

**Little Squalicum Shoreline Restoration Study  
90% 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.



December 14, 2009

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**Introduction**

Coastal Geological Services, Inc (CGS) is working under contract to the City of Bellingham for the Little Squalicum Shoreline Restoration Study, which aims to provide a feasible shoreline habitat enhancement project that will be brought to final design. The first major phase of the study consisted of feasibility analyses. The Final Feasibility report 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 feasibility study recommended development of design work 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.

This brief technical memo is intended to summarize results of the preliminary (30%) design phase and refinement of the design to near-final (90%) 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 90% design. The 90% design drawings are the major deliverable for this phase of the project (attached), with the basic design assumptions and preliminary excavation totals and created habitat areas outlined in this brief memo, which is a revised and updated version of the 30% design memo, dated Oct. 14, 2009.

## **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 likely habitat benefits to nearshore species.
2. The estuary will be designed to incorporate the re-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 Preferred Master Plan Alternative of early October 2009.
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 is 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 approximately 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 is 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 are designed into the 90% drawings in terms of elevation bands relative to tidal information but more detailed planting and log elements will be incorporated into the 90% design after project contours are close to final.

## **Overview of 90% 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 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 conducted by CGS for 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.

<b>Elevation Band (ft MLLW)</b>	<b>Typical Design Slopes (horizontal:vertical)</b>
+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 Parks Department. 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 Preferred Alternative in the 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 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 would upstream creek habitat), as the proposed design shortens the distance that the creek has to drop to intertidal elevations. This effectively lowers the base level of the creek channel. 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 90% design was created 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 area 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 was not started with BNSF by the consultant, as this will require coordination with the Parks Dept and it was not clear what the best time for this was as there are many coordination issues to be addressed.

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 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 total wetland area converted, including portions of wetland 9 that would not be significantly altered, would be 27,900 sq ft. This represents approximately 6% of the total area of the proposed estuary. If wetland 9 is not included, the total area converted to estuary would be 2,200 sf, or approximately 0.5% of the proposed estuary area. With such small amount of wetland conversion 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.

Additional analysis of the potential influences of environmental contaminants (which is still underway and there is an area that may contain hydrocarbons or other contaminants within the lower Park) 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) 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. 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. Large shrubs recommended for this application include ocean spray and others. Small shrubs recommended include Nootka rose, common snowberry, and other species. This should not be taken as a complete or final plant list.

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.

**Table 5.** High marsh vegetation species list. \* denotes that species was predominant in the assemblage.

Abbreviation	Latin Name	Common Name
*DISP	<i>Distichlis spicata</i>	Salt grass
*AMCH	<i>Ambrosia chamissonis</i>	Silver Burweed
ELMO	<i>Ellymus mollis</i>	Dune grass
GRIN	<i>Grindelia integrifolia</i>	Pacific Gumweed
TRMA	<i>Triglochin maritimum</i>	Sea Arrow-grass
PLMA	<i>Plantago maritima</i>	Sea Plantain
<i>Achillea sp</i>	<i>Achillea millefolium</i>	Yarrow
LEDE	<i>Lepidium densiflorum</i>	Prairie Peppergrass

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 is delivered by tidal flow and deposited in the wrack after high tides.

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 (not 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 log above elevation +11.30 ft MLLW. This is a concept that has been previously discussed and agreed upon with the COB Parks Department. Dense log and root mass placement is mostly intended for areas that will not have extensive upland vegetation planting, and is shown in Sheet 6.

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 toes), 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.

