in a crossing pattern as shown in the site plan. No anchoring would be used, as logs are all kept with on the order of 90% of the length of the logs above elevation +11.30 ft MLLW. This is a concept that has been previously discussed and agreed upon with the COB Parks Department. Several logs were added in the final stages of design to reflect the need for a physical barrier between the park uplands and the proposed estuary

Specifications for logs and root mass are not as critical (tight) as other design elements or if the wood had a true structural element for this project. Materials used can include freshly cut wood with or without bark or long-fallen pieces. These could include the use of old log boom “boom sticks” (logs used to contain log tows), which are often very affordable in large size. Sizes for logs are listed in terms of diameter. Minimum diameter for the logs will be 16 inches (narrow end of log) and 20 inches for root wads (stumps) with stem, measured at the cut end. Species of wood acceptable for the project include western redcedar, Douglas fir, hemlock, and grand fir. Western maple and red alder should be suitable for use and are available from the site as these trees species are growing within the estuary footprint. These hard woods do not last quite as long in the weather but will suffice for this purpose. Cottonwood, poplars, and similar species are not acceptable as they rot too fast.

Park Trails

Modifications to existing Park trails will be required under the proposed estuary design, and have been included in the recently approved Little Squalicum Park Master Plan. The approximate location of Master Plan trails within the immediately vicinity of the proposed estuary is shown on Sheet 6. Detailed designs for these trails will be completed by Parks. Construction of trails in the lower park should be completed in conjunction with the proposed estuary to help save costs and avoid additional permit applications. Ideally, trail construction would occur during the final stage of estuary construction.

Cost Estimate

A planning level cost estimate was created as part of the design work (Appendix B). This is only a rough estimate, and the condition of the site at the beginning of construction and the level of contamination throughout the park are not known with any certainty at this time. Additionally, the amount of excavated soil that may be reused on site as part of the clean up is not known, nor is the disposal location for the remainder of the excavated soil. Cost estimates were not obtained from licensed contractors for these reasons. Rather, costs are based on generally accepted material prices and professional experience with projects of this type.

Assumptions that were made in development of the planning level cost estimate include the following:

- Study and potential cleanup expense was estimated and included for determining the extent of contamination, however, assumption was that no major contamination is found before or during construction
- A structural engineering assessment will be conducted concerning the proposed tidal inlet through the railroad right of way and adjacent to the railway supports and BNSF cooperation will be obtained
- Heavy equipment will be able to access the site existing roads, such as using the old road grade/trail starting at the intersection of Eldridge Ave. and Lindbergh Ave. and running under the Eldridge Ave./Marine Dr. bridge, with minor improvements needed
- The City of Bellingham, Port of Bellingham, or other major landowner in downtown waterfront will accept approximately 36,000 tons (80%) of excavated soils for use in the Waterfront Redevelopment project
- The remainder of excavated soils (9,800 tons) will be exported to other portions of the Park as part of the overall site cleanup design or off-site for other uses
- Barge access for loading material out would be difficult but not impossible due to the very shallow nature of the beach
- 100 ft of new stream channel will have to be excavated and contoured leading into the new estuary; the work involved in re-meandering and lowering the upstream portions of the channel is not included here
- COB Parks will construct trails, boardwalk, a bridge, and fencing; these costs are not included here

Overall at a planning level, the project is expected to cost roughly $1,473,130. Adding sales tax and a contingency of 30% brings the total to approximately $2,038,800 (details of the cost estimate are presented in Appendix B). Bear in mind that there are many uncertainties in this cost estimate,

and that a relatively large contingency was used to reflect that. However, estimated costs may be off more than the 30% contingency added, either lower or higher.

Limitations of This Report

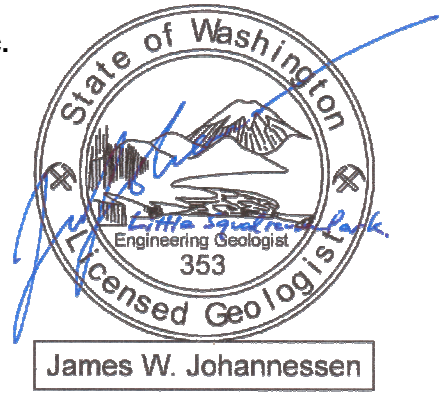
This report was prepared for the specific conditions present at the subject property to meet the needs of specific individual property owners. No one other than the client and their agents should apply this report for any purposes other than that originally contemplated without first conferring with the engineering geologist who prepared this report. The findings and recommendations presented in this report were reached based on several brief field visits. The report does not reflect detailed examination of sub-surface conditions present at the site, or drainage system designs, which are not known to exist. It is based on examination of surface features, bluff exposures, soils characteristics, and beach features, and processes. In addition, conditions may change at the site due to human influences, floods, earthquakes, groundwater regime changes, or other factors.

