Pre-Design Report
Mukilteo Watershed-Based Stormwater Retrofit Plan
Ecology Grant G1300137

Prepared for

City of Mukilteo, Washington

April 30, 2015

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Table of Contents

List of Figures

List of Tables

List of Abbreviations

ac	acre(s)
Aspect	Aspect Consulting LLC
BC	Brown and Caldwell
BMP	best management practice
BSM	bioretention soil media
cfs	cubic foot/feet per second
City	City of Mukilteo
DEM	digital elevation model
EB	east bioretention swale
Ecology	Washington State Department of Ecology
GIS	geographic information system
LiDAR	light detection and ranging
LID	low-impact development
MMC	Mukilteo Municipal Code
MR	minimum requirement
NEP	National Estuary Protection
PAU	project analysis unit
PIT	pilot infiltration testing
SEPA	State Environmental Policy Act
SFAP	stormwater financial assistance program
SWMMWW	Stormwater Management Manual for Western Washington
SPU	Seattle Public Utilities
SWPP	stormwater pollution prevention
WB	west bioretention swale
WSDOT	Washington State Department of Transportation
WWHM	Western Washington Hydrology Model

Executive Summary

The City of Mukilteo (City) received grant money from the Washington State Department of Ecology (Ecology) through the National Estuary Protection (NEP) Watershed Protection and Restoration Grant Program to perform site-specific retrofit planning and pre-design work. This project includes the following for three project analysis units (PAU):

- updating the stormwater inventory geodatabase
- catchment analysis
- retrofit project selection and prioritization
- geotechnical investigation
- pre-design and cost estimation for three project sites

The goals of this project are to address key impaired watershed processes to the extent possible; integrate stormwater retrofit projects into the landscape; optimize management of runoff from existing developed land; and provide a methodology for analysis, project selection, and prioritization that can be applied citywide.

The objective of this project is to perform a detailed analysis of each target sub-basin to support site-specific retrofit planning and pre-design work. To meet this objective, the project team has developed a detailed database of catchments and stormwater facilities using geographic information system (GIS), collected geologic and geotechnical data necessary to understand the movement of groundwater and infiltration feasibility in the study area as well as the stability/susceptibility of ravines, identified and prioritized (based on a number of criteria) project retrofits, and performed pre-design on three selected projects. This report summarizes the pre-design analysis, including rationale for selecting the project, and presents a conceptual design and planning-level cost estimate for each site.

Based on the Mukilteo Stormwater Retrofit Project Identification and Prioritization Report (ESA, 2014, and Appendix A) developed during this project and in support of the pre-design, the three top-rated projects for pre-design are the following:

- **Site 1, Staybridge Suites Pond:** retrofit existing detention pond to increase storage and decrease peak discharge
- **Site 2, Harbour Pointe Middle School:** construct bioretention to manage runoff in this catchment
- **Site 3, 55th Place W/127th Street SW:** construct bioretention to improve water quality and reduce peak flows currently entering two undersized detention ponds and wetlands

During pre-design, a site visit was conducted and different stormwater facilities were considered for implementation at each site. With low-impact development (LID) facilities being the preferable option, the following facilities were considered:

- bioretention facilities, including swales and planters
- pervious pavement
- detention pond retrofit

Site 1, Staybridge Suites Hotel Detention Pond

The team decided to maximize the size of the pond as much as possible given constraints of property size and design criteria. The pond will be expanded along its north, west, and south borders, and will include a 6-foot-wide embankment and new fencing around the perimeter. The new pond will be 9 feet deep from pond bottom to top of embankment berm and will include 6 inches of sediment trapping along the bottom of the pond, 6 inches of freeboard to the overflow, and 6 inches of freeboard to the emergency spillway. A new emergency overflow spillway will be constructed on the north side of the pond with riprap that will allow any overflows to discharge to the existing stormwater system. A new control structure will be installed and will connect to existing downstream piping.

Modeling of this site and preliminary design calculations indicate that expansion of the existing stormwater detention pond meets the flow duration standard and will improve the water quality prior to discharge to the ravine.

Site 2, Harbour Pointe Middle School

Alternatives evaluated for Site 2 consist of bioretention to treat roof runoff, permeable pavement and sidewalk in the main parking lot to reduce flow, and bioretention along the parking areas to treat parking lot runoff. Model results indicate that all of the alternatives were able to meet water quality requirements; however, none of the alternatives could meet the Ecology flow control or LID performance standards.

Parking area bioretention facilities were selected as the preferred alternative due to their adaptability for retrofitting into existing site landscaping and minimal impact to the school grounds. The recommended facilities can provide water quality treatment and reduce peak flows.

Site 3, 55th Place W/127th Street SW

Bookend alternatives evaluated for Site 3 consist of lined bioretention along the right-of-way with inflow from road runoff, and unlined bioretention along the right-of-way with permeable pavement and sidewalk, with inflow and infiltration from the road and sidewalk. The preliminary model results indicated that both alternatives could achieve the water quality requirement; however, neither of the alternatives could meet the Ecology flow control or LID performance standards.

Bioretention swales along the right-of-way were selected as the preferred alternative due to their smaller footprint (less residential impact) and similar flow control results for up to the 5-year storm. These facilities can provide water quality treatment and reduce peak flows and require relatively low maintenance.

Section 1

Project Overview

The city of Mukilteo (City), like many urban and urbanizing Puget Sound area cities, has experienced high peak stream flows, erosion in ravines, low summer flows, and decreased water quality associated with increased levels of development and impervious surfaces. Specifically, bank erosion and shallow slope failures in ravines have become common throughout Mukilteo due to changes in hydrology.

1.1 Previous Analysis

To address these issues, Mukilteo used grant funding provided by the Washington State Department of Ecology (Ecology) through the National Estuary Protection (NEP) Watershed Protection and Restoration Grant Program to develop a Stormwater Strategy Plan in 2011–12 based on data and methods from the Puget Sound Characterization Project. This recently completed Watershed-Based Stormwater Strategies Plan identified the Picnic Point Ravine, Big Gulch North, and Big Gulch South sub-basins as high priorities for stormwater retrofits as compared to other sub-basins within the study area (ESA, 2013). Each sub-basin, referred to as a project analysis unit (PAU), had high importance for the water delivery process and is also moderately degraded for this process. In addition, Ecology identified these PAUs as target watersheds, suggesting that retrofit actions within the PAUs would have a beneficial effect on water delivery processes. The Watershed-Based Stormwater Strategies Plan identified conceptual engineering strategies in these PAUs that focused on distributed infiltration and treatment of stormwater (ESA, 2013). Retrofitting these areas directly addresses recovery targets established in the Puget Sound Partnership's Action Agenda by improving water quality, reducing the frequency and magnitude of peak flow events, and protecting summer stream flows.

1.2 Current Analysis

For this project, Mukilteo received additional grant money from Ecology through the NEP Watershed Protection and Restoration Grant Program to perform site-specific retrofit planning and pre-design work. This work includes the following for a total of three PAUs:

- updating the stormwater inventory geodatabase
- catchment analysis
- retrofit project selection and prioritization
- geotechnical investigation
- pre-design and cost estimation for three retrofit projects

The goals of this project are to address key impaired watershed processes to the extent possible; integrate stormwater retrofit projects into the landscape; optimize management of runoff from existing developed land; and provide a methodology for analysis, project selection, and prioritization that can be applied citywide.

The objective of this project is to perform a detailed analysis of each target PAU to support site-specific retrofit planning and pre-design work. To meet this objective, the project team developed a detailed database of catchments and stormwater facilities using GIS, identified and prioritized project retrofits, and collected geologic and geotechnical data necessary to understand the movement of groundwater and infiltration feasibility in the study area as well as the stability/susceptibility of ravines.

1.2.1 Updating the Stormwater Inventory Geodatabase

The City's stormwater Inventory geodatabase was updated to include new data and correct existing data sets. Updates were generally limited to the geographic extents of the study area, which consist of Big Gulch North and South, and Picnic Point Ravine PAUs, although a limited number of edits were made outside of this spatial extent. Most updates were associated with stormwater management facilities such as vaults, drainage ponds, and dual function ponds. Updates to drainage points, catch basins, and network feature classes were based on geo-referenced as-built drawings obtained from the City.

1.2.2 Catchment Analysis

The catchment analysis consisted of subdividing the PAUs into catchments, where a catchment is a small area that drains to a single discharge point. Catchments were delineated using topography, the updated stormwater geodatabase, and field observations (ESA, 2014). Catchments with no stormwater treatment, or stormwater treatment designed by older standards (pre-2005), were identified.

1.2.3 Retrofit Project Selection and Prioritization

An initial field-based screening analysis was conducted to identify catchments where stormwater retrofit would be feasible and potential stormwater retrofit projects and locations. Eight locations were identified and potential stormwater retrofit projects were developed based on stormwater infrastructure mapping, topography, field observations of development, flow patterns, and best professional judgment.

Prioritization of stormwater retrofit projects was conducted using a scoring system that represents three spatial scales: PAU, catchment, and stormwater retrofit (ESA, 2014). These scales are described below:

- **PAU prioritization score:** The PAU prioritization score developed in the Stormwater Strategies Plan (ESA, 2013) is based on the relative importance and level of intactness of watershed processes at the PAU scale. This score also represents secondary processes such as maintenance of fish and wildlife habitat and sediment transport and delivery. The intention of this score is to prioritize stormwater retrofit most important for watershed processes.
- **Catchment prioritization score:** A catchment prioritization score was developed based on relative amount of impervious surface area of each catchment and the level of existing stormwater management. This score prioritizes stormwater retrofit projects with high levels of impervious area and low levels of existing stormwater management.
- **Stormwater retrofit project-specific score:** The stormwater retrofit project score is intended to prioritize stormwater retrofit projects based on site-specific considerations. Each potential retrofit project identified during the field screening was scored based on ease of partnership, engineering suitability, geotechnical suitability, permitting feasibility, cost, benefits, and other considerations. This score has a maximum value of 3.

The final prioritization score for stormwater retrofit projects is a combination of scores from each spatial scale:

Retrofit project recommendation = normalized PAU prioritization score + normalized catchment prioritization score + stormwater retrofit project score

Scoring for the eight identified projects is summarized in Table 1.

Table 1. Summary of Stormwater Retrofit Project Scores

Stormwater retrofit project name	Summary				
	Normalized PAU prioritization score	Normalized catchment prioritization score	Stormwater retrofit project-specific score	Total score	Rank
Project 1: Staybridge Suites Pond	0.9	0.5	2.0	3.4	3
Project 2: Harbour Pointe Place	0.8	0.7	1.5	2.9	7
Project 3: Library	0.8	0.3	1.4	2.4	8
Project 4: Harbour Pointe Middle School	0.8	0.6	2.2	3.6	2
Project 5: YMCA/47th Place W	0.8	1.0	1.6	3.3	4
Project 6: Harbour Pointe Golf Course	0.8	0.5	1.8	3.1	5
Project 7: 55th Place W/127th Street SW	0.8	0.5	2.3	3.6	1
Project 8: Private vault	0.8	0.6	1.6	3.0	6

Because the scoring is based on a normalization process, the results of this evaluation of stormwater catchments and potential stormwater retrofit projects applies only to the three study area PAUs.

1.2.4 Geotechnical Investigation

Subsurface explorations were conducted to assess soil and groundwater conditions and the feasibility of deep and shallow infiltration at two site-specific locations for potential retrofit projects: Site 2, Harbour Pointe Middle School, and Site 3, 55th Place W/127th Street SW. Two borings were drilled near Harbour Pointe Middle School to determine if deep infiltration was feasible: one in the school's driveway in the center of the parking area and another southeast of the school, in 47th Place W, adjacent to the YMCA. Based on the results, the soil found here has low permeability and will not support infiltration. A pilot infiltration test (PIT) was also conducted adjacent to the YMCA , and confirmed the boring results. One boring was drilled at 55th Place W to explore shallow infiltration and found low permeability of these soils as well, suggesting that shallow infiltration will not be feasible here. More details on this investigation can be found in Section 3 of this report.

1.2.5 Pre-design and Cost Estimation for Three Retrofit Projects

This pre-design report builds on the recommendations of the Mukilteo Stormwater Retrofit Project Identification and Prioritization Report (ESA, 2014) by presenting the pre-design of the three top-rated projects:

- Site 1, Staybridge Suites Pond: retrofit existing detention pond to increase storage and decrease peak discharge
- Site 2, Harbour Pointe Middle School: construct bioretention to manage runoff in this catchment
- Site 3, 55th Place W/127th Street SW: construct bioretention to improve water quality and reduce peak flows currently entering two undersized detention ponds and wetlands

Section 2

Basin Descriptions

The three projects are located in the Big Gulch and Picnic Point Creek watersheds. The Big Gulch watershed includes four sub-basins: Big Gulch North, Big Gulch South, Big Gulch West, and Big Gulch Southeast. The Picnic Point Creek watershed includes Picnic Point Ravine, Picnic Point Ravine West, and Picnic Point Ravine East sub-basins.

The three projects selected for pre-design are located within the sub-basins (also called PAUs): Big Gulch North, Big Gulch South, and Picnic Point Ravine, as shown in Figure 1. Site 1 lies within Big Gulch North, Site 2 is within Big Gulch South, and Site 3 is located in Picnic Point Ravine. Runoff from these PAUs is ultimately discharged into Puget Sound via Big Gulch Creek and Picnic Point Stream.

2.1 PAU Areas

The PAU boundaries are the most recent delineation based on light detection and ranging (LiDAR), digital elevation model (DEM), and stormwater infrastructure maps (ESA, 2013). Table 2 summarizes the project site PAU area and existing land use information.

Table 2. Project Analysis Unit Properties

Watershed	Project analysis unit	Area (acres)	Percent total impervious area	Existing land use
Big Gulch	Big Gulch North	303	23%	Residential, Commercial, Undeveloped
	Big Gulch South	419	41%	Residential, Commercial, Industrial, Undeveloped
Picnic Point Creek	Picnic Point Ravine	441	16%	Residential, Forested

Each PAU was further delineated into catchments, where a catchment is defined as an area that drains to an outfall, stormwater facility, or connection with a main storm drain. Catchments were delineated using topography, the updated stormwater geodatabase, and field observations (ESA 2014). The catchments containing a project site were further refined during pre-design to represent observed conditions in the field. Table 3 summarizes the catchment information for each project location, and catchments are shown in Figure 1.

Table 3. Project Catchments

Project site	PAU	Catchment	Total area (acres)[a]
Site 1, Staybridge Suites Pond	Big Gulch North	BG08	14.8
Site 2, Harbour Pointe Middle School	Big Gulch South	BG17	11
Site 3, 55th Place W/127th Street SW	Picnic Point Ravine	PPR18/PPR20	5.6

a. *The total area was updated during the pre-design, based on conditions observed in the field.*

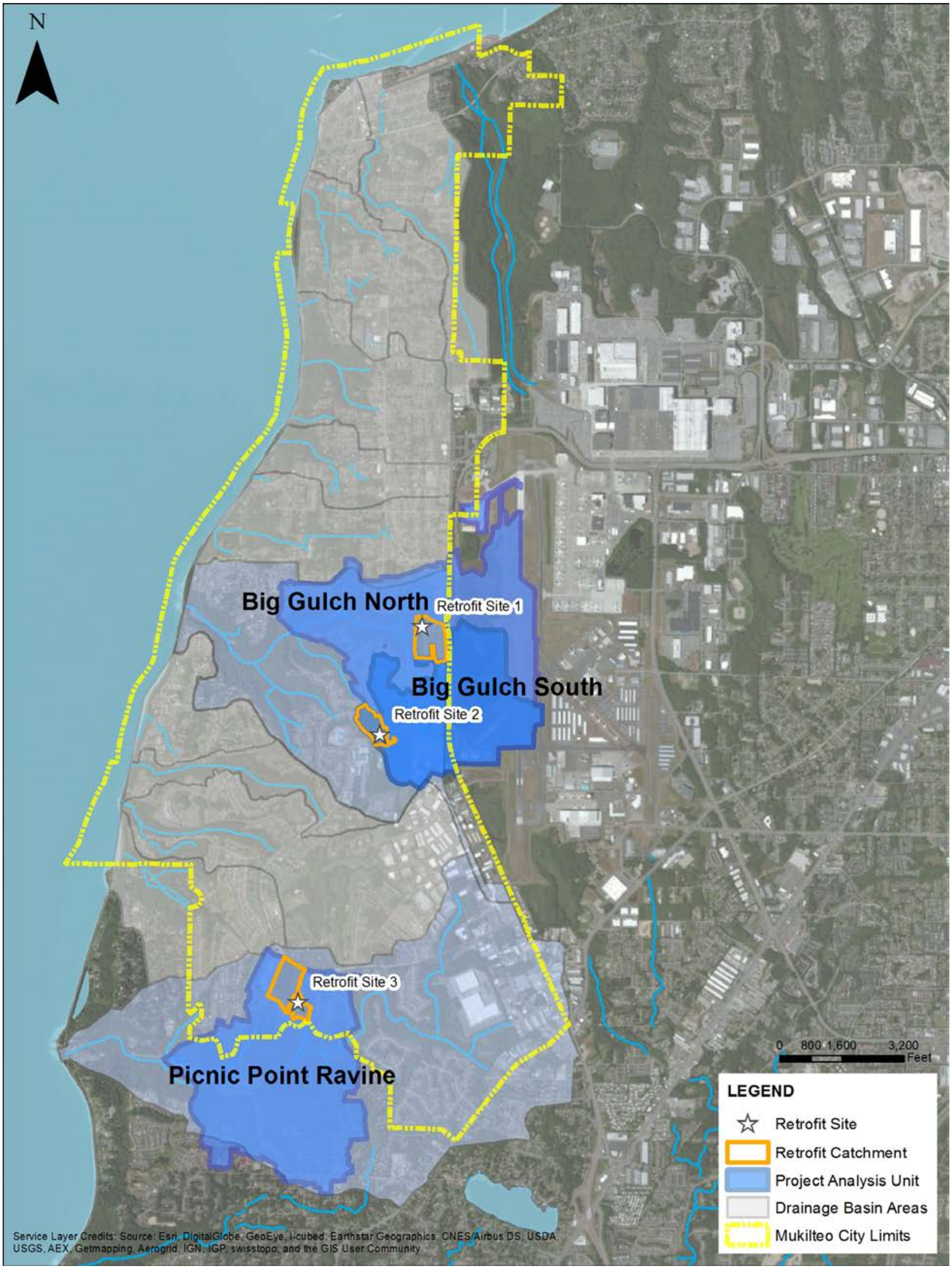

Figure 1. Project analysis units and catchment areas

2.2 Current and Future Land Use

Currently, the catchment areas for all three projects are fully developed, with the exception of a 5-acre parcel of land located in BG08, the Staybridge Suites Pond Site. This area is currently undeveloped, but has been approved for future commercial use in previous City planning efforts. Stormwater management for the development of the parcel will need to be considered at the time the development is occurring.

2.3 Basin Soils: Infiltration Feasibility

Prior to the pre-design, as part of the effort to update the 2001 Comprehensive Surface Water Management Plan, Aspect Consulting LLC (Aspect) performed a citywide analysis of infiltration feasibility. The results can be found in the Infiltration Feasibility Assessment Report (Aspect, 2015a), included in Appendix B of this report. In Aspect's analysis, shallow infiltration feasibility was considered a function of three factors: surficial geology/permeability, surface slope gradient, and proximity to steep slope hazard areas. Deep infiltration feasibility was considered a function of two factors: steep slope hazard areas and potential for a deep infiltration receptor horizon. GIS layers of each factor were created and the infiltration feasibility of each unique combination of factors was evaluated. Maps of infiltration feasibility were created for the City and the results are summarized below:

- **Shallow infiltration feasibility:** Most of the city is not suitable for shallow infiltration due to the presence of low-permeability glacial till soils at the surface and/or proximity to steep slope hazards. Small areas, scattered throughout the city, are considered moderate or good for shallow infiltration.
- **Deep infiltration feasibility:** There is uncertainty in the feasibility of deep infiltration due to the limited availability of reliable subsurface information. However, recently acquired regional data on the geology of the city's ravine slopes and deep explorations suggest a low potential for deep infiltration below most upland portions of the city. Because of the potential for steep slope hazards including landslides, deep infiltration is generally not feasible along the city's shoreline and within or near the steep ravines and gulches found in the city.