## **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](mailto: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. Existing Conditions - Topography

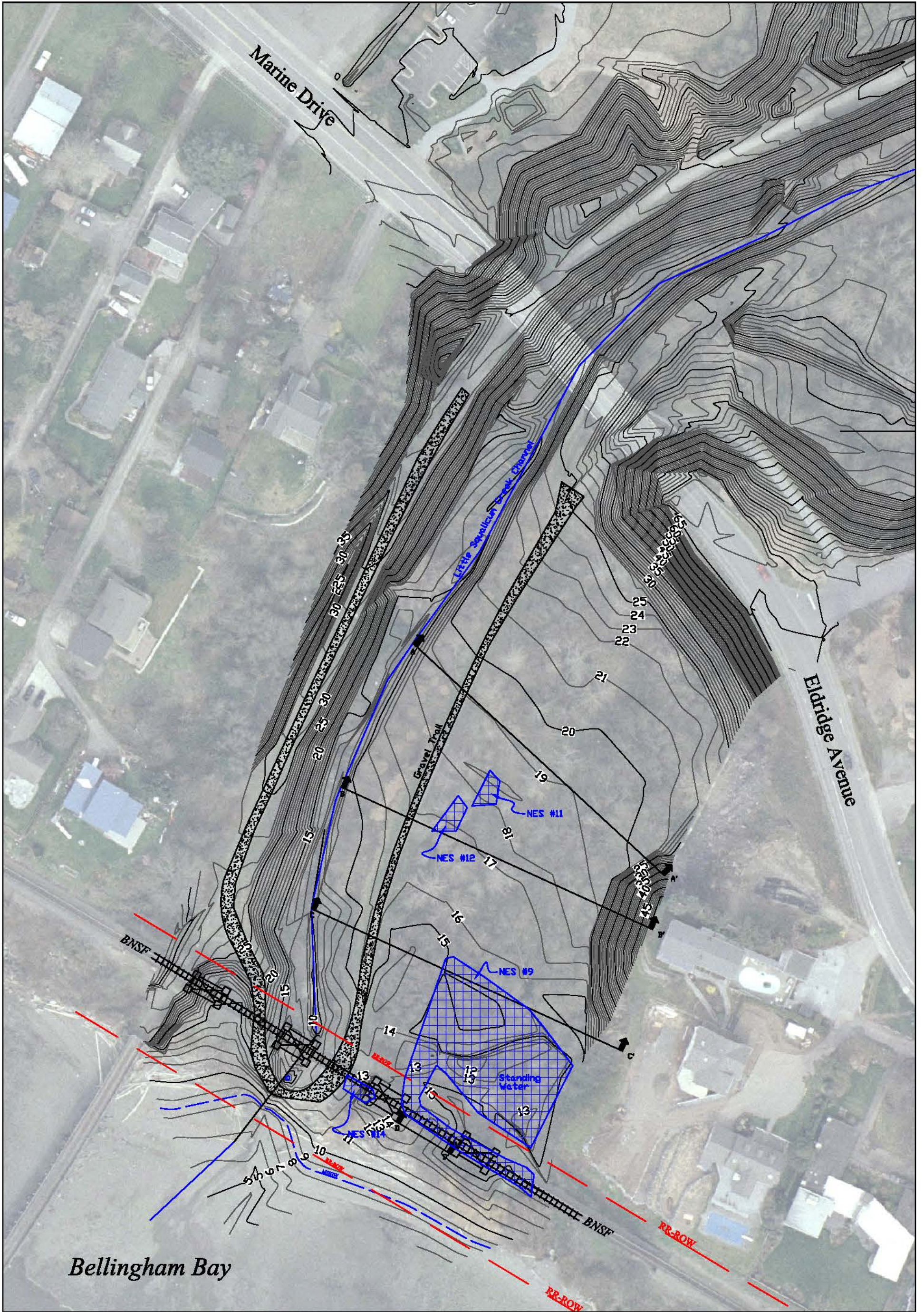
Sheet 2: Proposed Conditions - Topography

Sheet 3: Cross Sections

Sheet 4: Volume Analysis

Sheet 5: Proposed Conditions - Vegetation Zones

Sheet 6: Proposed General Upland Vegetation and LWD Placement Plan



Existing surface surveyed by White Shield, Inc. in 2008 in NAVD88 datum. Datum conversion acquired from VDatum v2.2.3: 0.0' NAVD88 = 5.2' MLLW  
 MHHW = +8.5 ft MLLW (NOAA station #9449211, Bellingham, WA)  
 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