Thank you for engaging the professional services of Coastal Geologic Services, Inc. If we can be of any additional assistance please contact our office at (360) 647-1845 or at jim@coastalgeo.com.

References

Northwest Ecological Services LLC, 2009. Wetland Reconnaissance and Existing Conditions Report, Little Squalicum Park, October 2009, revision 1.0, Prepared for City of Bellingham, Parks and Recreation Dept.

Coastal Geologic Services Inc.



Jim Johannessen,
Licensed Engineering Geologist and MS

ATTACHMENTS:

Sheet 1. Cover Sheet
Sheet 2. Existing Conditions - Topography
Sheet 3. Proposed Conditions - Topography
Sheet 4. Cross Sections
Sheet 5. Volume Analysis
Sheet 6. Proposed Conditions - Vegetation Zones
Sheet 7. Proposed General Upland Vegetation and LWD Placement Plan

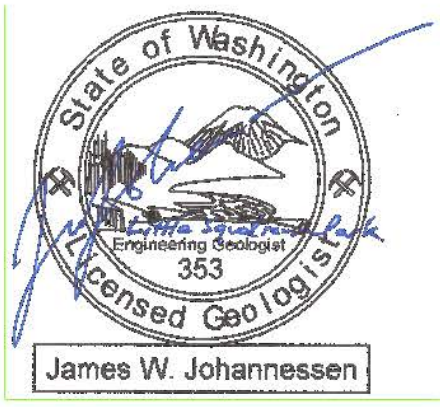
Appendix A. Soil test pit field sheets
Appendix B. Planning level cost estimate

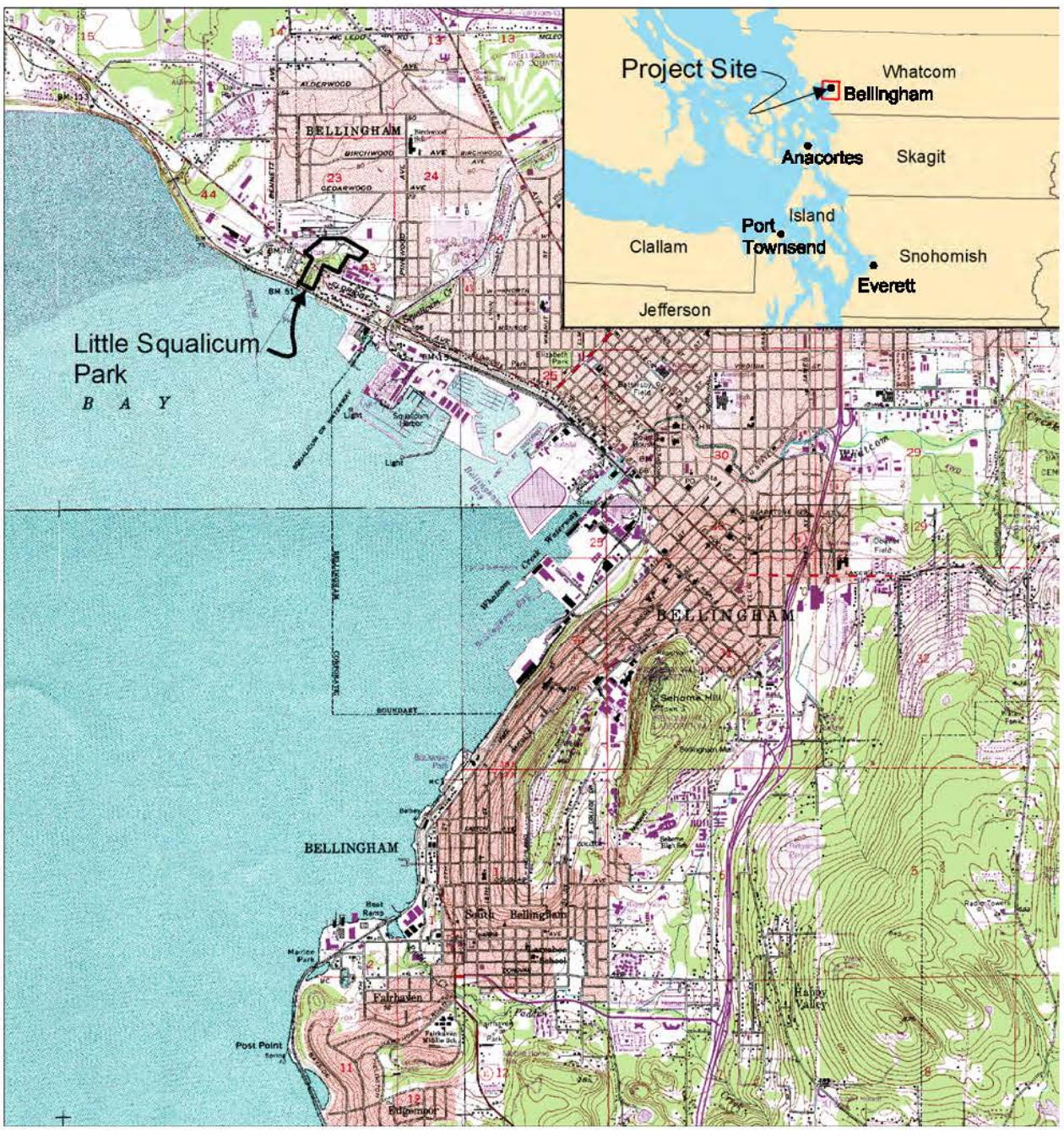
Little Squalicum Park
Proposed Estuary Design