The infiltration feasibility assessment was used during pre-design for identification and evaluation of potential infiltration retrofits. Subsurface explorations, infiltration testing, and additional analysis were recommended to verify the information that provides the basis for the assessment included in the report. Some of these analyses have been performed in order to obtain site-specific information and are discussed in later sections of this report.

Section 3

Site Descriptions

The descriptions for each project site provided below include information on existing stormwater controls, drainage areas, land use, soils, and access. Site drainage areas were delineated based upon the updated catchment boundaries in the GIS geodatabase and field reconnaissance. For detailed design, topographic survey of each site will be needed to verify grading, location, and elevations of existing infrastructure and utilities, and other assumptions made during pre-design.

3.1 Soils

Subsurface explorations were conducted to assess soil and groundwater conditions and the feasibility of deep and/or shallow infiltration at two site-specific locations for potential retrofit projects including stormwater infiltration: Site 2, Harbour Pointe Middle School, and Site 3, 55th Place W/ 127th Street SW.

Explorations were completed using a truck-mounted drill rig advancing hollow-stem auger and mud-rotary drilling methods, operated by Holocene Drilling. Disturbed soil samples were obtained at 2.5- to 5-foot intervals using non-standard penetration test methods. Two borings (B-1 and B-3) were drilled in the vicinity of Site 2, Harbour Pointe Middle School and the “YMCA Site,” in order to determine deep infiltration feasibility. One boring (B-4) was drilled at 55th Place W at the “Green Streets Site” near Site 3, 55th Place W/127th Street SW, to determine shallow infiltration feasibility. Boring locations are shown on Figure 2 and Figure 3.

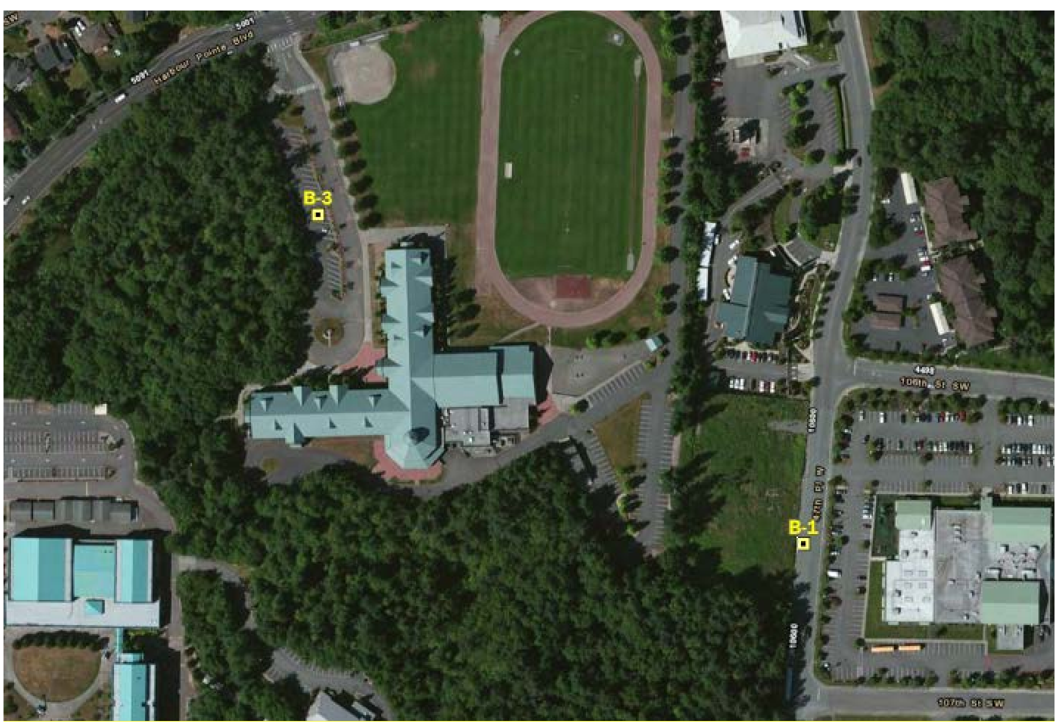

Figure 2. YMCA Site Borings B-1 and B-3, near Pre-design Site 2, Harbour Pointe Middle School

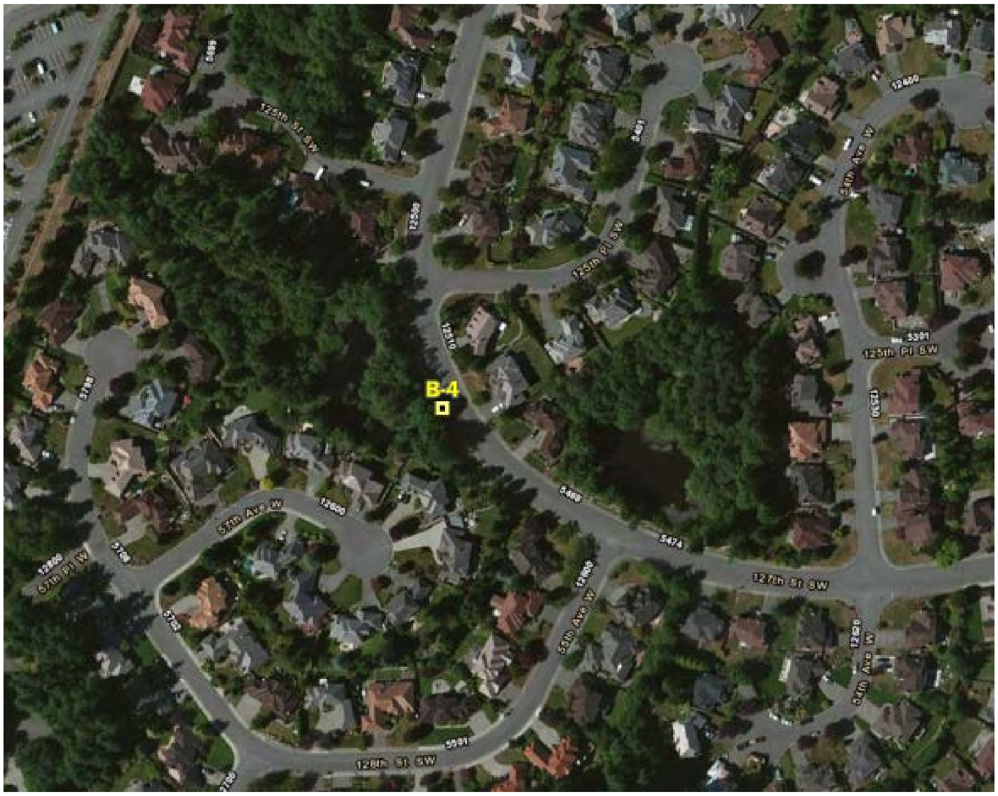

Figure 3. Green Streets Site Boring B-4, Pre-design Site 3, 55th Place W/127th Street SW

At the YMCA Site, Boring B-1 was located on 47th Place W near the T-intersection with 106th Street SW. Boring B-3 was located on the main entrance and angle-parking lot for Harbour Pointe Middle School. The YMCA Site contains a thick layer of glacial till and subglacial meltout till. These units possess low permeability and will not support infiltration. The thickness of the till units (greater than 100 feet) suggests that it is unlikely that a sufficiently thick and unsaturated sand and gravel unit is present below the site. Therefore, deep infiltration is not feasible at this site (Aspect, 2015b).

Also at the YMCA Site, a PIT was completed on November 5, 2014. Results of the PIT indicate that the long-term design infiltration rate is negligible. Perched water was also present above the till layer. This information confirms the results of the analysis conducted during initial explorations: this area is not feasible for shallow infiltration.

Boring B-4 was located on 55th Place W, in front of 12523 55th Place W. The extremely low permeability of the till, combined with wetland areas with standing water adjacent to the street, indicates that shallow infiltration is not feasible (Aspect, 2015b). The potential suitability of deep infiltration was not investigated at the Green Streets Site area.

Because impervious glacial till underlies the YMCA, Middle School, and Green Streets sites, it is recommended that all bioretention facilities proposed in this Pre-design Design Report be equipped with underdrains to convey treated stormwater to an appropriate discharge location. Further site-specific tests should be completed to determine if liners (low-permeability compacted soil or a geo-membrane) are required, based on site conditions including groundwater seepage zones, hydraulic restriction layers, and/or existing utility trenches. If determined to be necessary, the liner would ensure that natural groundwater seepage does not interfere with the bioretention swale, and would reduce the potential for unintended seepage into adjacent utility trenches or other pervious soil backfill or structures.

3.2 Site 1, Staybridge Suites Pond

The Staybridge Suites Pond site is located in the BG08 catchment in Big Gulch North PAU and features an existing stormwater detention pond receiving runoff from the adjacent hotel roof, landscaping and parking area, Harbour Place roadway, an office building roof, parking lot, and undeveloped parcel (Figure 4). The pond was constructed in 2000 and is undersized based on current regulations. In addition, record drawings for the detention pond indicate that the constructed pond size is smaller than the designed pond size.

The contributing area to the pond is approximately 14.8 acres, 55 percent of which is impervious. Current land use is mostly commercial, but includes a 5-acre undeveloped lot with patchy areas of grass in the southeast of the catchment and a small wetland area in the southwest corner according to current mapping of the area. The westernmost edge of the site has a steep slope to a ravine and is heavily vegetated with mature trees, Staybridge Suites is accessible via Harbour Place Road, and there is a pond access road in the north end of the hotel parking lot.

Stormwater drainage is captured by catch basins along the Harbour Place roadway and the Staybridge Suites parking lot. These flows are conveyed to a grass- and rock-lined swale west of the Staybridge Suites Hotel. This swale drains north into the detention pond in the northwest corner of the site. The detention pond discharges east, to a catch basin, and then to an outfall, which is located in the ravine northeast of the pond. The ravine discharges to Big Gulch Creek.

Based on Natural Resources Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database, the western portion of the site features hydrologic Group A soils, which indicate a high infiltration rate. The remainder of the site has hydrologic Group C soils, which indicate moderately high runoff potential with low infiltration rates. The northwestern portion of the site lies within a high landslide hazard area. No borings or PITs have been completed or are scheduled for this site.

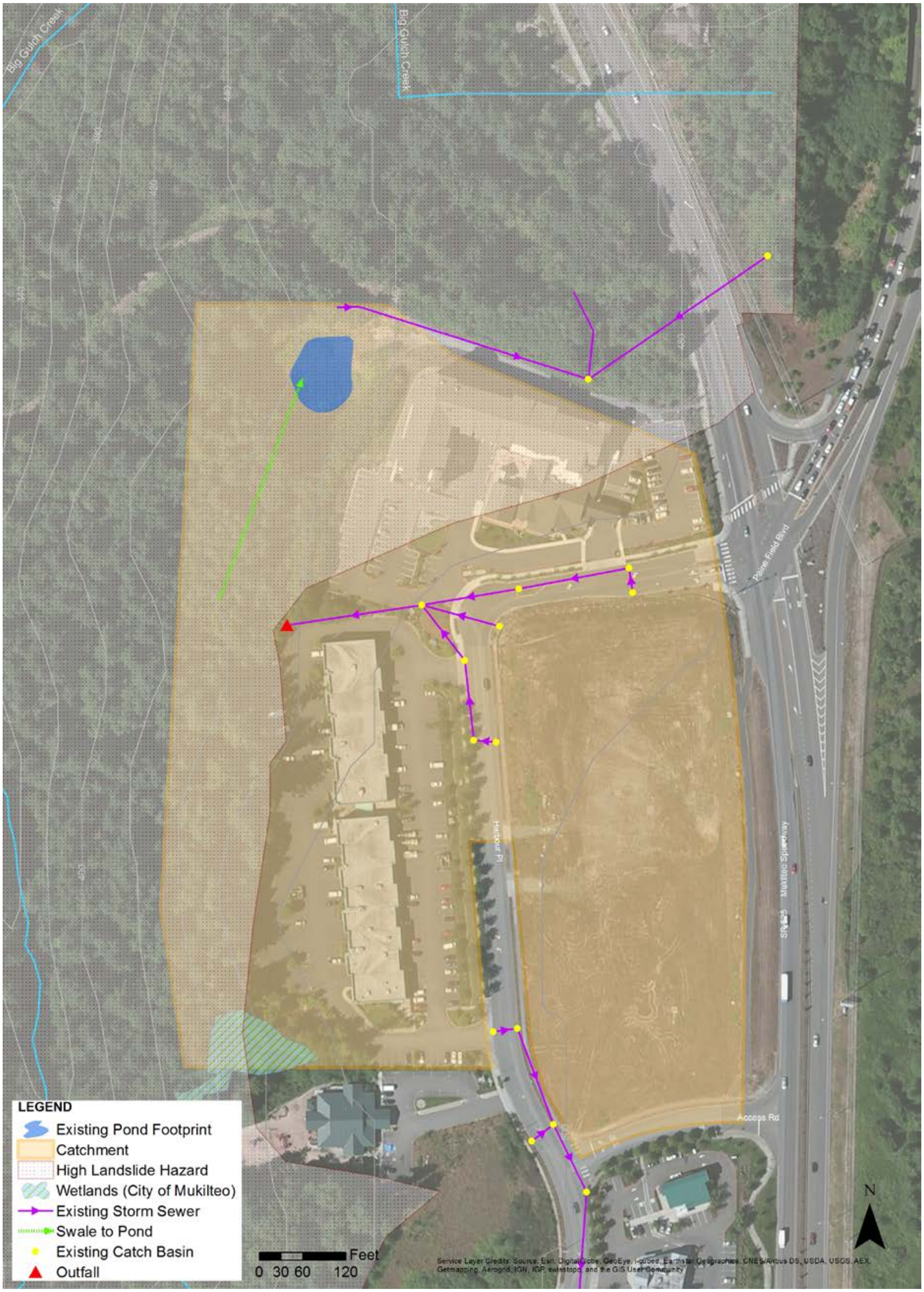

Figure 4. Site 1, Staybridge Suites Pond

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3.3 Site 2, Harbour Pointe Middle School

Harbour Pointe Middle School is located in catchment BG17, in the Big Gulch South PAU. The total catchment area is about 11 acres, 48 percent of which is impervious. Current land use is a mix of commercial and undeveloped forested wetland area, with residential area surrounding the school. The site is easily accessible from Harbour Pointe Boulevard. A paved access road enters the school grounds and loops around a grassy roundabout.

Catch basins along the school driveway were identified during a site visit; these are assumed to connect to existing infrastructure that is shown in the City's stormwater geodatabase and discharge to the adjacent wetland. The wetland as well as other storm drains in the catchment discharge into Big Gulch Creek, a high landslide hazard area. Roof downspouts at the school are assumed to connect to the storm sewer system. For detailed design, system connectivity will need to be verified. Site features are shown in Figure 5.

Based on SSURGO database, this site has hydrologic Group C soils, which indicate moderately high runoff potential with low infiltration rates. The northernmost part of the catchment, where the outfall to the Big Gulch Creek ravine is located, lies within a high landslide hazard area, but is off the school property.

Boring B-3 near this site indicates that the underlying soils are very dense, gray, very silty, and matrix-supported, suggesting Vashon Till (Qvt) (Aspect, 2015b). These soils feature low permeability and poor infiltration rates. Subglacial Meltout Till (Qvtm) was noted at about 78 feet deep.

The school property contains a Category 1 wetland. Mukilteo Municipal Code (MMC) 17B.52B.070.E states that the habitat score for the wetlands is needed to determine the actual required buffer width. The habitat score and actual buffer width will be determined during detailed design. The existing roadways and drainage facilities are considered non-conforming uses of wetland buffers (MMC 17B.52B.070.J). Based on MMC 17B.52B.070.M, stormwater retrofits would be allowed as long as they can demonstrate that there would be no increase in impacts to the wetland. For this pre-design, it was assumed that the project work would occur in the buffer and, because the proposed project is intended to improve water quality at the site, it complies with existing City regulations.

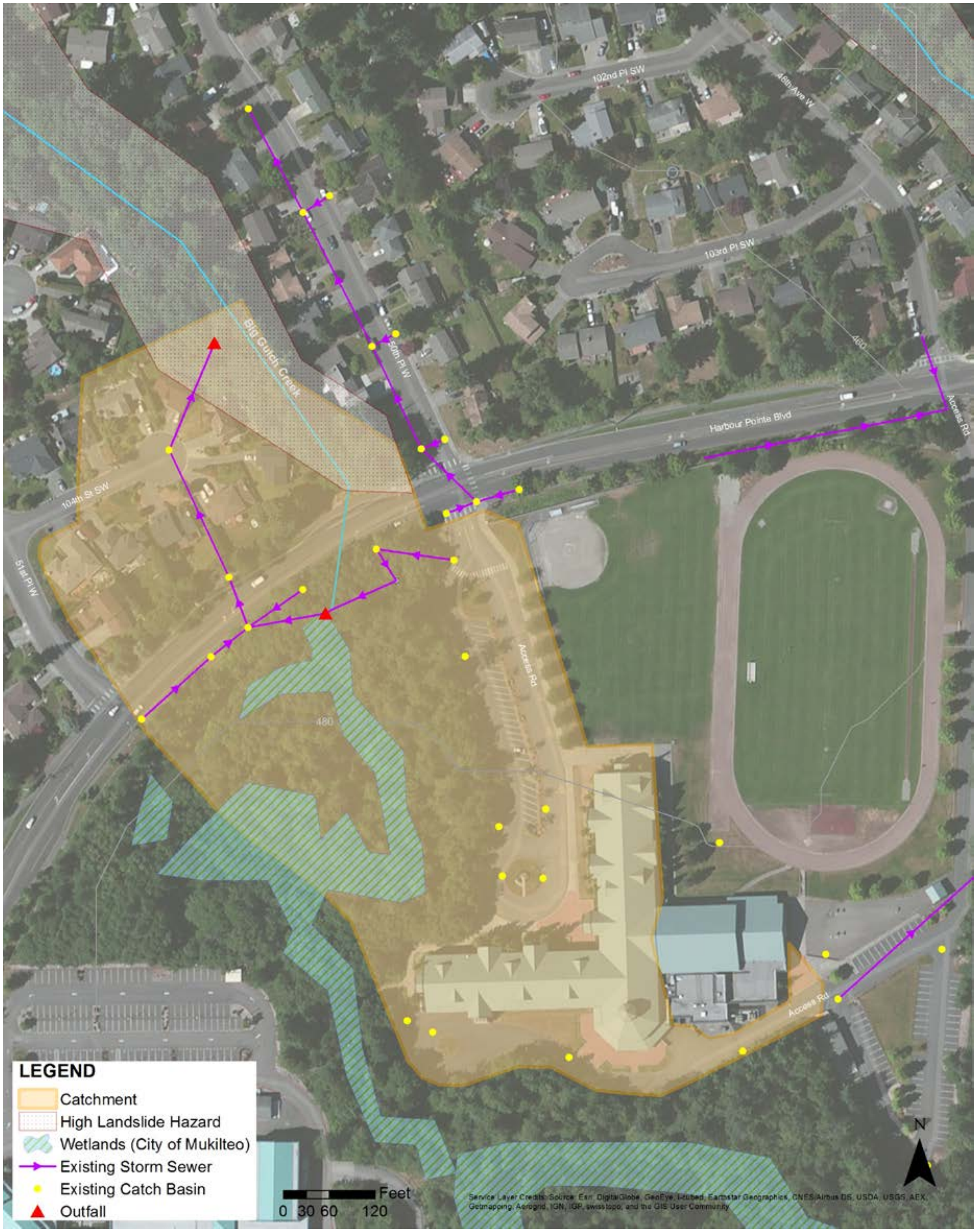


Figure 5. Site 2, Harbour Pointe Middle School

3.4 Site 3, 55th Place W/127th Street SW

This site is located in the Harbour Pointe neighborhood. The total site, which includes catchments PPR18 and PPR20, is about 21 acres, 10.75 of which is impervious. Current land use is predominantly single family residential, with some forested and heavily vegetated areas surrounding two detention ponds and a 1.5-acre wetland area. The site is easily accessed via residential streets within the project area. Pond and wetland areas may be accessed directly from the roadway.