**Little Squalicum Park**

**Existing Conditions - Topography**

For: City of Bellingham, Public Works

Date: 12/14/09

1"=80'

Site Plan


Sheet: 1 of 6

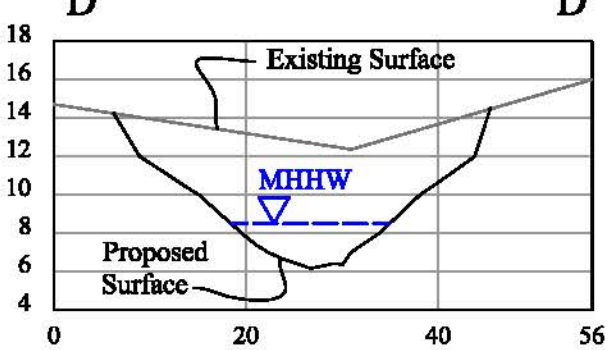
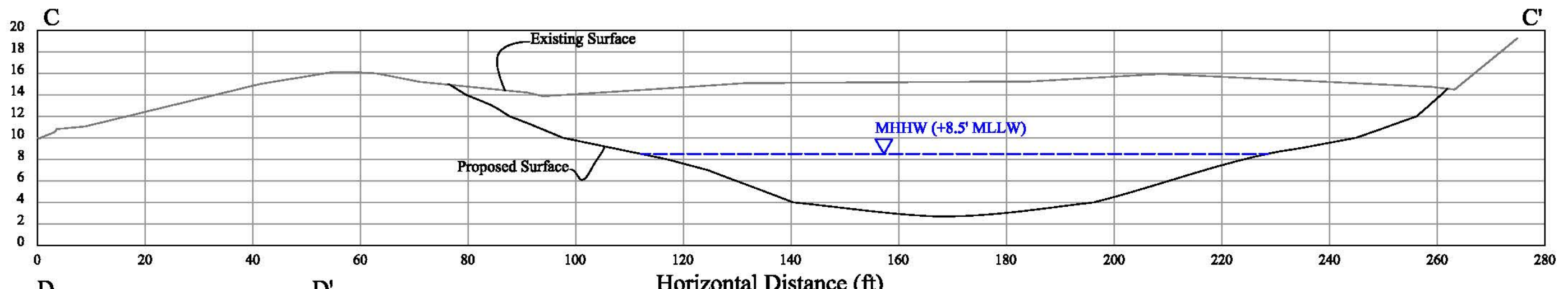
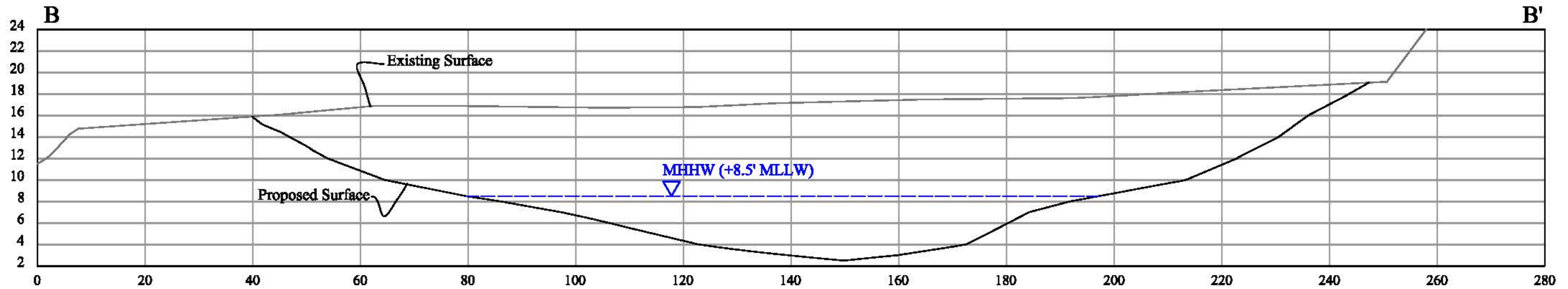
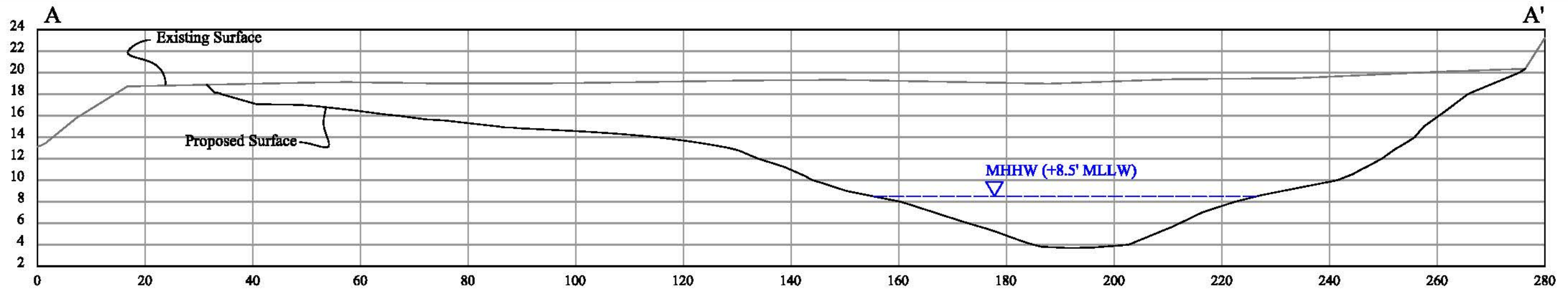