Design By
Coastal Geologic Services, Inc.
Jim Johannessen, MS, LEG

Design For:
City of Bellingham Public Works
City of Bellingham Parks & Recreation

Sheet Index





Little Squalicum Park		COASTAL GEOLOGIC SERVICES 1711 Ellis St, suite 103 Bellingham, WA 98225 360-647-1845 - coastalgeo.com
Cover Sheet		
For: City of Bellingham, Public Works		
Date: 4/14/10 -09-017A-LSP-100prt-design.dwg		DATUM: MLLW=0.0'
NTS	Cover Sheet: 1 of 7	

HORIZONTAL CONTROL AS REPORT BY WHITE SHIELD (2008)
DATUM: NAD83 STATE PLANE WA NORTH FT
VERTICAL CONTROL SHIFTED FROM WHITE SHIELD'S NAVD88 TO MLLW
DATUM: MLLW

NUMBER	NORTH	EAST	ELEVATION	TYPE
1	648567.51	1234469.54	20.59	HUB & TACK
2	648190.34	1234323.45	12.77	HUB & TACK
3	648306.50	1234186.95	31.91	8" IRON PIPE

State of Washington
Licensed Geologist
Engineering Geologist
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James W. Johannessen

Marine Drive
649,000 North
648,800 North
648,600 North
648,400 North
648,200 North
Lindbergh Avenue
Eldridge Avenue
Little Squalicum Creek Channel
APPROXIMATE PARK BOUNDARY
APPROXIMATE PARK BOUNDARY
Ecology Block Retaining Wall
NES #9
NES #11
NES #12
NES #14
Standing Water
A
A'
B
B'
C
C'
D
D'
BNSF
RR-ROW
48" Concrete Culvert
IE = 7.95'
48" Concrete Culvert
IE = 7.76'
Lehigh Cement Pier
Bellingham Bay
1,234,200 East
1,234,400 East
1,234,600 East
1,234,800 East
0 40 80 120 160 240
1" = 80'

Existing surface surveyed by White Shield, Inc. 2008 in NAVD88. Datum conversion acquired from VDatum v2.2.3: 0.0' NAVD88 = 5.2' MLLW. MHHW = +8.5 ft MLLW (NOAA station #9449211, Bellingham, WA). Horizontal control from White Shield in NAD83 WA SP-N. BNSF ROW boundary by Larry Steel & Associates as part of COB Parks Millenium Trail Project, 2003. Wetlands delineated by Northwest Ecological Services (2009) and shown here as approximate boundaries, labeled with NES numeric designation. Park boundary is approximate and shown for reference only.