Existing stormwater controls at this site include two detention ponds, which were constructed in 1988 and are undersized according to current regulations (ESA, 2014). These ponds receive stormwater runoff from the adjacent residential roadway. Observed pond conditions indicate they receive high nutrient loading due to residential activities including landscaping areas that are maintained and fertilized (ESA, 2014). The site features are shown in Figure 6.

Based on SSURGO database, this site has hydrologic Group C soils, which indicate moderately high runoff potential with low infiltration rates. The southern tip of the catchment, where the outfall to the ravine is located, lies within a high landslide hazard area.

Preliminary soil boring results (boring B-4) indicated that the roadway may be underlain by Vashon glacial till (Qvt), which features poor infiltration rates (Aspect, 2015b).

The wetland areas are a Category 2 wetland. The wetlands habitat score and buffer width will be determined during detailed design. The existing roadways and drainage facilities are considered non-conforming uses of wetland buffers (MMC 17B.52B.070.J). Based on MMC 17B.52B.070.M, stormwater retrofits would be allowed as long as they can demonstrate that there would be no increase in impacts to the wetlands. For this pre-design, it was assumed that the project work would occur in the buffer, and because the proposed project is intended to improve water quality at the site, it should comply with existing City regulations.

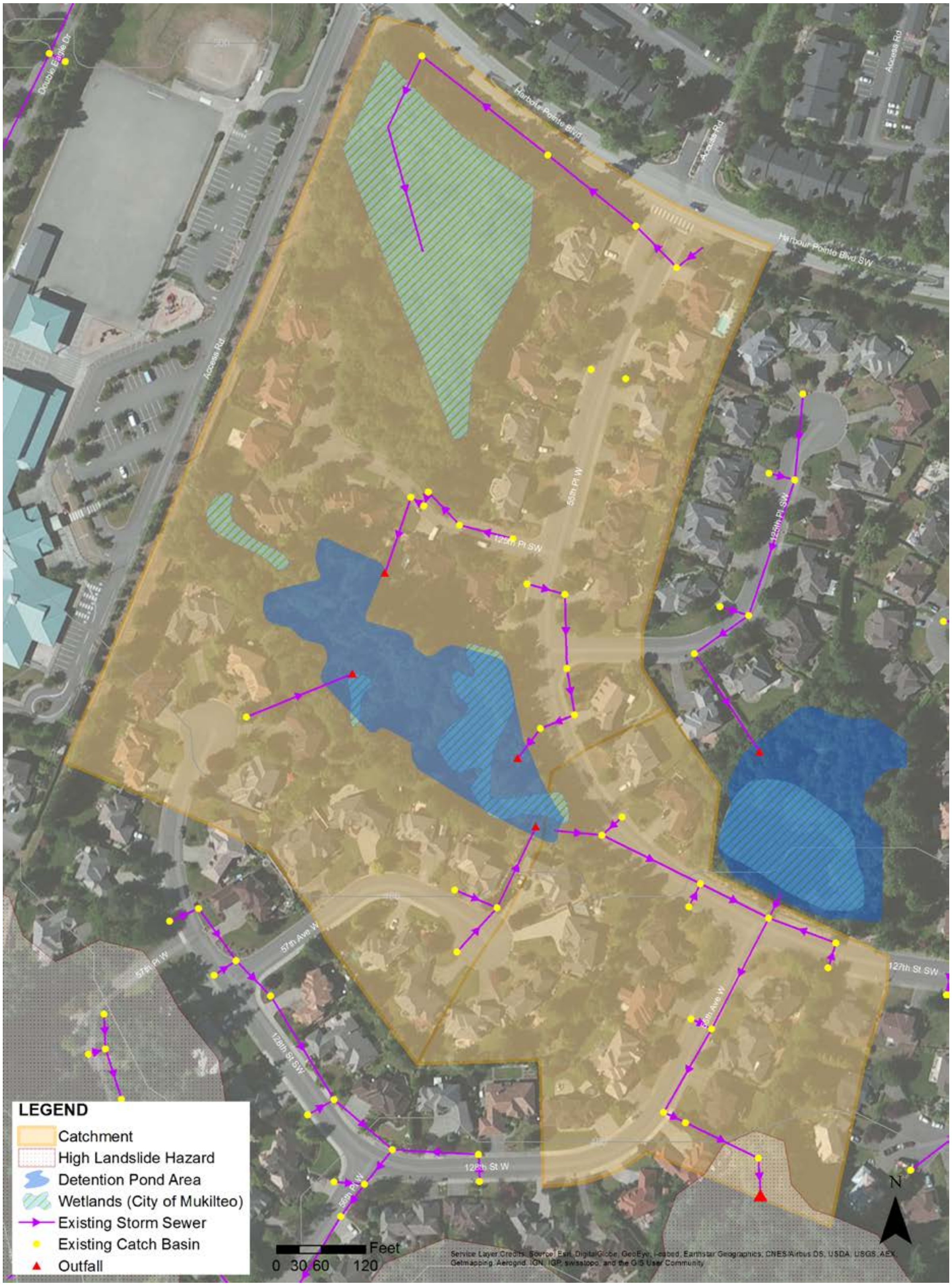


Figure 6. Site 3, 55th Place W/127th Street SW

Section 4

Minimum Requirement (Core Element) Analysis

This section compares the minimum requirements (MRs) that would apply to a typical redevelopment project with the proposed retrofit projects, given their existing site constraints. The details of these requirements, and which projects can meet each requirement, are presented below.

4.1 Minimum Requirements Applicable to the Project

Based on Section 2.4 of Volume 1 of the Ecology Stormwater Management Manual for Western Washington (SWMMWW), if these three projects were redevelopment projects, they would be required to meet MRs 1–5. This was determined by following Figure 2.4.1, Flow Chart for Determining Requirements for New Development, and Figure 2.4.2, Flow Chart for Determining Requirements for Redevelopment, in the SWMMWW. According to Figure 2.4.1, because each site has more than 35 percent existing impervious coverage, new development requirements do not apply. According to Figure 2.4.2, only MRs 1–5 apply to the three pre-design projects due to the following conditions:

- all projects have land-disturbing activity greater than 7,000 square feet, minimum requirements
- the projects do not add and/or replace 5,000 square feet or more of new or hard surfaces
- the projects do not convert 3/4 acres or more of vegetation to lawn or landscaped areas
- the projects do not convert 2.5 acres or more of native vegetation to pasture

The following MRs were determined to be applicable to the project:

- **Minimum Requirement 1: Preparation of Stormwater Site Plans.** This project will include preparation of Stormwater Site Plans for all three sites. Preliminary plans developed during this pre-design can be found in Appendix C of this report.
- **Minimum Requirement 2: Construction Stormwater Pollution Prevention (SWPP).** Based on the total project disturbed area, the project will include either preparation of Construction SWPP Plans or development of controls for the 13 Elements of Construction Stormwater Pollution Prevention.
- **Minimum Requirement 3: Source Control of Pollution.** All known, available, and reasonable source control best management practices (BMPs) will be applied to this project.
- **Minimum Requirement 4: Preservation of Natural Drainage Systems and Outfalls.** Existing drainage patterns will be maintained after the retrofit projects are complete by preserving current inflow conveyance via sheet flow and existing infrastructure and by connecting outflows of the proposed facilities to the existing infrastructure, where flows were originally routed. Also, runoff discharge will be improved at each site by improving water quality and reducing peak flows.

- **Minimum Requirement 5: Onsite Stormwater Management.** This MR requires that projects shall either use onsite stormwater management BMPs from List 1 presented in Section 2.5.5 of the SWMMWW, or demonstrate compliance with the LID performance standard. The LID performance standard requires that stormwater discharges match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 8 percent of the 2-year peak flow to 50 percent of the 2-year peak flow. Due to limitations of the existing sites for each project, MR5 cannot be met. Because Site 1 involves the retrofit of an existing pond, it is not included on List 1 and will not meet the requirements of the LID performance standard. At Sites 2 and 3, alternatives were evaluated, but none could meet the LID performance standard; Section 5 provides additional details on the analysis. Because bioretention was the preferred alternative at both sites, and underdrains were required at both sites due to soil infiltration limitations, the LID performance standard could also not be met at these sites.

4.2 Minimum Requirements Not Applicable to the Project

Although MRs 6–9 would not be applicable to these projects as redevelopment projects, Section 6, Design Analysis, includes discussion of flow control and water quality benefits each project has on the receiving waters, as compared to the standards developed for MRs 6 and 7, respectively. This discussion is included to meet Ecology requirements for this pre-design report. Because all of these projects are retrofits, any additional flow control and water quality treatment that can be accomplished will be an improvement upon the existing conditions at each site.

The following MRs were determined to be not applicable to the project:

- **Minimum Requirement 6: Runoff Treatment.** This MR requires that the treatment facility be sized based on the water quality design storm volume (6-month, 24-hour storm) and the water quality design flow rate (flow rate at or below which 91 percent of the runoff volume is treated, or 2-year release rate for detention facilities). This requirement is not applicable to this project. See Sections 5 and 6 for details on water quality treatment for each facility.
- **Minimum Requirement 7: Flow Control.** This MR requires that projects provide flow control to match developed discharge durations to predeveloped durations for the range of predeveloped discharge rates from 50 percent of the 2-year peak flow up to the 50-year peak flow. This requirement is not applicable to this project. See Sections 5 and 6 for details on flow control for each facility.
- **Minimum Requirement 8: Wetlands Protection.** This requirement is not applicable to this project.

  Minimum Requirement 9: Operation and Maintenance. This requirement is not applicable to this project.

Section 5

Alternatives Considered

During pre-design, a site visit was conducted and different stormwater facilities were considered to be implemented at each site. With LID facilities being the preferable option, the following facilities were considered:

- bioretention facilities, including swales and planters
- pervious pavement
- detention pond retrofit

5.1 Site 1, Staybridge Suites Pond

During the field visit to Site 1, Brown and Caldwell (BC) verified that retrofitting the existing detention pond will provide the most benefit to receiving waters based on the existing topography and limited space available for construction. Because this retrofit will still manage stormwater with detention, the project will not be able to meet the LID performance standard. The team decided to maximize the size of the pond within the constraints of the available property adjacent to the pond, adjacent critical areas, and design criteria.

5.2 Site 2, Harbour Pointe Middle School

During the field visit to Site 2, BC mapped existing catch basins found on the school property, observed site drainage, and developed alternatives for LID facilities that would fit in the existing paved and landscaped areas. Preliminary model simulations evaluated the following retrofits:

- Alternative A: bioretention to treat roof runoff
- Alternative B: permeable pavement and sidewalk in the main parking lot to reduce flow
- Alternative C: bioretention along the parking areas to treat parking lot runoff

Alternative C has the least impact to the school for both construction and maintenance. Alternatives A and B were evaluated as add-ons to Alternative C to see if further objectives could be achieved in minimizing impacts to receiving waters (i.e., flow control and LID performance standards). All of the alternatives were able to meet water quality requirements, but none of the alternatives could meet the flow control or LID performance standards. Because the additional retrofits did not provide significant improvements to receiving waters and would be a much larger impact to the school, Alternative C, parking area bioretention, was selected as the preferred alternative.

5.3 Site 3, 55th Place W/127th Street SW

During the field visit to Site 3, BC verified catch basin locations, observed site drainage, and developed alternatives for LID facilities that would fit in the existing paved and landscaped areas. Preliminary model simulations evaluated the following bookend retrofits:

- Alternative 1: lined bioretention along the right-of-way to treat road runoff (simulated for the lower bookend with no infiltration and small retrofit footprint)
- Alternative 2: infiltrating bioretention along the right-of-way and permeable pavement and sidewalk to treat road runoff and reduce flow (simulated for the higher bookend, with maximized infiltration, possible storage for flow control, and large retrofit footprint)

Alternative 1 was simulated to verify that, should the field testing indicate that infiltration is not recommended in this area, water quality benefits can still be achieved. Preliminary model results indicated that both retrofits could achieve the water quality standard; however, neither could meet the flow control nor LID performance standards. For the 2-year and 5-year storm, model results indicate that both retrofits achieve the same flow control. Because Alternative 1 has a smaller retrofit footprint and is achieving similar results with regard to impacts to receiving waters up to the 5-year storm, this retrofit was selected as the basis for this retrofit. The pre-design preferred alternative expands on Alternative 1 and includes unlined bioretention along the right-of-way, which has the same retrofit footprint, but provides potential to achieve further flow control and water quality treatment than the unlined bioretention facilities.

Section 6

Design Analysis

This section describes the design analysis conducted for the three top-rated projects for pre-design.

6.1 Site 1, Staybridge Suites Pond

The detention pond will be expanded along the north, northwest, and south borders. According to the record drawings, the southwest portion of the detention pond cannot be expanded due to a 10-foot-wide native growth protection area, and a 15-foot-wide special management area. The pond will include a 6-foot-wide embankment and new fencing around the perimeter. 2:1 H:V side slopes from the top of the embankment will transition grade to the bottom of the pond, and will match existing grade on the exterior slope of the embankment. The expanded pond will be deepened to 9 feet and will include 6 inches of sediment trapping along the bottom of the pond, 6 inches of freeboard to the overflow, and 6 inches of freeboard to the emergency spillway. Increasing the depth of the pond beyond 9 feet was not considered as it would require retaining walls and would be cost prohibitive.

A new emergency overflow spillway will be constructed on the north side of the pond with riprap and will allow any overflows to discharge to the existing stormwater system. The new location of the emergency overflow spillway will maximize the flow path between inlet and outlet, preventing short circuiting and maximizing sedimentation. The existing control structure will be removed, and a new control structure will be installed and will connect to existing downstream piping. The new control structure will include a new 18-inch riser with three orifices: 1.32-inch diameter at zero feet, 2-inch diameter at 6 feet, and 5-inch diameter at 7 feet. Figure 7 shows the retrofit pond location and tributary area. The preliminary plan and typical details are located in Appendix C as Exhibits 1, 2, and 3. The detention pond retrofit pre-design was based upon the design criteria in the Ecology SWMMWW Volume III, Section 3.2 Detention Facilities.

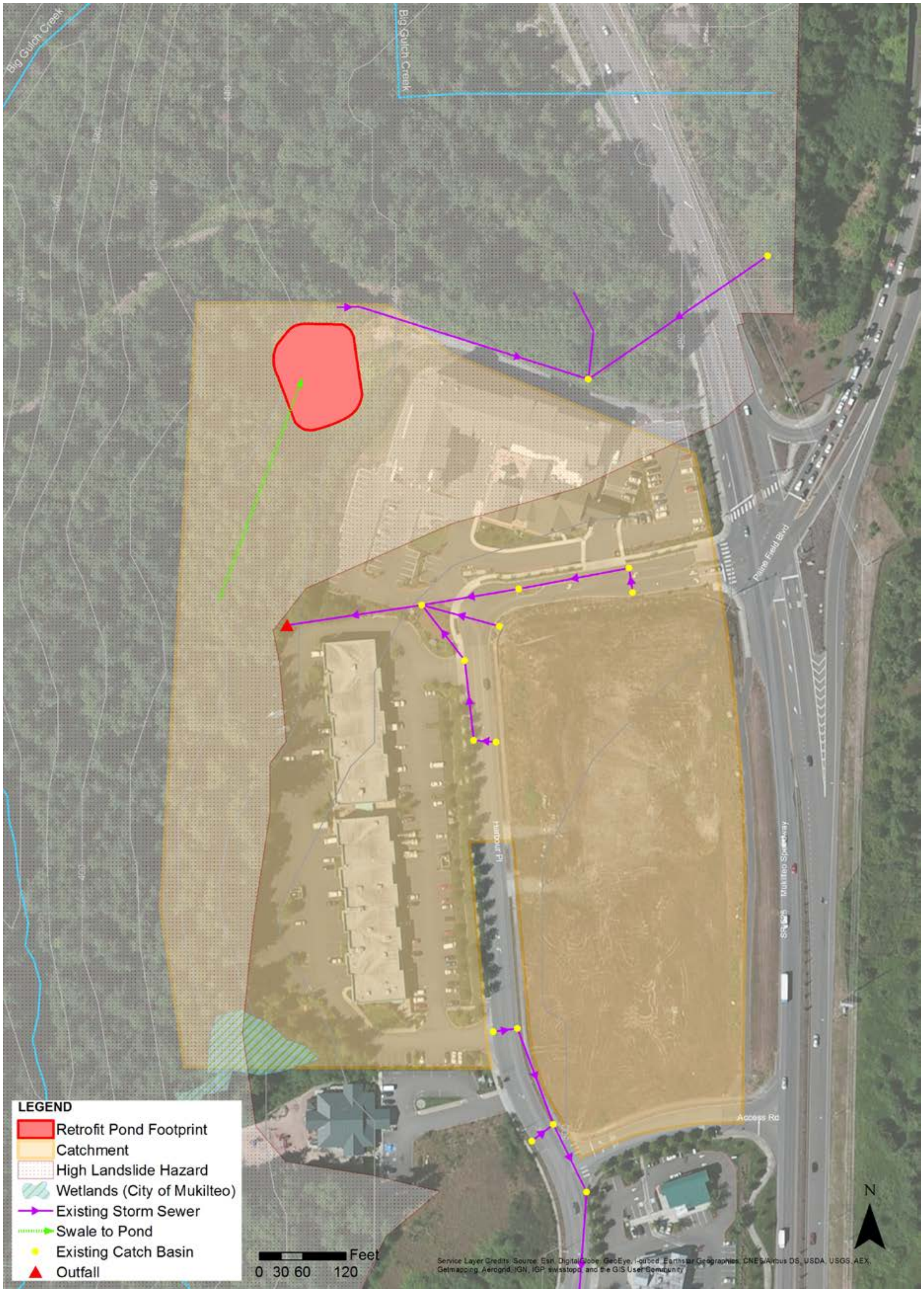


Figure 7. Site 1, Staybridge Suites Pond retrofit

6.1.1 Flow Control Design and Performance

Flow control calculations were performed through modeling using WWHM 2012; the modeling report, including scenario assumptions, is included in Appendix E.

Modeling of this site and preliminary design calculations indicate that expanding the existing stormwater detention pond to a bottom area of approximately 11,000 square feet will meet the flow duration standard. Model results are provided in the WWHM 2012 Project Report, found in Appendix E.

6.1.2 Water Quality Design and Performance

Water quality performance was simulated using WWHM 2012; the modeling report, including scenario assumptions, is included in Appendix E.

Modeling results indicate the water quality design storm volume is 0.19 acre-foot, or approximately 8,300 cubic feet, for the 91st percentile, 24-hour volume runoff. Based on the 6 inches of dead storage available along the bottom of the pond, the water quality volume of the pond is approximately 5,500 cubic feet. Although the pond is not meeting the Ecology treatment volume requirement, it is treating flows prior to discharge to the ravine.

It is recommended that during detailed design, the water quality design be revisited to determine if the Ecology treatment requirement can be met by slightly reshaping the pond based on survey results.

6.2 Site 2, Harbour Pointe Middle School

Parking area bioretention facilities were selected as the preferred alternative due to their adaptability for retrofitting into existing site landscaping and gardens and minimal impact to the school. These facilities can provide water quality treatment and reduce peak flows. They require relatively low maintenance.