1711 Ellis St, suite 103  
 Bellingham, WA 98225  
 360-647-1845 - coastalgeo.com

DATUM: Existing surface surveyed by White Shield, Inc. in 2008  
 MLLW=0.0'



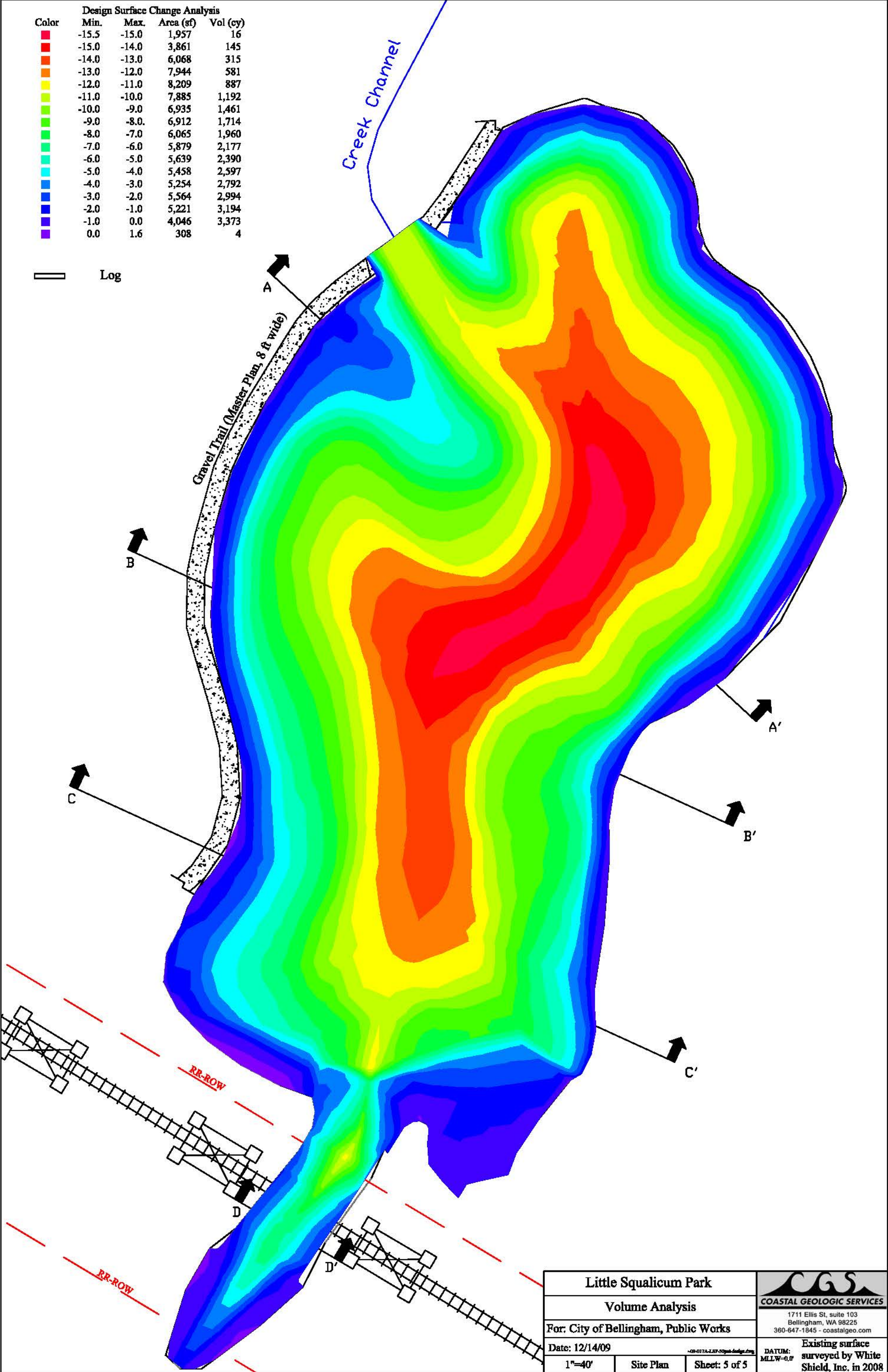
<b>Little Squalicum Park</b>		 <b>COASTAL GEOLOGIC SERVICES</b> 1711 Ellis St, suite 103 Bellingham, WA 98225 360-647-1845 - coastalgeo.com
<b>Proposed Estuary - Topography</b>		
<b>For: City of Bellingham, Public Works</b>		
Date: 12/14/09		-09-017A-LR-0902a.dwg
1"=40'	Site Plan	Sheet: 2 of 6
		DATUM: MLLW=0.0' Existing surface surveyed by White Shield, Inc. in 2008




<b>Little Squalicum Park</b>		<b>CGS</b> COASTAL GEOLOGIC SERVICES
Cross Sections		
For: City of Bellingham, Public Works		1711 Ellis St, suite 103 Bellingham, WA 98225 360-647-1845 - coastalgeo.com
Date: 12/14/09	-09-017A-120-50pt.dwg	
H:1"=20' V:1"=10'	Profiles	DATUM: MLLW=0.0'
Sheet: 3 of 6		Existing surface surveyed by White Shield, Inc. in 2008