Little Squalicum Park

Existing Conditions - Topography

For: City of Bellingham, Public Works

Date: 4/14/10 ~09-017A-LSP-1B0pst-design.dwg

1"=80'	Site Plan	Sheet: 2 of 7

COASTAL GEOLOGIC SERVICES
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DATUM:
MLLW=0.0'

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1,234,400 East

1,234,600 East
648,600 North

Creek Channel

APPROXIMATE PARK BOUNDARY

Gravel Trail (Master Plan, 8 ft wide)

6' gravel trail

Boardwalk

MHHW

A

A'

B

B'

C

C'

D

D'

RR-ROW

RR-ROW

APPROXIMATE PARK BOUNDARY

648,200 North

Bellingham Bay

0 20 40 80 120
1" = 40'

Little Squalicum Park		
Proposed Estuary - Topography		
For: City of Bellingham, Public Works		
Date: 4/14/10 -09-017A-LEP-100pct-design.dwg		
1"=40'	Site Plan	Sheet: 3 of 7

COASTAL GEOLOGIC SERVICES
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DATUM:
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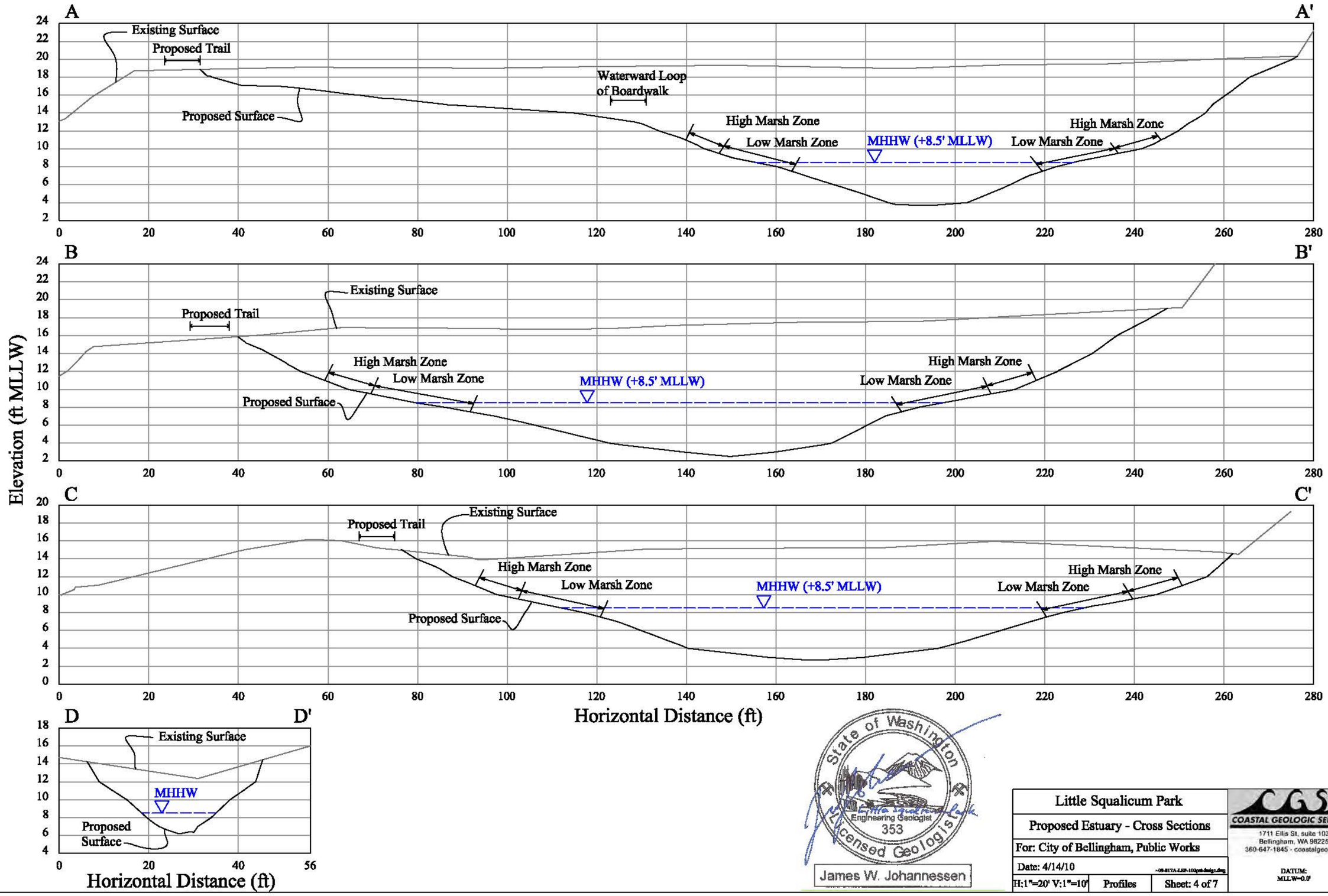

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Little Squalicum Park		
Proposed Estuary - Cross Sections		
For: City of Bellingham, Public Works		
Date: 4/14/10		-09-817A-ESR-100psh-Sedge.dwg
H:1"=20' V:1"=10'	Profiles	Sheet: 4 of 7