The following criteria were applied to the retrofit siting:

- roundabout areas were not considered for retrofitting due to the presence of fire hydrants and other utilities
- existing curbs will be maintained to ensure adequate lane width for bus traffic
- mature trees and vehicle step-out area will be preserved

Based on these criteria, site grading, and catch basin locations, the central garden strip of the driveway and the eastern garden strip adjacent to the wetland area were determined to be the most feasible locations for bioretention. The project includes a lined bioretention swale along the western edge of the parking area (Harbour Pointe Middle School: west bioretention swale [WB1]) and bioretention planters in the center parking strip, east of the swales (Harbour Pointe Middle School: east bioretention planters [EB1 and EB2]), as shown on Figure 8. The Harbour Pointe Middle School: WB1 receives runoff from the western parking area pavement. The Harbour Pointe Middle School: EB1 and EB2 receive runoff from the eastern parking area pavement and sidewalks. Because of the existing gradient, they are not hydraulically connected. The contributing area for each feature is presented in Table 5. Exhibit 4 in Appendix C shows the proposed dimensions of the bioretention facilities. Exhibit 5 in Appendix C shows typical sections and details of the bioretention swales and planters.

Table 5. Site 2, Harbour Pointe Middle School Contributing Areas

Project feature	Total area (acres)	Pervious area (acres)	Impervious area (acres)	Percent impervious
Harbour Pointe Middle School: WB1	0.55	0.10	0.45	82
Harbour Pointe Middle School: EB1	0.46	0.15	0.31	67
Harbour Pointe Middle School: EB2	0.19	0.07	0.12	63

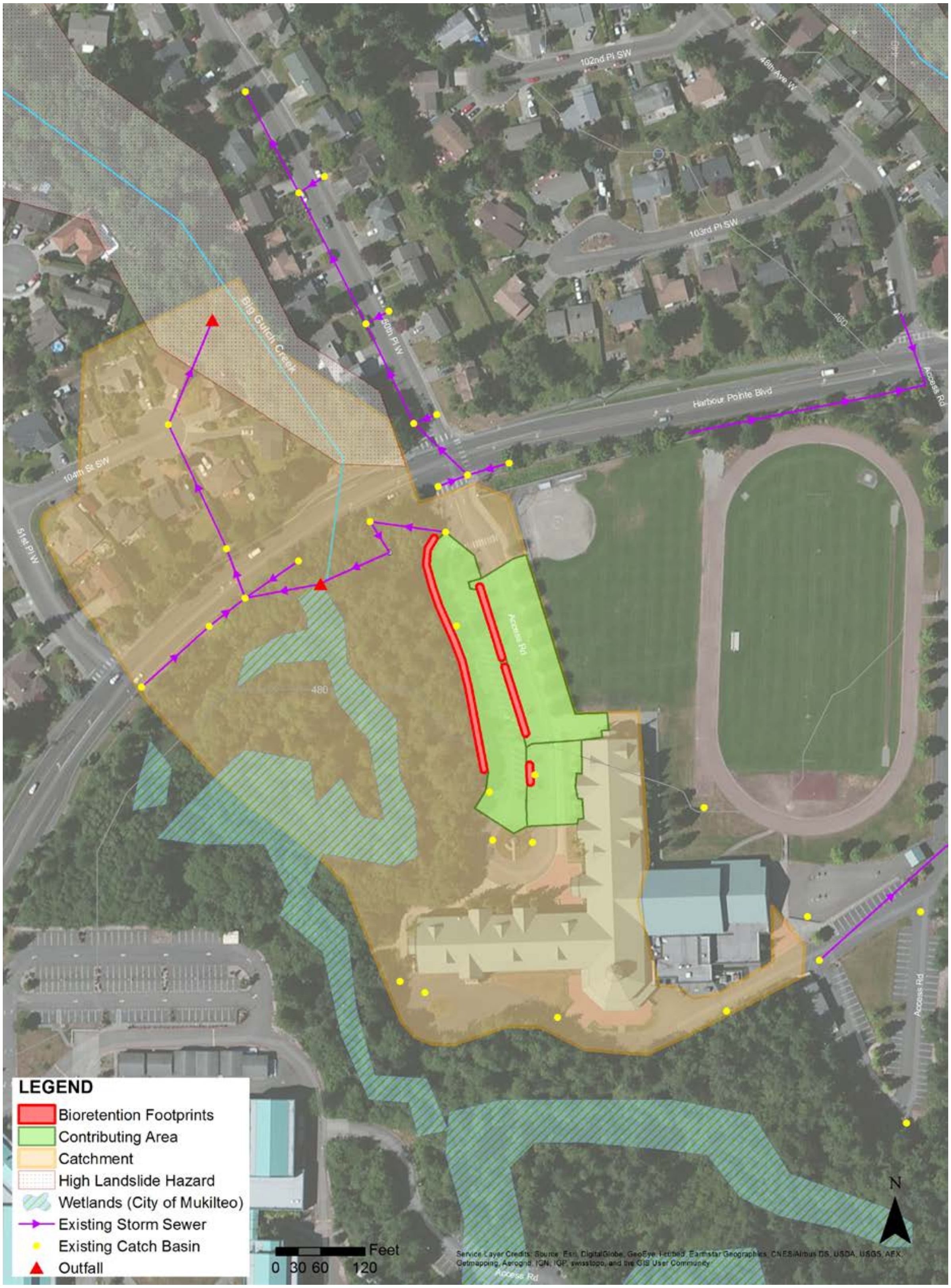


Figure 8. Site 2, Harbour Pointe Middle School bioretention

The bioretention planters and swales are sloped at 3:1 H:V and are fully vegetated along the flat bottoms and side and end slopes. Bottom widths vary between 1.5 and 2.5 feet based on the width available. The swales are 12 inches deep, which allows for 6 inches of ponding and 6 inches of freeboard. The bioretention soil media (BSM) and clean gravel depths were determined for maximum effective treatment and storage. Exhibit 5 in Appendix C shows typical sections and details of the bioretention planters and swales.

Overflow structures are proposed in all the bioretention swales. There are also two proposed control structures: one downstream of Harbour Pointe Middle School: WB1 and the other downstream of Harbour Pointe Middle School: EB1. These structures are the discharge location for flow from the underdrain, and will discharge to existing catch basins via the proposed new piping. Their need will be dictated by the elevation of the existing infrastructure, which will be determined during detailed design. The final design of the control structures may include:

- a weir to provide hydraulic flexibility in connecting the bioretention underdrains and overflows to the existing storm sewer system
- an end cap for the underdrain if the unlined bioretention areas are infiltrating better than expected

The proposed configuration connects the overflow structure in Harbour Pointe Middle School: EB2 to the existing adjacent catch basin. Harbour Pointe Middle School: WB1 may also be connected to an adjacent catch basin if existing hydraulic profiles allow, which will be determined during detailed design.

The location of the bioretention facilities in the parking area requires curb inlets to be cut into the existing curb, allowing runoff from the roadway into the bioretention. Each bioretention facility would have an inlet approximately every 6 feet to allow inflow. Exact number and locations will be determined during detailed design.

Based on information obtained from the borings drilled in the school's driveway and nearby at the YMCA Site, and the PIT conducted at the YMCA Site, infiltration rates in this area are negligible; therefore, the bioretention facilities were modeled with no native infiltration. Prior to detailed design, site PIT (or other geologic investigations) will be completed to determine locations of any hydraulic restriction layers and to estimate infiltration rate. If the estimated infiltration rate is higher than expected, bioretention facility sizing may be revised during detailed design. If perched groundwater or other hydraulic restriction layers are observed during site investigations, the bioretention facilities may require lining or be found to be infeasible. Detailed survey of topography and existing utilities and infrastructure, including piping invert elevations, will also be needed for detailed design.

The bioretention retrofit pre-design was based upon the design criteria in the Ecology SWMMWW Volume V, BMP T7.30: Bioretention Cells, Swales and Planter Boxes.

6.2.1 Flow Control Design and Performance

Flow control calculations were performed through modeling using WWHM 2012; the modeling report, including scenario assumptions, is included in Appendix E.

The predeveloped conditions for the catchment and contributing areas were assumed to be predominantly flat, forested area with 25 percent wetland area based on estimations from map data (saturated flat forest). Existing conditions were determined based upon catchment delineations and analysis of aerial imagery completed by ESA. Large grassy or garden areas within the contributing areas were modeled as flat lawn.

The retrofit flows are mitigated by the bioretention installations. Planter Harbour Pointe Middle School: EB1 was modeled as one planter with a length the sum of the lengths of two connected planters to simulate the entire treatment area of the bioretention system. For this pre-design, it was assumed that the planters can be installed unlined; this may change once the PIT (or other geologic investigations) is completed and the distance to any hydraulic restrictive layer is determined. The three proposed bioretention facilities were modeled assuming zero infiltration as a conservative approach.

The model results indicate the bioretention areas should reduce peak flow runoff from the contributing and catchment areas (Table 6). Of the peak flow storms presented, the 2-year, 5-year, and 25-year, the percent reduction of flow from the contributing area varies from 63 to 76 percent for the Harbour Pointe Middle School: WB1, 56 to 72 percent for Harbour Pointe Middle School: EB1 portion, and 75 percent reduction of Harbour Pointe Middle School: EB2 peak flows. While this is a significant reduction in flow, the peak flows after mitigation are still an order of magnitude higher than the simulated predeveloped flows.

Table 6. Site 2, Harbour Pointe Middle School Flow Control Analysis Summary				
Harbour Pointe Middle School: WB1 (Contributing area: 0.55 acre)				
	Peak flow (cfs)			
Return interval	Predeveloped	Existing	Retrofit	Percent flow reduction: existing to retrofit
2-year	0.0044	0.15	0.054	63
5-year	0.0074	0.20	0.062	69
25-year	0.013	0.30	0.072	76
Harbour Pointe Middle School: EB1(Contributing area: 0.46 acre)				
Return interval	Predeveloped	Existing	Retrofit	Percent flow reduction: existing to retrofit
2-year	0.0018	0.10	0.05	56
5-year	0.0031	0.14	0.05	62
25-year	0.0052	0.21	0.06	72
Harbour Pointe Middle School: EB2 (Contributing area: 0.19 acre)				
Return interval	Predeveloped	Existing	Retrofit	Percent flow reduction: existing to retrofit
2-year	0.0053	0.040	0.011	75
5-year	0.0089	0.066	0.014	75
25-year	0.015	0.085	0.021	75

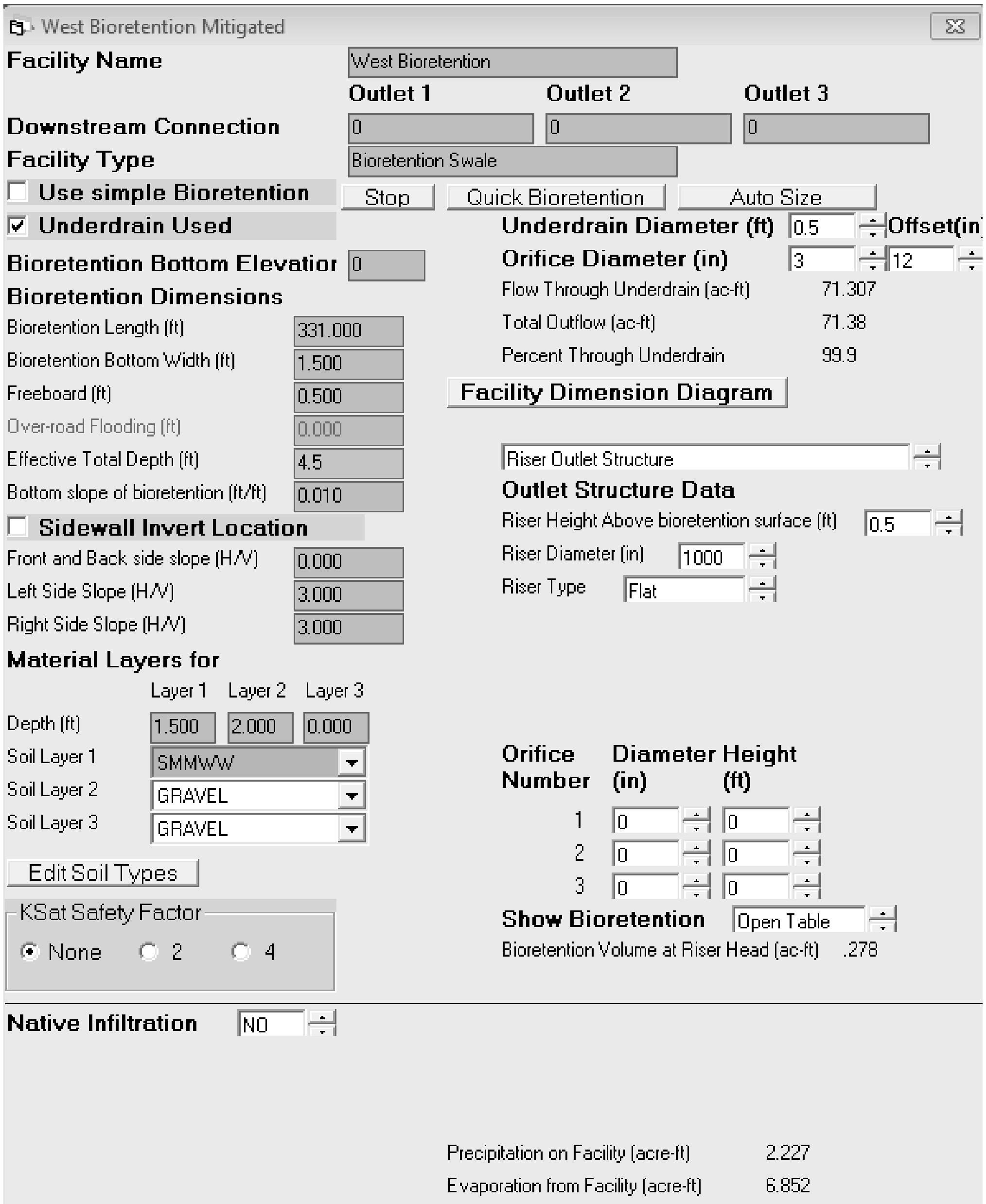
6.2.2 Water Quality Design and Performance

Water quality performance was simulated using WWHM 2012; the modeling report is included in Appendix E.

All bioretention areas were modeled using 18 inches of BSM and 24 inches of gravel for storage capacity. A 6-inch-diameter raised underdrain was included 1 foot above the bottom of the gravel layer. Runoff that has filtered through the BSM layer enters the underdrain once it has filled up the storage space below and is conveyed either into a downstream planter or into the storm sewer infrastructure.

Figure 9, Figure 10, and Figure 11 below show the model inputs and water quality results for the three bioretention areas. The model shows that nearly 100 percent of the contributing flow is treated by going through the BSM and being either infiltrated or discharged through the underdrain for both contributing areas. Table 7 summarizes the results.

Table 7. Site 2, Harbour Pointe Middle School Water Quality Analysis Summary	
Harbour Pointe Middle School: WB1 (Contributing area: 0.55 acre)	
WQ: percent volume treated	99.99%
Harbour Pointe Middle School: EB1 (Contributing area: 0.46 acre)	
WQ: percent volume treated	100%
Harbour Pointe Middle School: EB2 (Contributing area: 0.19 acre)	
WQ: percent volume treated	99.78%



West Bioretention Mitigated

Facility Name: West Bioretention

	Outlet 1	Outlet 2	Outlet 3
Downstream Connection	0	0	0

Facility Type: Bioretention Swale

☐ Use simple Bioretention — Stop — Quick Bioretention — Auto Size

☑ Underdrain Used

Underdrain Diameter (ft) 0.5 Offset(in)

Orifice Diameter (in) 3 12

Flow Through Underdrain (ac-ft) 71.307

Total Outflow (ac-ft) 71.38

Percent Through Underdrain 99.9

Bioretention Bottom Elevatior 0

Bioretention Dimensions

Bioretention Length (ft) 331.000

Bioretention Bottom Width (ft) 1.500

Freeboard (ft) 0.500

Over-road Flooding (ft) 0.000

Effective Total Depth (ft) 4.5

Bottom slope of bioretention (ft/ft) 0.010

Facility Dimension Diagram

Riser Outlet Structure

Outlet Structure Data

Riser Height Above bioretention surface (ft) 0.5

Riser Diameter (in) 1000

Riser Type Flat

☐ Sidewall Invert Location

Front and Back side slope (H/V) 0.000

Left Side Slope (H/V) 3.000

Right Side Slope (H/V) 3.000

Material Layers for

	Layer 1	Layer 2	Layer 3
Depth (ft)	1.500	2.000	0.000

Soil Layer 1 SMMWW

Soil Layer 2 GRAVEL

Soil Layer 3 GRAVEL

Edit Soil Types

Orifice Number	Diameter (in)	Height (ft)
1	0	0
2	0	0
3	0	0

KSat Safety Factor: ◉ None ○ 2 ○ 4

Show Bioretention: Open Table

Bioretention Volume at Riser Head (ac-ft) .278

Native Infiltration NO

Precipitation on Facility (acre-ft) 2.227

Evaporation from Facility (acre-ft) 6.852

Figure 9. Site 2, Harbour Pointe Middle School: WB1 water quality model inputs and results

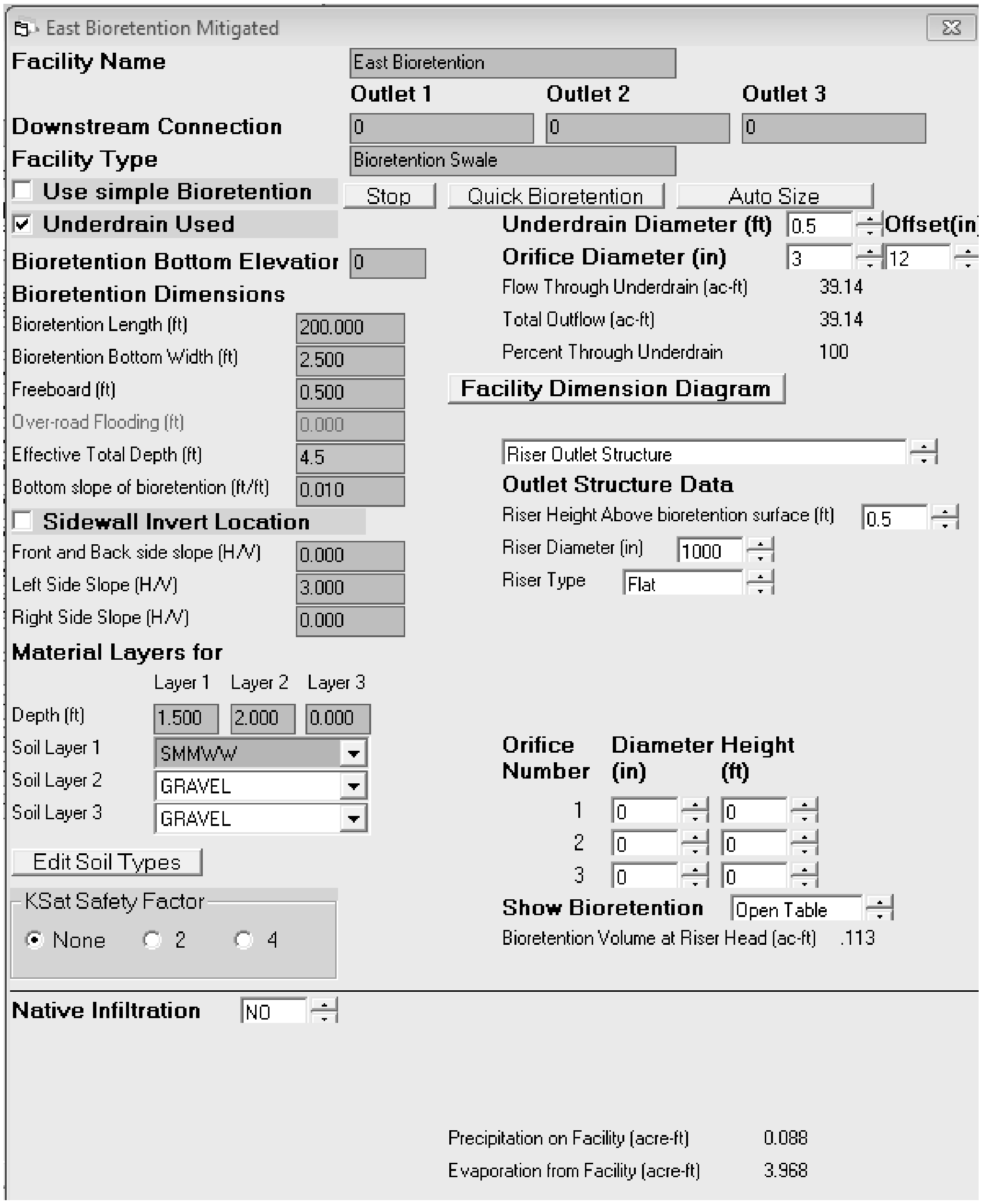


Figure 10. Site 2, Harbour Pointe Middle School: EB1 water quality model inputs and results