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

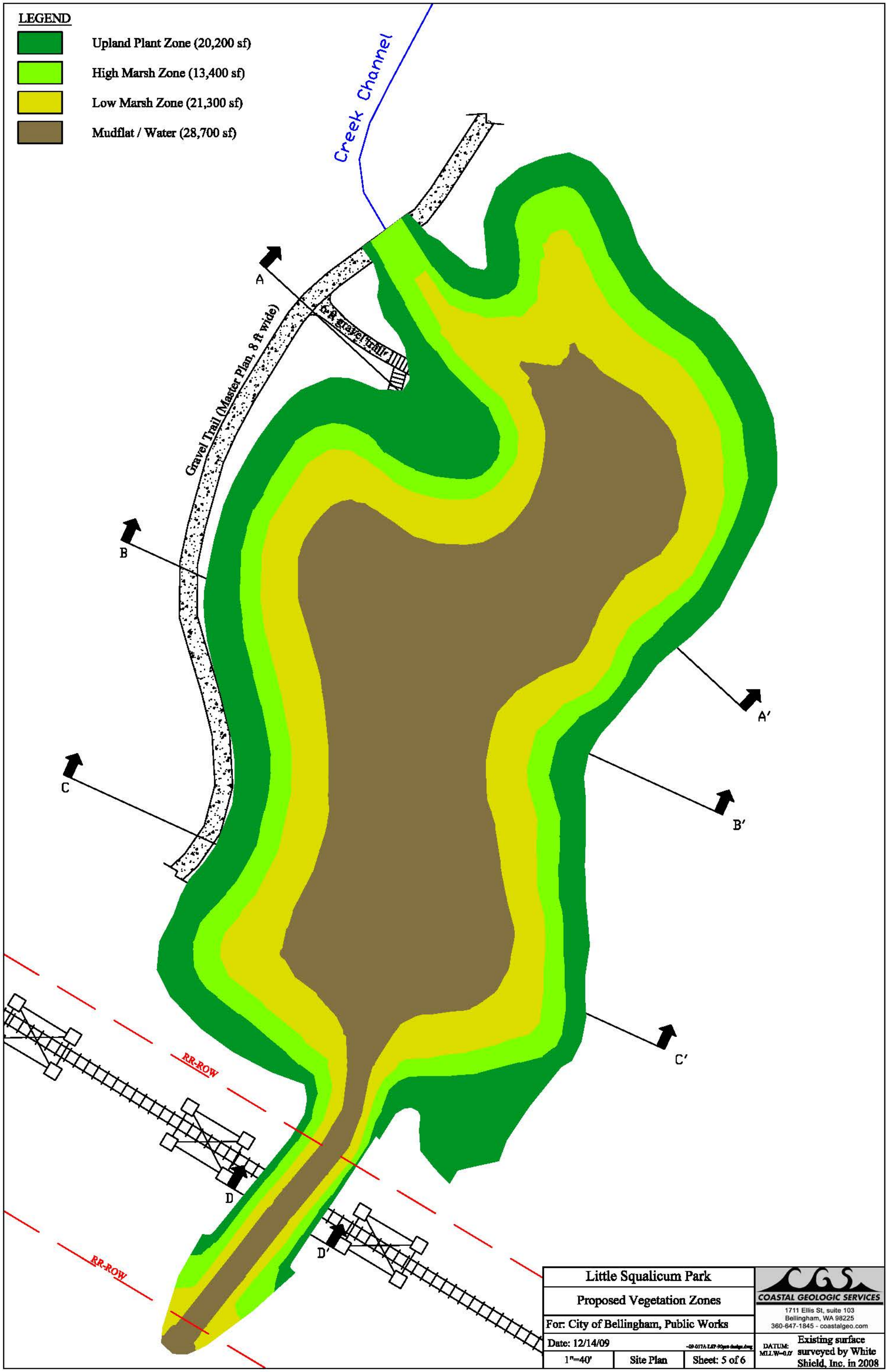
Log



Little Squalicum Park		 <b>COASTAL GEOLOGIC SERVICES</b> 1711 Ellis St, suite 103 Bellingham, WA 98225 360-647-1845 - coastalgeo.com
Volume Analysis		
For: City of Bellingham, Public Works		Existing surface surveyed by White Shield, Inc. in 2008 DATUM: MLLW=0.0'
Date: 12/14/09	-09-017A-LRP-00plan-design.dwg	
1"=40'	Site Plan	
Sheet: 5 of 5		

**LEGEND**

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



<b>Little Squalicum Park</b>		 <b>COASTAL GEOLOGIC SERVICES</b> 1711 Ellis St. suite 103 Bellingham, WA 98225 360-647-1845 - coastalgeo.com
Proposed Vegetation Zones		
For: City of Bellingham, Public Works		
Date: 12/14/09		-09-017A-L&P-00plan design.dwg
1"=40'	Site Plan	Sheet: 5 of 6
		DATUM: MLLW=0.0' Existing surface surveyed by White Shield, Inc. in 2008