COASTAL GEOLOGIC SERVICES
1711 Ellis St, suite 103
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DATUM:
MLLW=0.0'

Design Surface Change Analysis

Color	Min.	Max.	Area (sf)	Vol (cy)
	-15.5	-15.0	1,957	16
	-15.0	-14.0	3,861	145
	-14.0	-13.0	6,068	315
	-13.0	-12.0	7,944	581
	-12.0	-11.0	8,209	887
	-11.0	-10.0	7,885	1,192
	-10.0	-9.0	6,935	1,461
	-9.0	-8.0.	6,912	1,714
	-8.0	-7.0	6,065	1,960
	-7.0	-6.0	5,879	2,177
	-6.0	-5.0	5,639	2,390
	-5.0	-4.0	5,458	2,597
	-4.0	-3.0	5,254	2,792
	-3.0	-2.0	5,564	2,994
	-2.0	-1.0	5,221	3,194
	-1.0	0.0	4,046	3,373
	0.0	1.6	308	4

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James W. Johannessen

Creek Channel

APPROXIMATE PARK BOUNDARY

Gravel Trail (Master Plan, 8 ft wide)

6 ft gravel trail

Boardwalk

A

A'

B

B'

C

C'

D

D'

RR-ROW

RR-ROW

APPROXIMATE PARK BOUNDARY

Bellingham Bay

648,200 North

N

0 20 40 80 120

1" = 40'

Little Squalicum Park		
Proposed Estuary - Volume Analysis		
For: City of Bellingham, Public Works		
Date: 4/14/10 -09-017A-LSP-100pct design.dwg		
1"=40'	Site Plan	Sheet: 5 of 7

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

DATUM:
MLLW=0.0'

LEGEND

- Upland Plant Zone (20,200 sf)
- High Marsh Zone (13,400 sf)
- Low Marsh Zone (21,300 sf)
- Mudflat / Water (28,700 sf)

State of Washington
Licensed Geologist
Engineering Geologist
353
James W. Johannessen

1,234,400 East

Creek Channel

APPROXIMATE PARK BOUNDARY

Gravel Trail (Master Plan, 8 ft wide)

8 ft gravel trail

Boardwalk

MHHW

A

B

C

D

A'

B'

C'

D'

RR-ROW

RR-ROW

APPROXIMATE PARK BOUNDARY

1,234,600 East

648,200 North

Bellingham Bay

N

0 20 40 80 120

1" = 40'

Little Squalicum Park		
Proposed Estuary - Vegetation Zones		
For: City of Bellingham, Public Works		
Date: 4/14/10 -09-017A-LSP-100pct design.dwg		
1"=40'	Site Plan	Sheet: 6 of 7

COASTAL GEOLOGIC SERVICES
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DATUM:
MLLW=0.0'

LEGEND

- Deciduous Tree (large growing)
- Western redcedar
- Shore Pine / Evergreen Tree
- Large Shrub
- Small Shrub
- Root wad
- Log
- Backshore Planting

1,234,400 East

Creek Channel

State of Washington
Licensed Geologist
Engineering Geologist
353
James W. Johannessen

1,234,600 East
648,600 North

A
A'
B
B'
C
C'
D
D'

MHHW

6-ft gravel trail

Boardwalk

Gravel Trail (Master Plan, 8 ft wide)

APPROXIMATE PARK BOUNDARY

RR-ROW

Existing Wetland

Bellingham Bay

0 20 40 80 120
1" = 40'

Little Squalicum Park		
Proposed Estuary - General Upland Vegetation and LWD Placement Plan		
For: City of Bellingham, Public Works		
Date: 4/14/10 -09-017A-LSP-100psr-design.dwg		
1"=40'	Site Plan	Sheet: 7 of 7

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

DATUM:
MLLW=0.0'