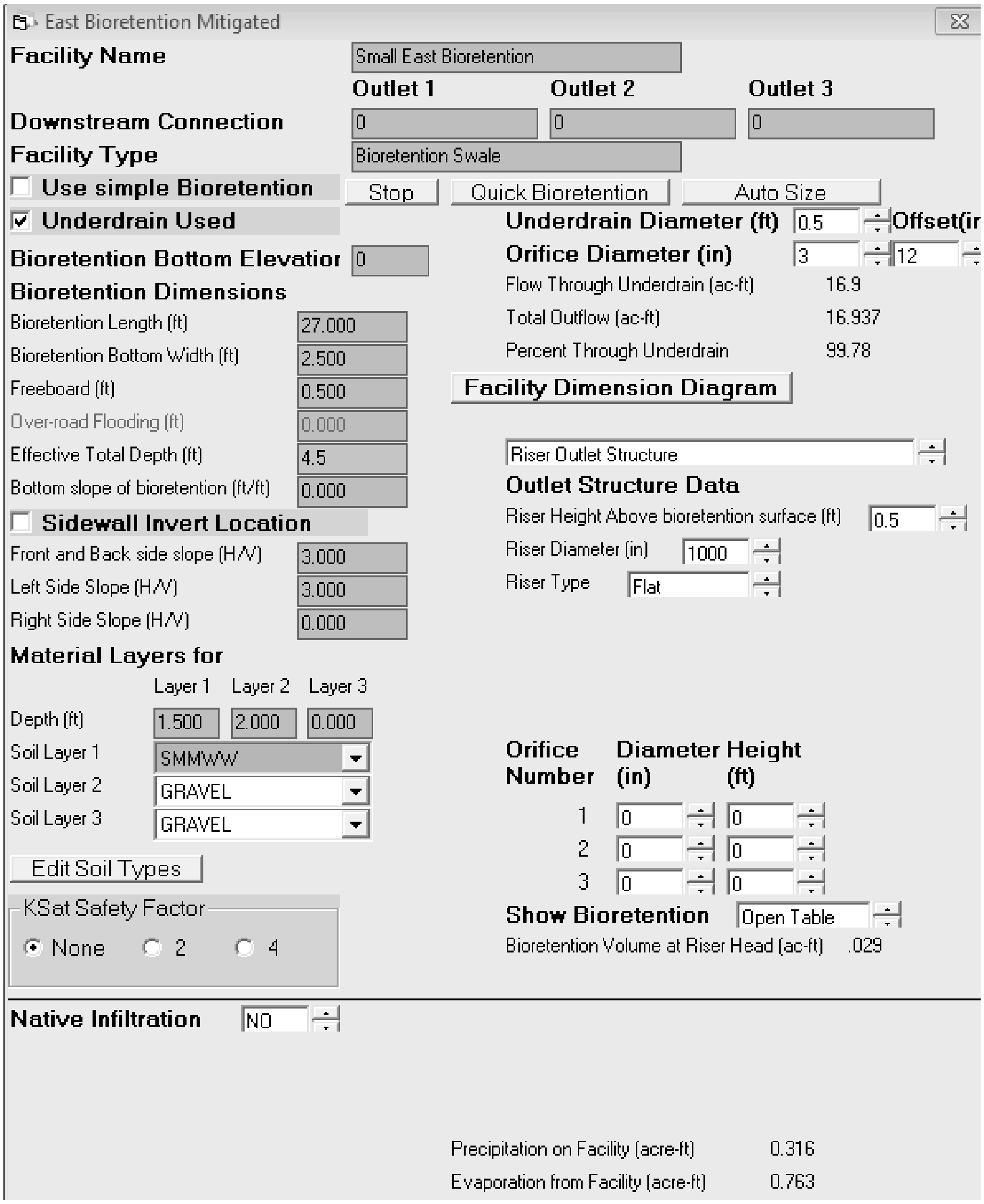


Figure 11. Site 2, Harbour Pointe Middle School: EB2 water quality model inputs and results

6.3 Site 3: 55th Place W/127th Street SW

Bioretention swales constructed in series along the right-of-way were selected as the preferred alternative due to their adaptability for retrofitting into existing site landscaping and minimal impact to the residential area. These facilities can provide water quality treatment, reduce peak flows, and require relatively low maintenance.

The west bioretention swales (55th/127th: WB1) are connected in series and receive runoff from the roadways, driveways, sidewalks, and lawns within the contributing areas from catchment PPR18. The eastern bioretention swales (55th/127th: EB1) are also connected in series and receive runoff from the roadways, driveways, sidewalks, and lawns within the contributing areas from catchment PPR20. Swale locations are shown on Figure 12. Exhibit 6 in Appendix C shows the proposed dimensions of the bioretention swales. The contributing area for each location is presented in Table 8. Although some of the contributing area is residential landscaping and lawn, this surface is developed and compacted. It was therefore assumed to be impervious as a conservative assumption during pre-design.

Table 8. Site 3, 55th Place W/127th Street SW Contributing Areas

Project feature	Total area (acres)	Pervious area (acres)	Impervious area (acres)	Percent impervious
55th/127th: WB1	1.6	0	1.6	100
55th/127th: EB1	1.3	0	1.3	100

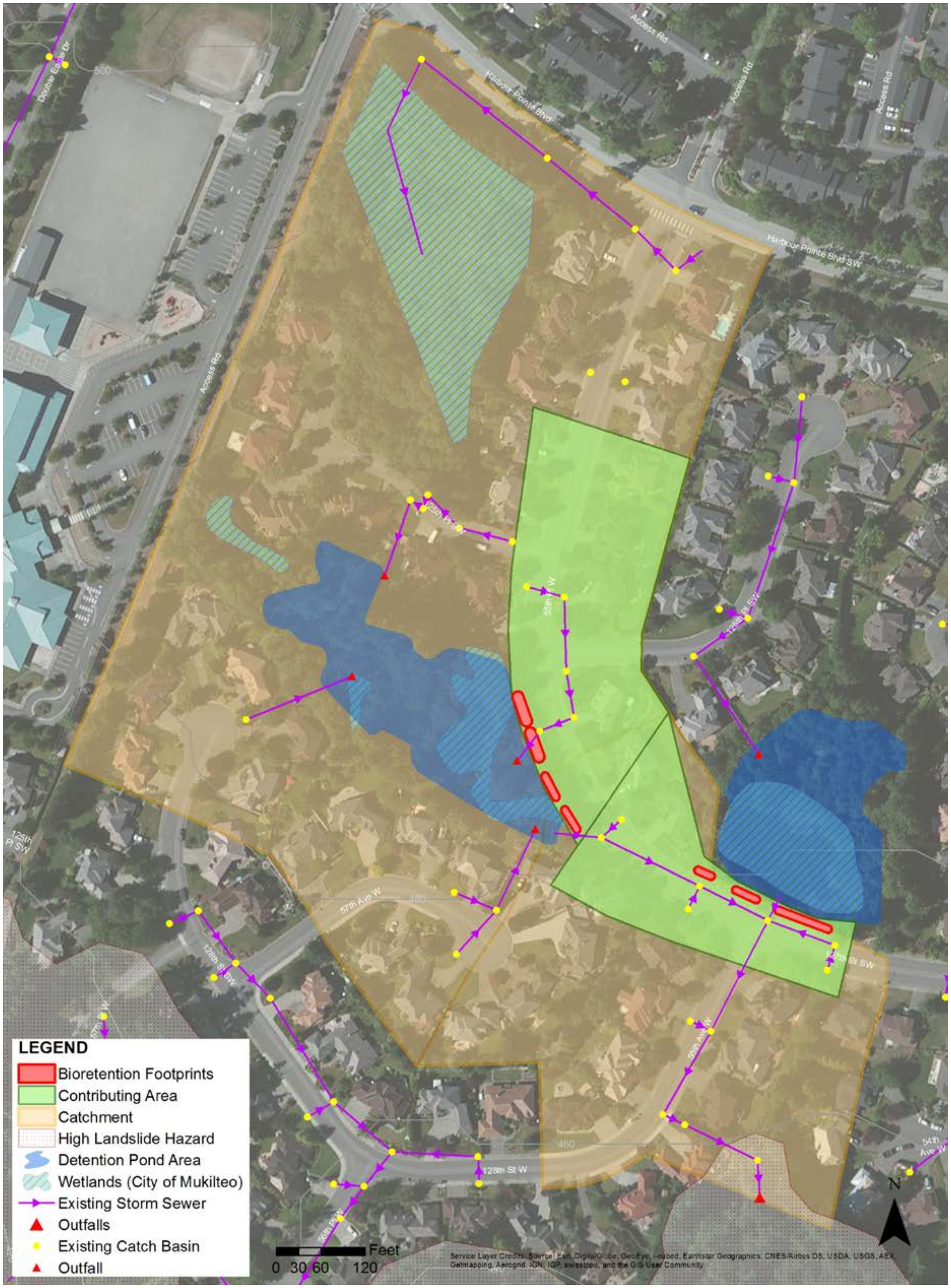


Figure 12. Site 3, 55th Place W/127th Street SW bioretention

The bioretention swales are sloped on all sides at 3:1 H:V and are fully vegetated along the flat bottoms and side and end slopes. Bottom widths vary between 3 and 6 feet based on the available area between the sidewalks and the wetlands or existing structures, including utility vaults and park benches. The swales are 12 inches deep, which allows for 6 inches of ponding and 6 inches of freeboard. The BSM and clean gravel depths allow for maximum effective treatment and storage. Exhibit 7 in Appendix C shows typical sections and details of the bioretention swales.

There are two proposed control structures: one downstream of each bioretention swale series. These structures are the discharge location for flow from the underdrain and act as the overflow for the final swale. Their need is dictated by the elevation of the existing infrastructure, which will be determined during detailed design. The final design of the control structures may include:

- a weir to provide hydraulic flexibility in connecting the bioretention swales to the existing storm sewer system
- an end cap for the underdrain if the unlined bioretention areas are infiltrating better than expected

The location of the bioretention swales, with a sidewalk between the road and the facility, requires grates and curb inlets to be located in the sidewalk to allow flow from the roadway into the bioretention swale. Each bioretention swale would have two inlets, presumably one at each end, to allow flow into the swale. The exact number and locations of inlets will be determined during detailed design. A typical detail of a curb inlet is included in Exhibit 7 in Appendix C.

Overflow structures are proposed for all the bioretention swales. The upstream bioretention swale overflow conveys excess ponding water (over the designed 6-inch ponding depth) into downstream bioretention swales. The most downstream bioretention swale overflow discharges into the existing storm sewer.

Based on information obtained from the borings drilled in the road at this site, infiltration rates in this area are negligible; therefore, the bioretention facilities were modeled with no native infiltration. Prior to detailed design, site PIT (or other geologic investigations) will be completed to determine the location of any hydraulic restriction layers and to estimate infiltration rate. If the estimated infiltration rate is higher than expected, bioretention facility sizing may be revised during detailed design. If perched groundwater is observed, the bioretention facilities may require lining or be found to be infeasible. Detailed survey of topography and existing utilities and infrastructure, including piping invert elevations, will be needed for detailed design.

The bioretention retrofit pre-design was based upon the design criteria in the Ecology SWMMWW Volume V, BMP T7.30: Bioretention Cells, Swales and Planter Boxes.

6.3.1 Flow Control Design and Performance

Flow control calculations were performed through modeling using WWHM 2012; the modeling report, including the scenario assumptions, is included in Appendix E.

The predeveloped conditions for both sites were assumed to be mostly forest on a moderate slope with a portion of wetland (saturated flat forest). The existing conditions for the sites are roads, a housing development, and forest or wetland. Although some of the contributing area is residential landscaping and lawn, this surface has been developed and compacted and is likely to have little infiltration, and was therefore modeled as impervious as a conservative approach. For modeling purposes, the lengths of the individual swales were summed for each contributing area. For this pre-design, it was assumed that the swales can be installed unlined; this may change once the PIT (or other geologic investigations) is completed and the distance to any hydraulic restrictive layer is determined. Bioretention sizing is based on a conservative assumption of zero native infiltration, based on the preliminary soil boring results (Aspect, 2015b).

The model results in Table 9 indicate that the bioretention swales reduce peak flow runoff from the contributing area. Of the peak flow storms presented, the 2-year, 5-year, and 25-year, the percent reduction of flow from the contributing area varies from 68 to 80 percent for 55th/127th: WB1 and 54 to 72 percent for 55th/127th: EB1. While this is a significant reduction in flow from the contributing area, the peak flows after mitigation are still an order of magnitude higher than the simulated predeveloped flows.

Table 9. Site 3, 55th Place W/127th Street SW Flow Control Analysis Summary

55th/127th: WB1 (Contributing area: 1.59 acres)				
	Peak flow (cfs)			
Return interval	Predeveloped	Existing	Retrofit	Percent flow reduction: existing to retrofit
2-year	0.02	0.63	0.12	80
5-year	0.03	0.85	0.21	76
25-year	0.05	1.23	0..40	68
55th/127th: EB1 (Contributing area: 1.31 acres)				
	Peak flow (cfs)			
Return interval	Predeveloped	Existing	Retrofit	Percent flow reduction: existing to retrofit
2-year	0.02	0.42	0.12	72
5-year	0.03	0.57	0.21	64
25-year	0.04	0.84	0.39	54

6.3.2 Water Quality Design and Performance

Water quality performance was modeled using WWHM 2012; the modeling report is included in Appendix E.

The bioretention swales were modeled with 24 inches of BSM. This depth is recommended when a high nutrient load is expected. A 6-inch-diameter raised underdrain is included below the BSM, 1 foot above the bottom of the clean gravel layer. This layer provides additional storage while the stormwater infiltrates. The raised underdrain conveys stormwater, once it has been treated by the BSM, into a downstream swale or storm sewer. The model results indicate nearly all of the contributing flow is treated. Table 10 summarizes the results of the water quality analysis.

Table 10. Site 3, 55th Place W/127th Street SW Water Quality Analysis Summary

55th/127th: WB1 (Contributing area: 1.59 acres)	
WQ: percent volume treated	99.3
55th/127th: EB1 (Contributing area: 1.31 acres)	
WQ: percent volume treated	98.5

Figure 13 and Figure 14 below show the model inputs and water quality results for the bioretention models.

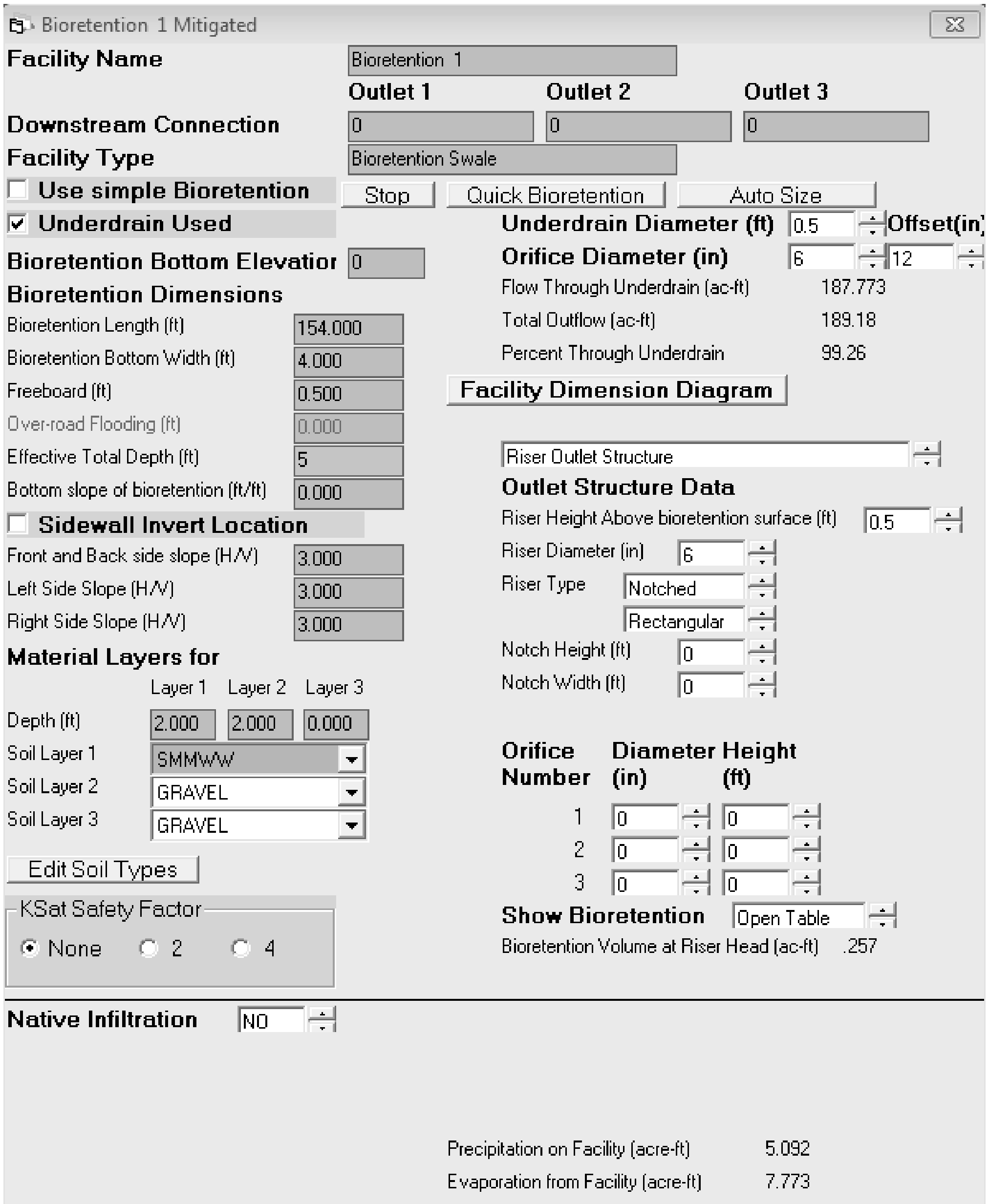


Figure 13. Site 3, 55th/127th: WB1 water quality model inputs and results

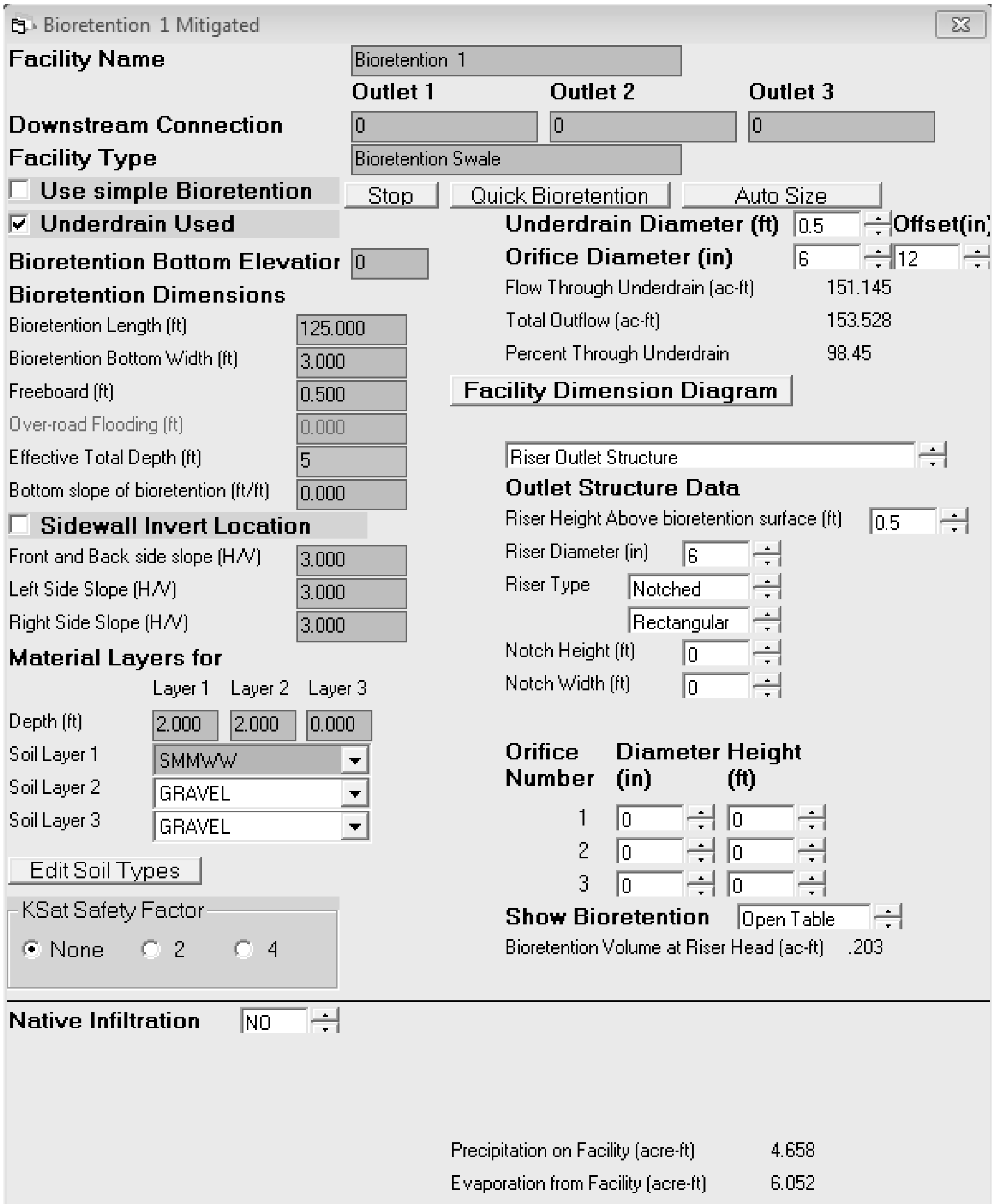


Figure 14. Site 3, 55th/127th: EB1 water quality model inputs and results

Section 7

Cost Estimate

A planning-level estimate for design and construction was developed for the retrofit projects. The estimate was developed based on conceptual design schematics, including preliminary quantity take-offs and estimated unit costs. Estimated unit costs were based on the City of Seattle *Unit Cost Report* (SPU, 2012), WSDOT Unit Bid Tab for the Northwest region (2012–2014), vendor quotes, and escalated project costs from recent projects with similar components, including basis of estimate of probable construction cost for Redmond Decant Facility bioretention facilities (Brown and Caldwell, 2013). The estimate is for construction costs and includes percent increases for other project costs including design engineering, environmental review and permitting, and contingency. All prices reflect construction in the Puget Sound region. A summary of the cost estimate is in Table 11. A detailed estimate is included in Appendix D.

Table 11. Design and Construction Estimated Cost Summary

Site ID	Site name	Estimated cost
Site 1	Staybridge Suites Pond	$577,000
Site 2	Harbour Pointe Middle School	$345,000
Site 3	55th Place W/127th Street SW	$351,000

In accordance with the Association for the Advancement of Cost Engineering International (AACE) criteria, this is a Class 4 estimate, which is defined as a Planning-Level or Design Technical Feasibility Estimate with engineering in the range of 1 to 15 percent complete. Class 4 estimates are used to prepare planning-level cost scopes or to evaluate alternatives in design conditions and form the base work for the Class 3 Project Budget or Funding Estimate. Expected accuracy for Class 4 estimates typically ranges from -30 to +50 percent, depending on the technological complexity of the project, appropriate reference information, and the inclusion of an appropriate contingency determination. In unusual circumstances, ranges could exceed those shown.

If the City decides to carry the projects through detailed design and construction, grants would be pursued to cover the costs. Remaining costs would be covered by the City's stormwater utility fund.

Section 8

Proposed Schedule

The project final design and construction schedule will depend on available grant funding and where the projects rank in a list of citywide surface water facility capital projects. That list is being compiled as part of the update of the City's Comprehensive Surface Water Management Plan, which is expected to be adopted in the second half of 2015.

Because surface water utility rates have been unchanged since 2001, the plan update includes a utility rate study. It is anticipated that new rates will become effective in 2016, generating increased revenues that, in part, could help fund capital projects.

The City intends to aggressively pursue grand funding for surface water capital projects in the coming years. With the analyses contained in this report, along with the May 2013 Mukilteo Watershed-based Stormwater Strategies Plan, the City should be well-positioned to receive stormwater grant funding.

Between the improved revenue stream and potential grand funding, the City will be better able to undertake capital improvements to the surface water management infrastructure. Those improvements may well include one, two, or all three of the projects described in this report. However, until the Comprehensive Surface Water Management Plan is adopted, it is impossible to project a date when final design and construction of any of the three projects in this report will be undertaken.

Section 9

Limitations

This document was prepared solely for City of Mukilteo in accordance with professional standards at the time the services were performed and in accordance with the contract between City of Mukilteo and Brown and Caldwell dated December 5, 2013. This document is governed by the specific scope of work authorized by City of Mukilteo; it is not intended to be relied upon by any other party except for regulatory authorities contemplated by the scope of work. We have relied on information or instructions provided by City of Mukilteo and other parties and, unless otherwise expressly indicated, have made no independent investigation as to the validity, completeness, or accuracy of such information.

Section 10

References

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Appendix A: Stormwater Retrofit Project Identification and Prioritization Report

MUKILTEO STORMWATER RETROFIT PROJECT IDENTIFICATION AND PRIORITIZATION REPORT

Prepared for

City of Mukilteo

December 2014

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ATTACHMENTS

1.0 INTRODUCTION

This study builds on the Watershed-Based Stormwater Strategies Plan (Mukilteo 2013) and identifies, prioritizes, and selects stormwater retrofit projects. The Watershed Based Stormwater Strategies Plan identified three target project analysis units (PAUs) - Big Gulch North, Big Gulch South, and Picnic Point Ravine - as the highest priority within the City for stormwater retrofits. In this effort, a finer spatial scale analysis identifies and prioritizes specific stormwater retrofit projects, including:

- Updated Stormwater Geodatabase
- Catchment Delineation and Analysis
- Stormwater Retrofit Project Identification
- Stormwater Retrofit Project Analysis

Numerous studies link development with impaired stream processes, degraded instream habitat, and degraded water quality (Booth 1991; Booth et al. 2002; Alberti et al. 2006). Since the early 1990s, state and local agencies have developed stormwater management manuals to mitigate impacts associated with development on stream hydrology and water quality. However, these manuals focused largely on reducing peak flow events and did not address increases in the duration of erosive flows. Additionally, much of the City was developed prior to the first stormwater management requirements or has stormwater management facilities designed to outdated stormwater regulations and design manuals. As a result of these two situations, much of the study area has little to no flow control or water quality treatment.

This report documents the analysis methods and results of each study element as well as the final stormwater retrofit project recommendations.

1.1 Project Goals

Primary goals of this investigation are to: continue improving regional collaboration and develop work products for advancing stormwater management and public education/outreach. This study has two overarching goals:

- Develop methods for identifying and prioritizing stormwater retrofit projects; and
- Use these methods to identify and pre-design three stormwater retrofit projects.

Although this study focuses on three PAUs, methods developed in this effort can be applied throughout the City to prioritize stormwater retrofit projects. An additional goal is to provide a foundation for the 2013/14 Mukilteo Stormwater Comprehensive Plan Update, which will develop and prioritize stormwater retrofit projects that target watershed process recovery throughout the City.

1.2 Background and History

In 2011, the City and several partners developed a Watershed-Based Stormwater Strategy Plan using grant funding provided by the Department of Ecology (Ecology) through the National Estuary Program

(NEP) Watershed Protection and Restoration Grant Program. The Stormwater Strategy Plan was based on data and methods from the Puget Sound Characterization Study (Stanley et al 2011). The Watershed-Based Stormwater Strategies Plan identified Big Gulch North, and Big Gulch South Picnic Point Ravine PAUs as high priorities for stormwater retrofits as compared to other PAUs evaluated that study (Figure 1).

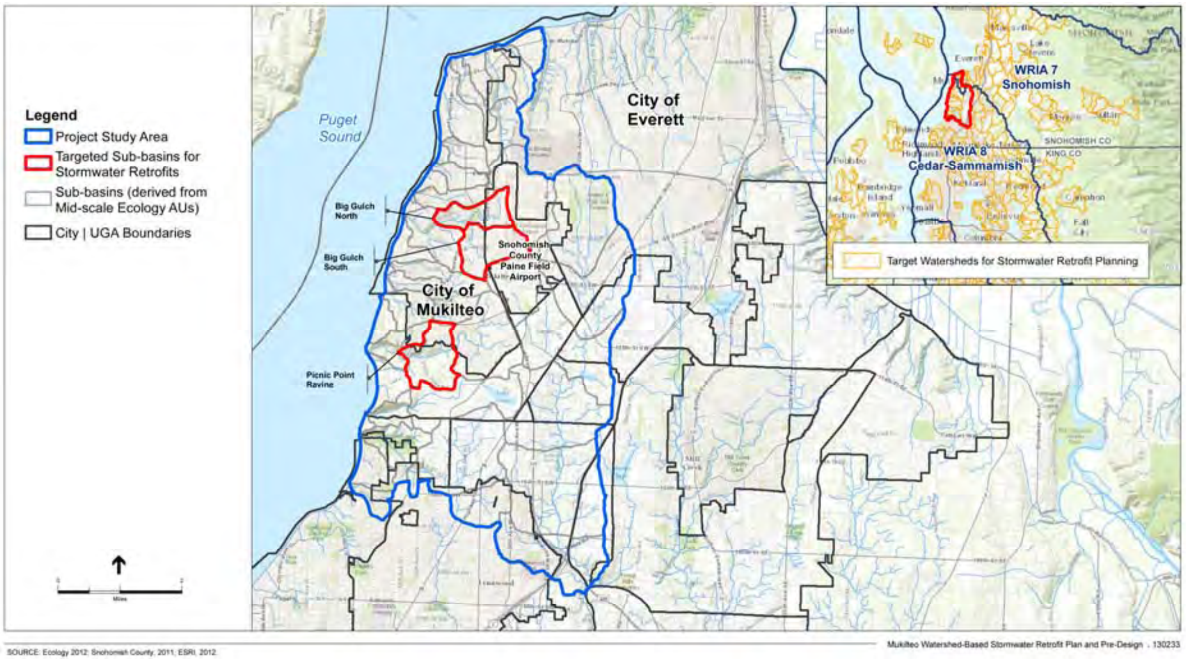

Figure 1. Study Area Location Map.

Several conceptual engineering strategies identified for these PAUs target delivery processes, such as reduced impervious surface area. Retrofitting existing development with stormwater management BMPs to reduce effective impervious surfaces, improve storage, or increase infiltration improves water quality, reduces the frequency and magnitude of peak flow events, and protects summer stream flows. In 2014, the City won another NEP grant to develop methods for the identified strategies, which funds this study.

1.3 Problem Statement

Many studies performed throughout Puget Sound link impervious cover with stream impairment. In general, higher levels of impervious cover relate to higher levels of physical, chemical, and biological impairments (Luchetti et al. 2014). Although detention facilities can attenuate peak flows from impervious surface; literature also indicates that stormwater facilities constructed during the 1990s and early 2000’s are not as effective at minimizing stream impairment (Booth et al. 2002).

Streams within the study area have been degraded as a result of direct manipulations to stream channels and an altered hydrology. Altered hydrology is largely results from changes in land cover dating back to the early 1900s when logging first occurred. Degradation to stream form and function include physical changes that follow the onset of greater runoff volumes, higher peak flows, and longer durations of erosive flows that reduce habitat functioning dependant on the physical and chemical characteristics of the stream channel.

Streams within the study area have been influenced to varying degrees and in some cases have had several decades to reach a new equilibrium. In addition, the City has constructed instream projects to improve the stability and habitat of Big Gulch and Picnic Point Ravines. However, the resulting habitat conditions within the stream will likely not approach desired levels without stormwater retrofits that better mimic natural runoff conditions.

2.0 UPDATED GEODATABASE

As part of this effort, ESA updated the City's Stormwater Inventory geodatabase, including adding in new data and correcting existing datasets. Updates were generally limited to the geographic extents of the study area, which included Big Gulch North and South, and Picnic Point Ravine PAUs, although a limited number of edits were made outside of this spatial extent. Most updates were associated with stormwater management facilities such as vaults, drainage ponds, and dual function ponds. Updates to drainage points, catch basins, and network feature classes were based on georeferenced as-built drawings obtained from the City.

Updates to existing datasets included changing drain features that were incorrectly coded as detention ponds to catch basins, removing an erroneously mapped detention pond record, reversing flow directions of network lines, and adjusting the geographic location of network features based on reviewing georeferenced as-built drawings. A significant portion of the Big Gulch water course line feature was also re-digitized based on a georeferenced CAD drawing of the Big Gulch sewer installation. This study created an additional 57 drainage point and 31 catch basin features; it also removed one drainage pond and two dual function pond features from the original geodatabase. This study also added the year stormwater features were constructed; the construction year was based on the date of as-built drawings or inferred from aerial photograph interpretation.

A new catchment polygon geodatabase feature class was created. Catchment polygons are a subset of the PAU polygons and were extracted from the existing PAU polygon dataset. ESA hydrologists delineated catchment boundaries using topographic data, stormwater drainage infrastructure data; catchments are defined as small areas that drain to a single discharge point. ESA hydrologists adjusted some of the catchment boundaries based on field observations of private or unmapped drainage systems resulted in drainage patterns that differed slightly from those inferred from the geodatabase maps.

3.0 METHODS OVERVIEW

Identification and prioritization of stormwater retrofit projects was conducted using a scoring system that represents three spatial scales. A score was developed at the PAU scale using the results of the

Watershed Based Stormwater Strategies Plan (Mukilteo 2013). Additionally, scores represent the catchment scale and stormwater retrofit project scale (Figure 2).

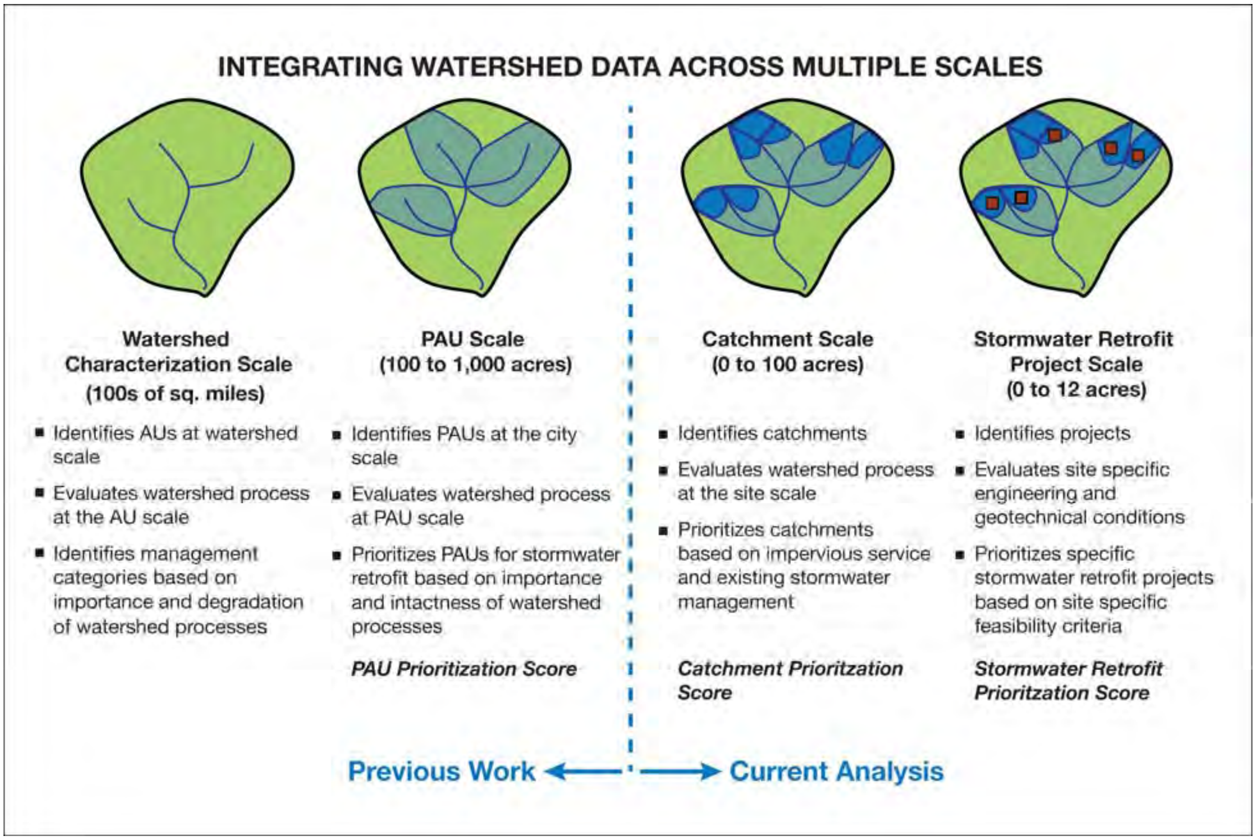

Figure 2. Integrating Watershed Data Across Multiple Scales

The final prioritization score for stormwater retrofit projects is a combination of scores from each spatial scale (Attachment C).

Retrofit Project Recommendation = PAU Score + Catchment Prioritization Score + Stormwater Retrofit Project Score

3.1 PAU Score

The PAU prioritization score developed in the Stormwater Strategies Plan (Mukilteo 2013), is based on the relative importance and level of intactness of watershed processes at the PAU scale. This score also represents secondary processes such as maintenance of fish and wildlife habitat and sediment transport and delivery. The intention of this score is to prioritize stormwater retrofit most important for watershed processes.

3.2 Catchment Prioritization Score

A catchment prioritization score was developed based on relative amount of impervious surface area of each catchment and the level of existing stormwater management. This score prioritizes stormwater retrofit projects with high levels of impervious area and low levels of existing stormwater management. Detailed methods and results of this scoring system are documented in Section 4 of this report.

3.3 Stormwater Retrofit Project Identification and Prioritization Score

The stormwater retrofit project score is intended to prioritize stormwater retrofit projects based on site specific considerations (Figure 3). This score was developed using a field screening analysis to identify catchments where stormwater retrofit would be feasible (Section 5.0). Catchments that did not meet the criteria for field screening were dropped for further consideration.

Following the field screening a more detailed analysis was conducted to identify stormwater retrofit project locations. Section 6.0 presents the methods used to evaluate and rank the stormwater retrofit projects.