Little Squalicum Shoreline Restoration Study

Appendix A

Soil Test Pit Field Sheets

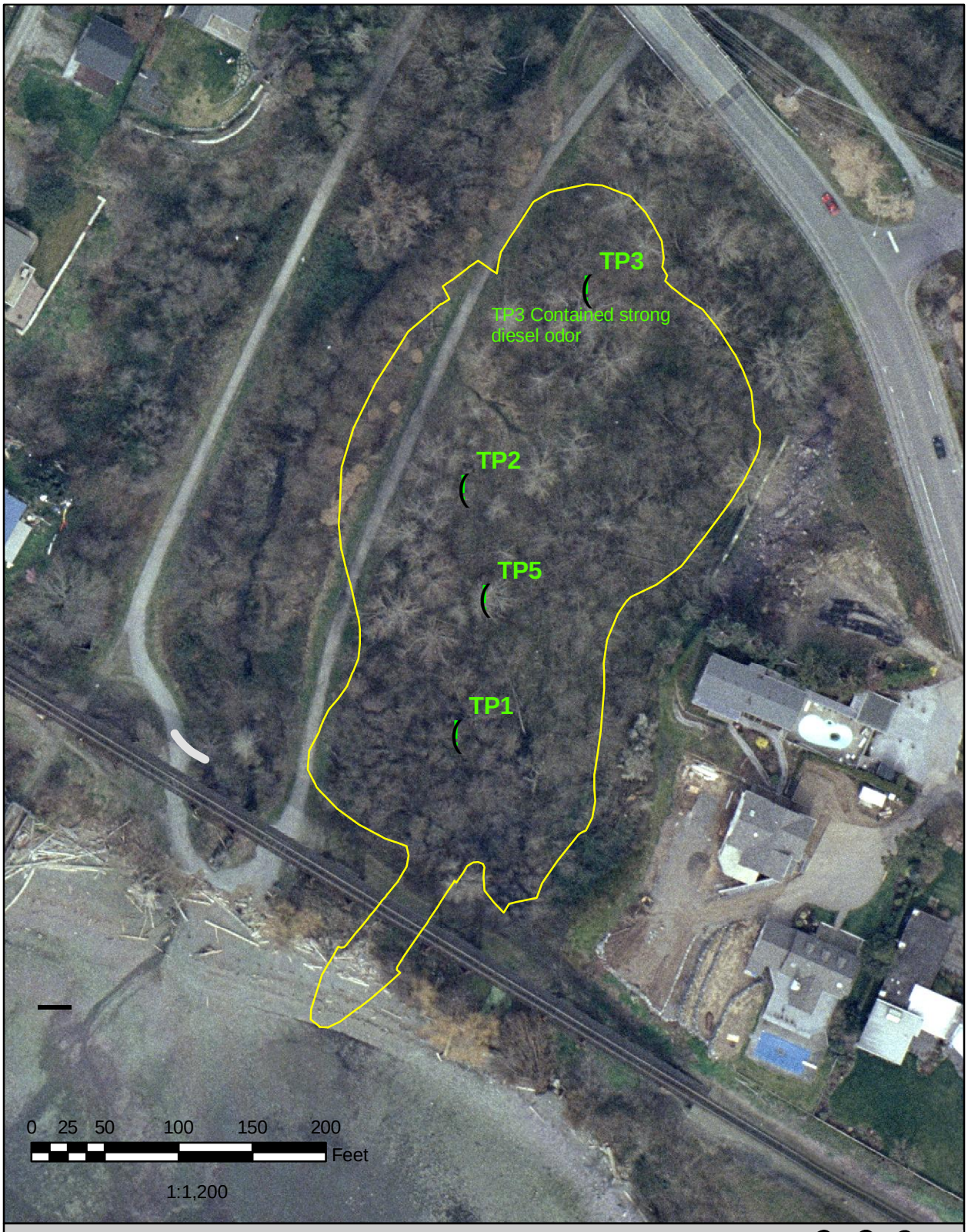


Figure A1. Test pits forwarded by Coastal Geologic Services.
Proposed estuary excavation area shown in yellow for reference.

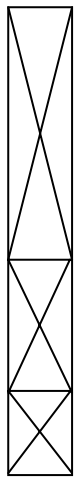
2008 City of Bellingham orthorectified aerial photography

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

Test Pit: TP 1

Location: N 48°45'53.79"
W 122°30'59.85"

Project name: Little Squalicum Park (LSP) Estuary Design
Project site: Lower LSP



Sample No.	Depth in Feet	Ground Surface Elevation in Feet: 15.0
	0	Topsoil
S - 1	1	SM - silty fine to med. sand, 15-20% silt, 10-15% organics, 30-35% fine to med. gravel, dry.
	2	
	3	
S - 2 water table	4	GW - silty sandy gravel, 10-15% silt, 35-40% med. to coarse sand, fine to med. gravel, moist.
	5	
S - 3	6	SW - sand, v. fine to med. sand, gravel, wet.
S - 4	7	SW - fine to coarse sand, fine to med. gravel, wet.

Notes: the water table was first observed at 4 to 4.5 ft bgs.

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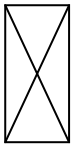
Test Pit: TP 2

Location: N 48°45'55.43"
W 122°30'59.83"

Project name: Little Squalicum Park (LSP) Estuary Design
Project site: Lower LSP

Sample Symbol	Sample No.	Depth in Feet	Ground Surface Elevation in Feet: 16.0
		0	Topsoil
	S - 1	1	GM - silty sandy gravel, 25-30% silt, 15-20% fine to med. sand, fine to coarse gravel, damp, organics and trace of roots.
	S - 2	2	GM - silty sandy gravel, 20-25% silt, 15-20% fine to coarse sand fine to coarse gravel with few cobbles, dry.
			Notes: compacted coarse gravel found near surface layer. Several attempts were made to dig in this location, but compaction made it difficult. Possibly an old staging area for gravel mine operations contributed to the highly compacted sediments.

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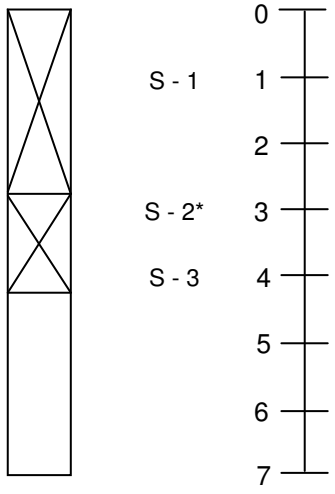
Test Pit: TP 3

Location: N 48°45'56.78"
W 122°30'58.63"

Project name: Little Squalicum Park (LSP) Estuary Design
Project site: Lower LSP



Ground Surface Elevation in Feet: 17.0

Topsoil
GW - sandy gravel, 25-30% fine to coarse sand, fine to coarse gravel, dry, trace of roots.
SM - silty fine sand, 30-35% silt, 30-35% v. fine to fine sand, v. fine to fine gravel, moist.
SM - silty sand, 15-20% silt, 20-25% fine to med sand, gravel, wet.
Notes: the auger drilled easily to a depth of 7 ft, however, the deepest sample obtained was from 4 ft bgs. No diesel smell was appearant at the time of the first boring. The next day sampler attempted bore again to bag sediment samples and a diesel smell was appearant in the sediments obtained from S-2*.

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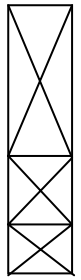
Test Pit: TP 5

Location: N 48°45'54.70"
W 122°30'59.59"

Project name: Little Squalicum Park (LSP) Estuary Design
Project site: Lower LSP



Sample Symbol	Sample No.	Depth in Feet	Ground Surface Elevation in Feet: 17.0
		0	Topsoil
	S - 1	1	GM - sitly sandy gravel, 20-25% silt, 20-25% v. fine to coarse sand, fine to coarse gravel, dry, trace of roots.
		2	
	S - 2		GC - clayey sandy gravel, 30-35% clay with medium plasticity, 10-15% fine to coarse sand, very fine to coarse gravel, moist.
		3	
	S - 3		SM - silty sand, 15-20% silt, 10-15% fine gravel, wet.
	water table	4	
			Notes: root horizon was appearent within the first foot and the static water table was found at 3.3 ft bgs.

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Little Squalicum Park Estuary Draft Cost Estimate **Appendix B**

Master Sheet - Summing worksheets By Coastal Geologic Services Inc. 3/3/2010

Project Element	**Cost**	**Notes**	**Confidence**
Pre-project Assessments			
Design revisions/Construction package	$20,000		low
Contamination Extent	$80,000	Unknowns include EPA work/clean up	low
RR Bridge Stability/Engineering	$30,000		low
Site Clean-up			
Possible contaminent clean-up	$400,000		low
Site Prep			
TESC	$15,043		moderate
Temporary access road	$9,200	Using Lindberg Ave access	moderate
Temporary creek bridge	$35,000	Single span to accommodate heavy equipment	low
Excavation / Construction			
Clear and grub site	$26,500	96,000 SF	low
Excavate 27,800 cy (39,000 tons)	$610,000	27,800 cy in place =~35,000 cy =~39,000 ton (1.4 ton/cy)	low
Disposal of 90% to GP Site (35K tons)	$108,000	Truck (barge?) to GP site (1,200 truck/trailer R/T)	low
Disposal of 10% off-site TBD (4K tons)	$90,000	Disposal site TBD (creek fill?)	low
New lagoon inlet	$9,500	open inlet following excavation	moderate
New stream channel	$14,600	redirect 100 LF of channel upstream of lagoon	low
Planting			
New LWD	$19,275		moderate
New Plantings	$6,012		good
Sub-total	$1,473,130		
Contingency (30%)	$441,939		
sales tax (8.5%)	$125,216		
Total Cost	**$2,040,284**		