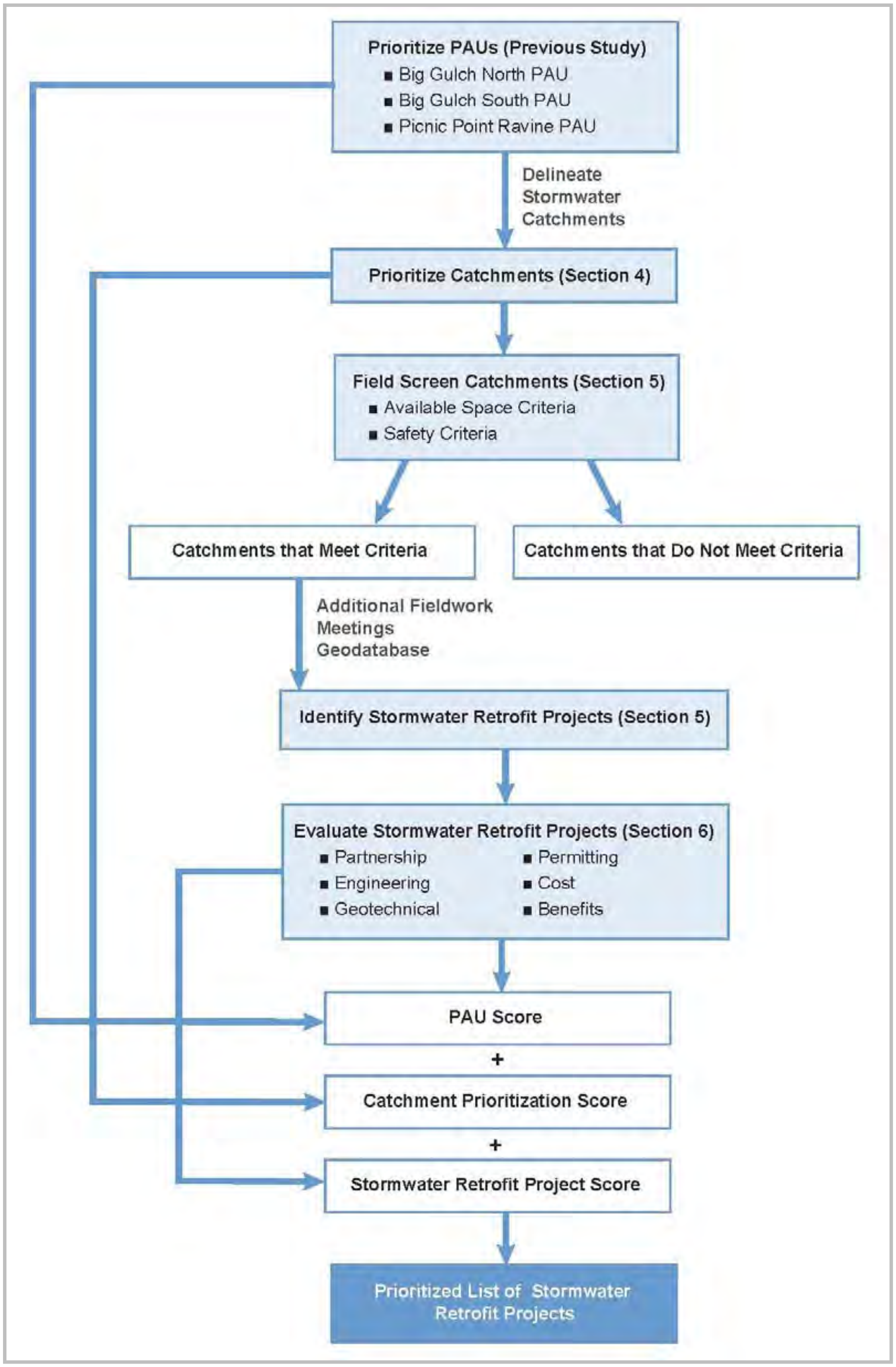

Figure 3. Stormwater Retrofit Identification and Prioritization Flow Chart

4.0 CATCHMENT PRIORITIZATION SCORE

The overall catchment prioritization score, discussed in the following sections, is the sum of the impervious surface and facilities scores and is intended to prioritize the catchment with the largest amount of impervious surface cover and the least amount of existing stormwater detention.

Catchment Prioritization Score = Impervious Surface Score + Existing Stormwater Facility Score

Each PAU within the study area was delineated into catchments (Maps 1 and 2). For each catchment, total impervious surface area (TIA) was calculated and level of stormwater management determined. Next, catchments were prioritized based on TIA and the level of existing stormwater management. The maximum score is 2.0 and high scores indicate a higher priority for stormwater retrofit.

4.1 Catchment Delineation

Catchments are areas that drain to an outfall, stormwater facility, or connection with main storm drain. Catchments were delineated using topography, the updated stormwater geodatabase, and field observations. Portions of each PAU were not included in the catchment analysis because they did not contain significant amounts of development or a point source of stormwater runoff. Catchment maps are provided in Attachment A.

4.2 Impervious Surface Score

Within the City limits effective impervious surface area (EIA) was estimated using the equations from Sutherland (2000) and field observations. EIA is a measure of the amount of impervious surface connected directly to the receiving stream, is estimated based on total impervious area (TIA), and is a more specific indictor of hydrologic impairment than TIA.

- $EIA = 0.1*TIA^{1.5}$
    - SFR roofs are NOT connected to the storm drain system
    - Curb and gutter/no infiltration
- $EIA = 0.4*TIA^{1.2}$
    - SFR roofs ARE connected to the storm drain system
    - Curb and gutter/no infiltration
- EIA = TIA
    - All TIA is connected to the storm drain system
- $EIA = 0.04*TIA^{1.7}$
    - SFR roofs are NOT connected to the storm drain system
    - Swales and ditches/some infiltration

TIA for the catchments located within the City was calculated using GIS and converted to EIA using field observations and the equations above. The area of EIA was normalized for the catchments within the City; catchment with the greatest amount of impervious surface received the highest score of 1.0; which corresponds to the highest priority for stormwater retrofit.

4.3 Existing Stormwater Facility Score

To identify catchments that are a high priority for stormwater retrofit, catchments with either no stormwater facilities or stormwater facilities that are undersized were compared to catchments under current regulations. An existing facility score was developed to give catchments with no or undersized stormwater facilities the high prioritization for retrofit.

A high priority designation is given to catchments more likely to contribute to impaired watershed processes (e.g., catchments with older or no stormwater facilities). Table 1 summarizes regulatory updates to surface water design standards that significantly affected detention facility size, thus influenced watershed processes; it is assumed that stormwater facilities designed to more recent manuals provide better protection of watershed processes. Any area served by a stormwater facility designed to the current manual would provide the best protection for watershed processes and would not be considered for stormwater retrofit project.

Table 1. Summary of Stormwater Design Standards

Stormwater Manual	Flow Control Standard			Water Quality Standard
	50%Q2, Q10, Q100 Peak Matching	50%Q2 to Q50 Duration Matching	LID Standard 8% – 50%Q2	6-month storm (91% Annual Vol.)
Ecology 1992	X			
Ecology 2001		X		X
Ecology 2005		X		X
Ecology 2012		X	X	X

Stormwater facilities located within the study area were grouped into three categories based on the year they were constructed. Categories act as surrogates for watershed impairment.

Pre-1992: Facilities constructed prior to 1992 were grouped together. These facilities were designed according to the rational method, which is a hydrologic analysis method that generally results in significantly smaller detention facilities and higher allowable peak discharge rates as compared to Santa Barbara Urban Hydrograph (SBUH) or continuous modeling (Attachment D).

1992-2001: Facilities constructed between 1992 and 2001 were grouped together. These facilities were sized with SBUH and designed to match peak flow rates for 50 percent of the 2-year storm and the 10-year storm. This standard generally results in larger facilities as compared to facilities sized with the rational method, but facilities that are approximately 35 percent smaller than those designed with continuous hydrologic modeling and a duration matching flow control standard (Attachment D).

2001-2012: Facilities constructed between 2001 and 2012 were grouped together. These facilities are generally in compliance with current flow control standards for larger storm events. Facilities constructed after 2012 are in compliance with the current Ecology Manual; including the LID standard for low intensity storm events. However, there are no facilities located within the City in this category.

Scores were given to each facility group based on a range of zero to one, with one being the most impaired (Table 2).

Table 2. Facility Score Summary

Stormwater Facility Group	Facility Score
No Facility	1.0
Facility constructed prior to 1992	0.9
Facility constructed between 1992 to 2001	0.5
Facility constructed between 2001 to 2012	0.2

Note: A score of 0.5 was also given to Paine Field, Washington State DOT facilities, and catchments located within the high flow by-pass system of Big Gulch South

4.4 Catchment Prioritization Score Results

Using the catchment analysis method, a total of 49 catchments were delineated within the study area; 29 of these catchments are located within the city limits (see Maps 1 and 2). Table 3 summarizes the results of the catchment analysis for the catchments located within the city. Results for all of the catchments can be found in Attachment C.

Table 3. Summary of Catchment Analysis Results for City Catchments

Catchment Name	Total Area (acres)	Impervious Surface Score	Facility Score	Catchment Prioritization Score (Impervious Surface Score + Facility Score)
BG21	25.76	1.00	1.00	2.00
BG12	11.96	0.44	1.00	1.44
BG08	17.51	0.80	0.50	1.30
BG22	5.62	0.25	1.00	1.25
PPR09	13.98	0.23	1.00	1.23
BG17	11.01	0.20	1.00	1.20
BG10	11.05	0.14	1.00	1.14
BG25	2.57	0.13	1.00	1.13
BG13	7.57	0.13	1.00	1.13
BG04	6.91	0.11	1.00	1.11
BG02	8.32	0.11	1.00	1.11
BG16	2.28	0.08	1.00	1.08

Catchment Name	Total Area (acres)	Impervious Surface Score	Facility Score	Catchment Prioritization Score (Impervious Surface Score + Facility Score)
PPR08	11.84	0.07	1.00	1.07
BG15	3.16	0.05	1.00	1.05
BG09	26.52	0.05	1.00	1.05
BG03	8.12	0.05	1.00	1.05
PPR20	5.46	0.05	1.00	1.05
BG20	6.94	0.03	1.00	1.03
BG07	8.34	0.03	1.00	1.03
PPR11	23.16	0.25	0.75	1.00
PPR12	13.86	0.16	0.75	0.91
PPR18	15.92	0.10	0.75	0.85
BG06	4.56	0.16	0.75	0.91
PPR10	8.95	0.07	0.75	0.82
PPR19	5.63	0.04	0.75	0.79
BG05	24.49	0.04	0.75	0.79
BG11	1.38	0.04	0.50	0.54
BG18	25.76	0.21	0.50	0.71
BG14	2.00	0.06	0.50	0.56

5.0 STORMWATER RETROFIT PROJECT IDENTIFICATION

An initial field-based screening of each catchment identified potential stormwater retrofit project opportunities. Efforts were focused on the study area within City limits. This effort resulted in the identification of eight projects to be considered for further evaluation (Section 6.0).

5.1 Catchment Field Evaluation Methods

Within the City limits, the team assessed physical characteristics of each catchment in the field to evaluate any limitations to stormwater management based on available space and/or safety concerns of each catchment. Available space was qualitatively evaluated using best professional judgment by considering the physical characteristics of each catchment needed to accommodate either new stormwater ponds, retrofit of existing stormwater ponds, green stormwater infrastructure, or deep infiltration. The purpose of this effort was to identify catchments and locations within each catchment that could be feasible for a stormwater retrofit project. More dispersed retrofits like amended soils or downspout disconnection were not considered.

5.1.1 Available Space

Catchments with open space, either undeveloped or owned by the City, or an existing stormwater facility that had adequate space for expansion were considered to have adequate space for a stormwater retrofit project.

Roads within each catchment were qualitatively evaluated to determine if the right-of-way (ROW) was adequate for a stormwater retrofit project, such as green streets. Roads within the study area included local access and arterials. Local access roads provided the most feasible retrofit opportunities. Arterials were not considered for green streets because of additional risks associated with higher traffic volumes and/or truck traffic.

Criteria were developed for determining road retrofit feasibility. For the purposes of this analysis, a site was considered to have adequate space if the road had at least 30 feet of existing pavement and prohibited street parking. The 30-ft road width is based on the City road standards (Mukilteo 2012) and guidance from the Low Impact Development Technical Guidance Manual for Puget Sound (PSP and WSU, 2012). In the future, as the City evaluates retrofits city-wide, they may consider roads less than 30-ft in width if other site characteristics suggest the location would be a good candidate for stormwater retrofit. Adequate road ROW was also defined as a road with less than 2 percent slope. This threshold was determined using guidance in the Ecology Stormwater Management Manual, which requires additional structural elements for raingardens if installed with a slope greater than 2 percent. Many of the roads within the study area were either narrow or steep making them less feasible for a green street retrofit.

Evaluation of available space included an assessment of site access. If there was an existing road or a maintained ROW, the site had adequate access.

Catchments with steep and/or narrow roads; little or no city owned land, vacant land, or open space; or sites with no access were dropped from further consideration.

5.1.2 Safety Concerns

Stormwater facilities should not be located close to areas with high risk of landslides. An analysis of landslide hazards by Aspect Consulting (2014) divided the study area into three landslide hazard categories:

- High Hazard
- Moderate Hazard
- Low Hazard

Aspect Consulting utilized coarse scale maps to conduct their analysis, with the intention of supporting stormwater retrofit project screening and prioritization. Stormwater facilities dropped from consideration were located in, catchments with steep slopes making it potentially hazardous to construct/retrofit and operate a stormwater facility. Detailed geotechnical evaluation will occur during the pre-design phase for high priority facilities that are located adjacent to or within areas mapped as high or moderate hazards. The detailed analysis will evaluate the amount of infiltration, site-specific geology, and groundwater conditions and refine feasibility and risk assessments.

5.2 Catchment Field Evaluation Results

Based on the catchment field evaluation; initial evaluation identified 10 catchments where additional feasibility and evaluation work is appropriate for prioritizing site specific stormwater retrofit projects (Maps 3 and 4; Table 4).

Table 4. Summary of Field Evaluation Results

Catchment ID	PAU Score[1]	Catchment Prioritization Score[2]
BG08	1.5	1.3
BG12	1.3	1.4
BG14	1.3	0.6
BG17	1.3	1.2
BG21	1.3	2.0
PPR08	1.4	1.1
PPR11	1.4	1.0
PPR18	1.4	1.0
PPR19	1.4	0.8
PPR20	1.4	1.1

1. The maximum score is 1.7 (Mukilteo 2013).
2. The maximum score is 2.0

Detailed information about the entire field screening process is provided in Attachment C.

5.3 Identification of Stormwater Retrofit Projects

A stormwater retrofit project was identified for each catchment identified by the catchment field screening evaluation as being a good candidate for stormwater retrofit projects (see Table 4). Potential stormwater retrofit projects were developed for each catchment based on stormwater infrastructure mapping, topography, field observations of development, flow patterns, and best professional judgment. ESA identified eight potential stormwater retrofit project locations, which were carried forward to a more detailed feasibility and prioritization evaluation (Table 5, see Maps 3 and 4).

Table 5. Potential Stormwater Retrofit Projects

Stormwater Retrofit Project ID	Catchment ID	Description
1	BG08	**Existing pond retrofit:** retrofit pond with additional storage and a modified orifice structure to reduce peak surface discharges. Pond located behind the Staybridge Suites Hotel (Stormwater Retrofit Project Fact Sheet 1, Attachment B). It currently detains runoff from the hotel, a portion of Harbor Point Pl, an office building, and an undeveloped parcel. This pond was constructed in 2000 and is undersized according to current regulations. This catchment also has areas of vacant land, that were recently annexed the City. Future development on this land may be grandfathered into regulations in place at the time of annexation.
2	BG12	**Construct new pond**: construct a new detention pond/infiltration facility in the vacant lot located north and west of Harbor Point Pl. (Stormwater Retrofit Project Fact Sheet 2, Attachment B). Runoff from this catchment is currently undetained.
3	BG14	**Retrofit existing swale**: Retrofit the existing library detention swale. The swale detains stormwater runoff from the library and parking lot. It was constructed in 1997; therefore, it is undersized according to current regulations (Stormwater Retrofit Project Fact Sheet 3, Attachment B).
4	BG17	**Construct bioretention**: construct bioretention to treat and detain parking lot runoff along the Harbor Pointe Middle School parking areas. This project could include bioretention along the entrance drive (Stormwater Retrofit Project Fact Sheet 4, Attachment B). Runoff from this catchment is currently undetained.
5	BG21	**Construct a raingarden**: reconstruct a portion of 47th Place W and the YMCA landscaping to include raingarden and possible deep infiltration (Stormwater Retrofit Project Fact Sheet 5, Attachment B). Runoff from this catchment is currently undetained.
6	PPR08	**Construct stormwater wetland**: daylight a stormwater pipe that currently crosses the Harbor Pointe golf course and create a constructed wetland to provide detention and treatment of the adjacent residential development (Stormwater Retrofit Project Fact Sheet 6, Attachment B). Runoff from this catchment is currently undetained.
7	PPR18/19/20	**Construct a green street**: retrofit 55th Pl. W and 127th St. SW with a green street concept, such as bioretention swales in series, to provide water quality treatment and possible shallow infiltration to reduce peak flows (Stormwater Retrofit Project Fact Sheet 7, Attachment B). The detention ponds in this catchment were constructed in 1988 and are undersized according to current regulations. In addition, field observations indicate that this catchment may have high nutrient loading.
8	PPR11	**Retrofit existing vault**: retrofit an existing stormwater vault, constructed prior to 1992, with deep infiltration (Stormwater Retrofit Project Fact Sheet 8, Attachment B). The City current owns the ROW for access. The vault in this catchment was constructed prior to 1990 and is undersized according to current regulations.

6.0 STORMWATER RETROFIT PROJECT SCORE

Each potential stormwater retrofit project identified during the field evaluation (see Table 5) was further evaluated and prioritized based scores developed for each of the following categories:

- Ease of Partnership
- Engineering Suitability
- Geotechnical Suitability
- Permitting Feasibility
- Cost
- Benefits
- Other Considerations

Scores were developed for each category using a 0 to 3 scale. A score of 3 corresponds to the highest priority and/or projects that are most feasible for a particular category. Scores for each category were summed with equal weight and used to calculate an overall stormwater retrofit project score.

6.1 Ease of Partnership

Potential stormwater retrofit projects that would be located on City owned land, easement, or ROW were given the highest score (3) for ease of partnership. Projects that would be located on private property, but held by an entity such as the Mukilteo School District, Sno-Isle Library, or YMCA, were given the next highest score (2) for the ease of partnership. All other projects that would be located on private property were given the lowest score (1).

6.2 Engineering Suitability

Engineering suitability was used to prioritize locations most suitable for stormwater facilities. Engineering suitability elements used for this analysis are based on stormwater management BMPs developed by Ecology (Ecology 2012):

- High Vehicle Traffic Areas
- Suitability to intercept flows in existing stormwater conveyance pipes

Locations with relatively high volumes of traffic or high volumes of truck traffic were given a lower priority due to safety concerns. Scoring was based on the following metrics:

3 points: Project is located on an easement

2 points: Project is located in a street ROW, but street has lower traffic volumes

1 point: Project is located in a street ROW; but has higher traffic volumes/truck traffic

Potential stormwater retrofit projects were also prioritized based on the relative feasibility to connect to the existing conveyance system. Scoring was based on the following site characteristics:

3 points: Project would retrofit an existing facility, or treat roof runoff or sheet flow

2 points: Project would connect to stormwater system less than 6-ft below the surface

1 point: Project would connect to stormwater system greater than 6-ft below the surface.

The overall engineering suitability score was calculated by combing the scores for traffic volume and feasibility to connect to the existing stormwater system;

Engineering Suitability Score = (Traffic Score + Connection Score)/2

6.3 Geotechnical Suitability

Geotechnical suitability prioritizes projects with good potential for shallow or deep infiltration because of the added benefit of reduced runoff volume and improved groundwater recharge. . If a site is not feasible for infiltration (shallow or deep), stormwater detention is likely still an option, but would not receive a high score for this category.

6.3.1 Shallow Infiltration System

Aspect Consulting performed an analysis of mapped surficial geology to estimate the permeability of the surface soils. They identified three broad permeability categories:

- Good Permeability - greater than 10 inches/hour;
- Moderate Permeability -2 – 10 inches/hour; and
- Poor Permeability – 0 - 2-inches/hour.