Little Squalicum Park Estuary Draft Cost Estimate By CGS 3/3/2010

Site Preperation Worksheet

Project Element	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**	**Confidence**	**Notes**
Temporary Erosion & Sedimentation Controls						
Silt Fencing	425	LF	$6.60	$ 2,805	good	
Coir logs	425	LF	$6.50	$ 2,763	good	
Straw Bales (swales and exposed soils)	150	ea	$5.00	$ 750	good	
Stakes, wooden	125	ea	$1.00	$ 125	good	
Equip time/ trucking		LS		$ 5,000	low	
Labor	80	hrs	$45.00	$ 3,600	moderate	
Total				**$ 15,043**		

Temporary access road	**Quantity**	**Unit**	**Unit Cost**	**Total Cost**		
Quarry Spalls	400	ton	$11.00	$ 4,400	good	Using Lindberg Ave access
Hog Fuel	200	CY	$15.00	$ 3,000	good	Using Lindberg Ave access
Labor	40	hrs	$45.00	$ 1,800	moderate	
Total				**$ 9,200**		

TOTAL **$ 24,243**

Little Squalicum Park Estuary Draft Cost Estimate By CGS 3/3/2010

Construction/Excavation Worksheet

Project Element	Quantity	Unit	Unit Cost	Total Cost	Confidence	Notes
Clear and Grub site						
General Clearing and Grubbing	96,000	SF	$0.25	$ 24,000	moderate	
Remove large trees and stumps	25	ea	$100.00	$ 2,500	moderate	
Total				**$ 26,500**		
Excavate 27,800 cy (45,000 tons)						
Excavate and load	45,000	Ton	$12.00	$ 540,000	moderate	
Add'l trucking/conveyor		LS		$ 40,000	low	
Add'l groundwater pumping etc.		LS		$ 30,000	low	
Total				**$ 610,000**		
Dispose 80% to GP/Bell Bay site (36K tons)						Trucking
Disposal cost (beneficial reuse)	800	hrs	$135.00	**$ 108,000**	moderate	1.5 RT/hr
						800 hrs at $135/hr
						site to GP is 6 miles (not on Central Ave)
Disposal of 20% off-site TBD (9K tons)						30 T/load truck and trailor = 1,200 RT
Disposal cost (off-site)	9,000	Ton	$10.00	**$ 90,000**	low	trucking currently around $120/hr
						federal funding would require higher rates
New lagoon inlet						(around $150/hr)
Excavate Inlet	200	LF	$20.00	$ 4,000	moderate	
Finish grade with excavated beach sediment	5,500	SF	$1.00	$ 5,500	moderate	
Total				**$ 9,500**		
New stream channel (not included in total)						
Excavate and load	800	Ton	$12.00	$ 9,600	moderate	
New channel to new lagoon contouring	100	LF	$50.00	$ 5,000	low	
Total				**$ 14,600**		
TOTAL				**$ 858,600**		

Does not include Park trail upgrades, trail bridges, park access routes etc.

Little Squalicum Park Estuary Draft Cost Estimate By CGS 2/2/2010

LWD & Planting Worksheet

Project Element	Design Quantity	Unit	Unit Cost	Total Cost	Confidence
New LWD					
Log (min. 20" dia. & 20-30 ft ea)	785	LF	$15.00	$ 11,775	moderate
Root Wad	8	ea	$100.00	$ 800	moderate
Machinery	30	hr	$90.00	$ 2,700	low
labor	80	hr	$50.00	$ 4,000	moderate
Total				**$ 19,275**	

New Plants	Design Quantity	1.5 Density	Unit	Unit Cost	Total Cost	
Native Deciduous Tree (2 gal)	18	27	ea	$12.00	$ 324	good
Western redcedar (2 gal)	12	18	ea	$12.00	$ 216	good
Shore pine (2 gal)	34	51	ea	$12.00	$ 612	good
Large shrub (1 gal)	10	15	ea	$6.00	$ 90	good
Small shrub (4 inch)	60	90	ea	$3.00	$ 270	good
Groundcover	na	200	ea	$3.00	$ 600	moderate
Backshore planting	200	300	ea	$3.00	$ 900	moderate
Planting Crew	1		LS	$3,000.00	$ 3,000	good
Total					**$ 6,012**	