Aspect Consulting also estimated surface slope from LiDAR to determining the potential for shallow infiltration to migrate along a perched layer and daylight at the ground surface or in a crawl space/basement down slope. They identified three broad slope categories:

- Good - less than 5 percent;
- Moderate - between 5 percent and 15 percent; and
- Poor - greater than 15 percent.

Based on the coarse scale evaluation of landslide hazard, permeability of surface soils, and slope, Aspect Consulting identified three categories of shallow infiltration feasible (Maps 5 and 6). These categories are general and are intended to prioritize projects that would be most cost effective and unlikely to pose any significant hazards.

- Good Potential
    - Low landslide hazard;
    - Good surface slopes (less than 5 percent); and
    - Good or moderate surface soil permeability.
- Moderate Potential
    - Low or moderate landslide hazard;
    - Good or moderate surface slopes (less than 15 percent); and
    - Good or moderate surface soil permeability.
- Poor Potential
    - Poor surface slope (greater than 15 percent); and
    - Poor surface soil permeability.

6.3.2 Deep Infiltration Systems

Aspect Consulting evaluated study area geology to evaluate the suitability of deep infiltration as a technique for managing stormwater runoff. They considered a site suitable when a permeable, unsaturated soil horizon exists beneath low permeability surface soils. Based on their analysis, Aspect identified nine unique hydrogeomorphic units and assigned each unit to a deep infiltration category. These categories are general and are intended to prioritize projects that would be most cost effective and unlikely to pose any significant hazards (Maps 7 and 8).

- Good Potential
    - Low landslide hazard; and
    - Higher potential for a deep infiltration receptor horizon.
- Moderate Potential
    - Low or moderate landslide hazard; and
    - Higher or moderate potential for a deep infiltration receptor horizon.
- Poor Potential
    - High landslide hazard; and
    - Lower potential for a deep infiltration receptor horizon.

6.3.3 Overall Scoring For Geotechnical Suitability

Stormwater retrofit projects were scored for geotechnical suitability based on the suitability of either shallow or deep infiltration according to the site characteristics summarized in Table 6.

Table 6. Geotechnical Suitability Score

Points	Description	Shallow Infiltration		Deep Infiltration
3	Good	Low landslide hazard	or	Low landslide hazard
		Moderate to Good Permeability		Higher potential for a deep infiltration receptor horizon.
		Good surface slopes		
2	Moderate	Low or moderate landslide hazard;	or	Low or moderate landslide hazard; and
		Moderate to Good Permeability		Higher or moderate potential for a deep infiltration receptor horizon.
		Moderate surface slopes		
1	Poor	Poor permeability	or	High landslide hazard
		Poor surface slopes		Lower potential for a deep infiltration receptor horizon.

6.4 Environmental Permitting

Construction of a stormwater retrofit project requires several environmental permits. The purpose of this category is to identify potential stormwater retrofit projects that would have relatively high permitting costs/risks based on the following criteria, which were combined in to a single environmental permitting score:

- Streams/wetlands and their buffers known to be on or near the site;
- Cultural resources known to be on or near the site.

If a site has the potential to affect critical areas such as streams and wetlands or their buffers it was assumed that environmental permitting would be more costly relative to other similar projects and therefore was given a lower priority.

The proximity of a stormwater retrofit project to a critical area was determined using City critical areas maps. Project scoring:

3 points: Project would have no impacts to critical areas or buffers

2 points: Project would impact a critical area buffer

1 point: Projects that would directly impact a stream or wetland.

The proximity of a stormwater retrofit project to a potential cultural resources site was determined using mapping provided by the Washington Information System for Architectural and Archeological Records and Data (WISAARD, 2014) database and the mapped results of the statewide predictive model.

Project scoring was developed to prioritize projects located in an area with a lower risk of encountering a cultural resource.

3 points: Project located in an area as moderate to low risk

2 points: Project located in an area mapped as high risk

1 point: Project located in an area mapped as very high risk

The scores for critical areas and cultural resources were combined into a single score representing the ease of environmental permitting:

Environmental Permitting Score = (Critical Area Score + Cultural Resources Score)/2

6.5 Costs

Numerous studies have been performed throughout the country to evaluate the cost and benefit of stormwater management. Evaluation of costs and benefits are based on construction costs (e.g., Ecology 2013) and operation and maintenance costs (e.g., Minton 2003; Ecology 2013).

Estimates of construction costs vary more due to intrinsic site conditions such as soils, existing development, utility conflicts, design, and site layout. As a result, Minton (2003) concluded that there is too much variability to develop accurate unit costs for specific BMPs or even estimate relative cost differences between retrofit projects and new construction. However, many studies agree that land acquisition is a significant portion of any project cost (Minton 2003; King County 2012; Ecology 2013). Therefore, this evaluation used land acquisition as a screening method for cost. Projects that would be required to acquire land specifically for stormwater management facilities would cost relatively more than those located in an existing easements or within the ROW.

3 points: Project located in an existing easement or ROW

1 point: Project that require land acquisition

Ecology recently completed an evaluation of 14 different development scenarios to evaluate long term costs associated with a variety of stormwater management techniques (Ecology 2013). The Ecology study developed long term operation and maintenance costs per acre for different types of BMPs. Table 7 summarizes the estimated cost per acre for various types of BMPs from 2013 Ecology and the corresponding score developed for this evaluation.

Table 7. Summary of Operation and Maintenance Costs

Points	Cost per acre O&M (Ecology 2013)	BMP
3	Low ($3.36/sf)	Infiltration Basin
2	Moderate ($9.01/sf)	Wet Pond
		Combined Detention/Wetpool
1	Poor ($21.84/sf)	Bioretention
		Raingarden

6.6 Benefits

Many studies throughout Puget Sound have linked development with altered stream hydrology, sediment regime, morphology, and instream habitat (Booth et al. 2002).Altered hydrology due to land use practices is highly correlated to stream condition; however, methods to estimate watershed development do not capture spatial or temporal variation in development patterns that may influence site specific conditions (Luchetti et al. 2014). In addition, there is not a direct correlation between stormwater retrofit at the site scale and stream condition and it is impossible to quantify the benefit of a single stormwater retrofit project. As a result, this study used the total area served by the proposed retrofit project to conceptually represent a beneficial stream response. In some cases, the total contributing area to a stormwater retrofit facility is not the same as the catchment area. The contributing area to each stormwater facility was normalized relative to the contributing area of other stormwater retrofit projects to estimate relative benefit. Projects that would retrofit an existing facility instead of constructing a new facility would have a reduced benefit.

Benefit Score = (contributing area/max contributing area) x 3

6.7 Other Considerations

Each project was then evaluated to determine if there were specific and unique elements of the proposed site that would either elevate its prioritization or decrease its prioritization. Factors considered include:

- Unique opportunities for public outreach and education
- Site specific flooding, erosion or water quality problems,
- Known/anticipated development projects that would include stormwater retrofit

Although erosion and ravine instability are linked to non-point source runoff; these problems exist throughout both ravines located within the study area. Therefore, it was difficult to link specific stormwater retrofit projects with a site specific improvement in stream health.

Additional points were given to sites that address a specific problem such as water quality in small lakes and wetlands, flooding, and outfall erosion.

Points were taken away from a project if the City has already received permit applications or pre-applications for projects that would address stormwater management as part of a planned site improvement.

6.8 Overall Stormwater Retrofit Project Score

The stormwater retrofit project score was calculated by summing normalized scores for each category into one overall score:

> ***Stormwater Retrofit Project score =***
> ***(Ease of Partnership Score + Engineering Suitability Score + Geotechnical Suitability Score + Permitting Feasibility Score + Cost Score + Benefits Score +/-Other Considerations Score)/7***

Based on this methodology the overall stormwater retrofit project score has maximum value of 3.0. This score was then added to the normalized PAU score (maximum value of 1.0) and the normalized catchment score (maximum value of 1.0) to get an overall retrofit project score (Table 8).

Retrofit Project Recommendation = PAU Score + Catchment Prioritization Score + Stormwater Retrofit Project Score

Scores for each individual category are summarized in Attachment C.

Table 8. Summary of Stormwater retrofit Project Scores

Stormwater Retrofit Project Name	Summary				
	Normalized PAU Score	Normalized Catchment Score	Project Specific Score	Total Score	Rank
Project 1: Staybridge Suites Pond	0.9	0.5	2.0	3.4	3
Project 2. Harbor Pointe Pl.	0.8	0.7	1.5	2.9	7
Project 3. Library	0.8	0.3	1.4	2.4	8
Project 4. Harbor Pointe Middle School	0.8	0.6	2.2	3.6	2
Project 5. YMCA/47th Pl. W	0.8	1.0	1.6	3.3	4
Project 6. Harbor Pointe Golf Course	0.8	0.5	1.8	3.1	5
Project 7. 55thPl. W/127th St. SW	0.8	0.5	2.3	3.6	1
Project 8. Private vault	0.8	0.6	1.6	3.0	6

Because this process of scoring is based on a normalization process, the results of this evaluation of stormwater catchments and potential stormwater retrofit projects only applies to the three study area PAUs; Big Gulch North, Big Gulch South, and Picnic Point Ravine.

7.0 FINAL RECOMMENDATIONS

City staff and members of the consulting team discussed opportunities and risks of each potential retrofit project during a meeting held on June 17, 2014. Based on that discussion, City staff determined that all of the projects have merit and should continue to be considered in the context of the Stormwater Comprehensive Plan Update. The final relative ranking of the retrofit projects results in the following projects being identified as the top projects:

(1) Retrofit Project 7. 55thPl. W/127th St. SW
(2) Retrofit Project 4. Harbor Pointe Middle School
(3) Retrofit Project 1. Staybridge Suites Pond

Additional site specific data will be collected and these projects will be carried forward to pre-design.

Furthermore, methods used to delineate catchments, score and prioritize catchments, and identify, score, and prioritize stormwater retrofit projects could be used City wide for additional analysis.

8.0 REFERENCES

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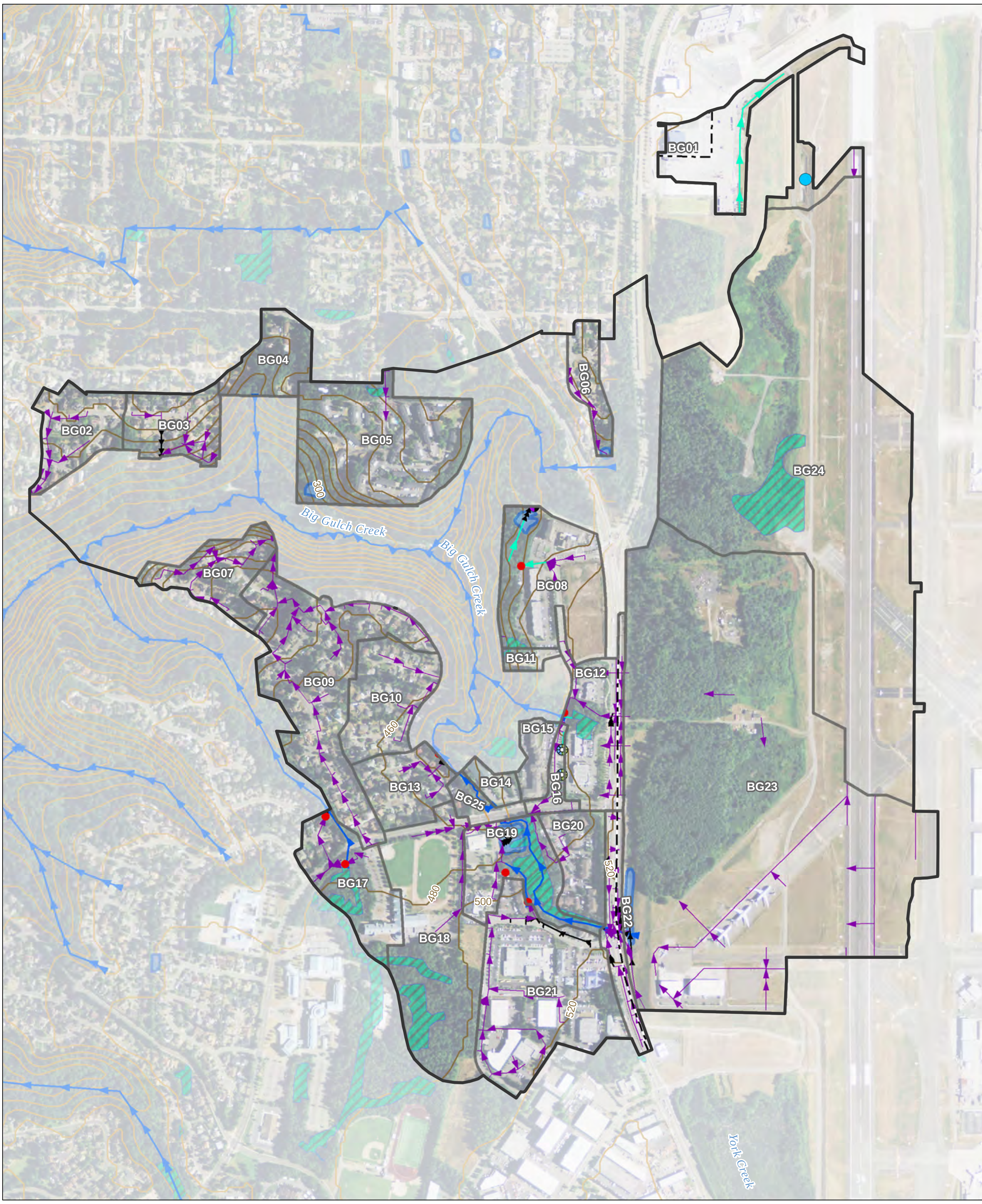
Attachment A: Study Area Maps



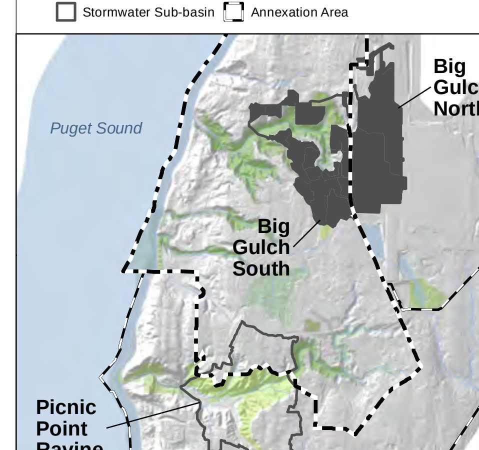
Legend

Stormwater Drainage Network
- Bioswale
- Control Structure
- Detention Pond
- Stormwater Outfall
- Open Channel System
- Stormwater Drainage Network
- Connection Network
- Stream
- Detention Pond
- Dual Function

- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

Stormwater Sub-basin Index Map

- Mapped Catchments
- Mukilteo City Limits
- Stormwater Sub-basin
- Annexation Area



City of Mukilteo

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1 inch = 800 feet

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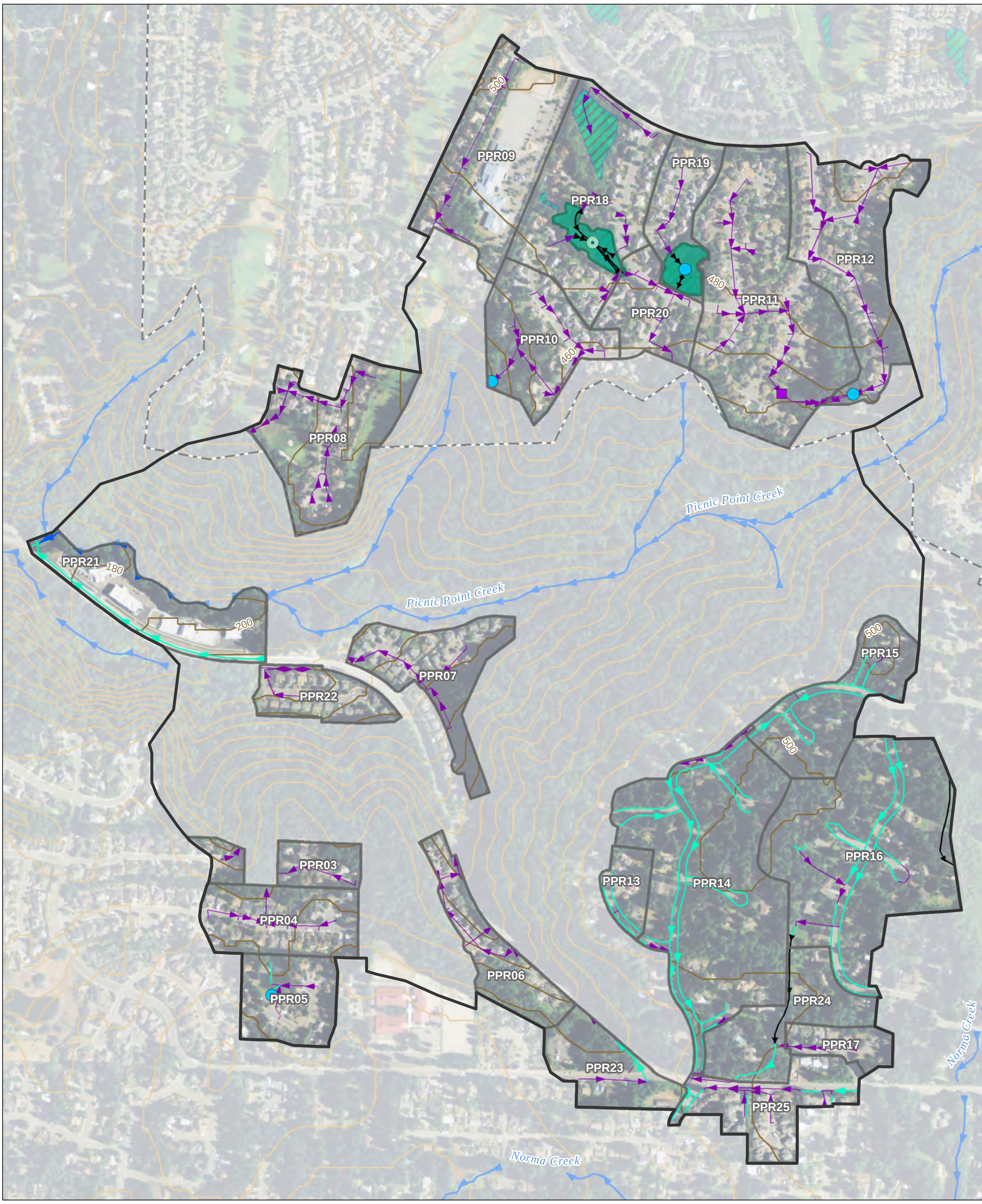
City of Mukilteo Stormwater Management Plan . 130589

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map1: Big Gulch North and South Catchment Map

Big Gulch North and South

City of Mukilteo, Washington



Legend

Stormwater Drainage Network
- Detention Pond
- Dual Function
- Vault
- Open Channel System
- Stormwater Drainage Network
- Connection Network
- Stream
- Dual Function

- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

City of Mukilteo

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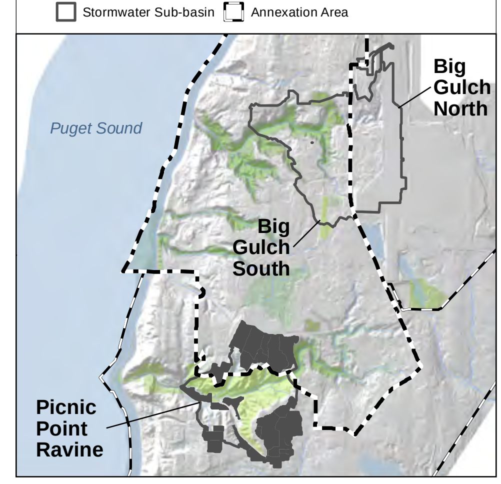
Stormwater Sub-basin Index Map

- Mapped Catchments
- Stormwater Sub-basin
- Mukilteo City Limits
- Annexation Area



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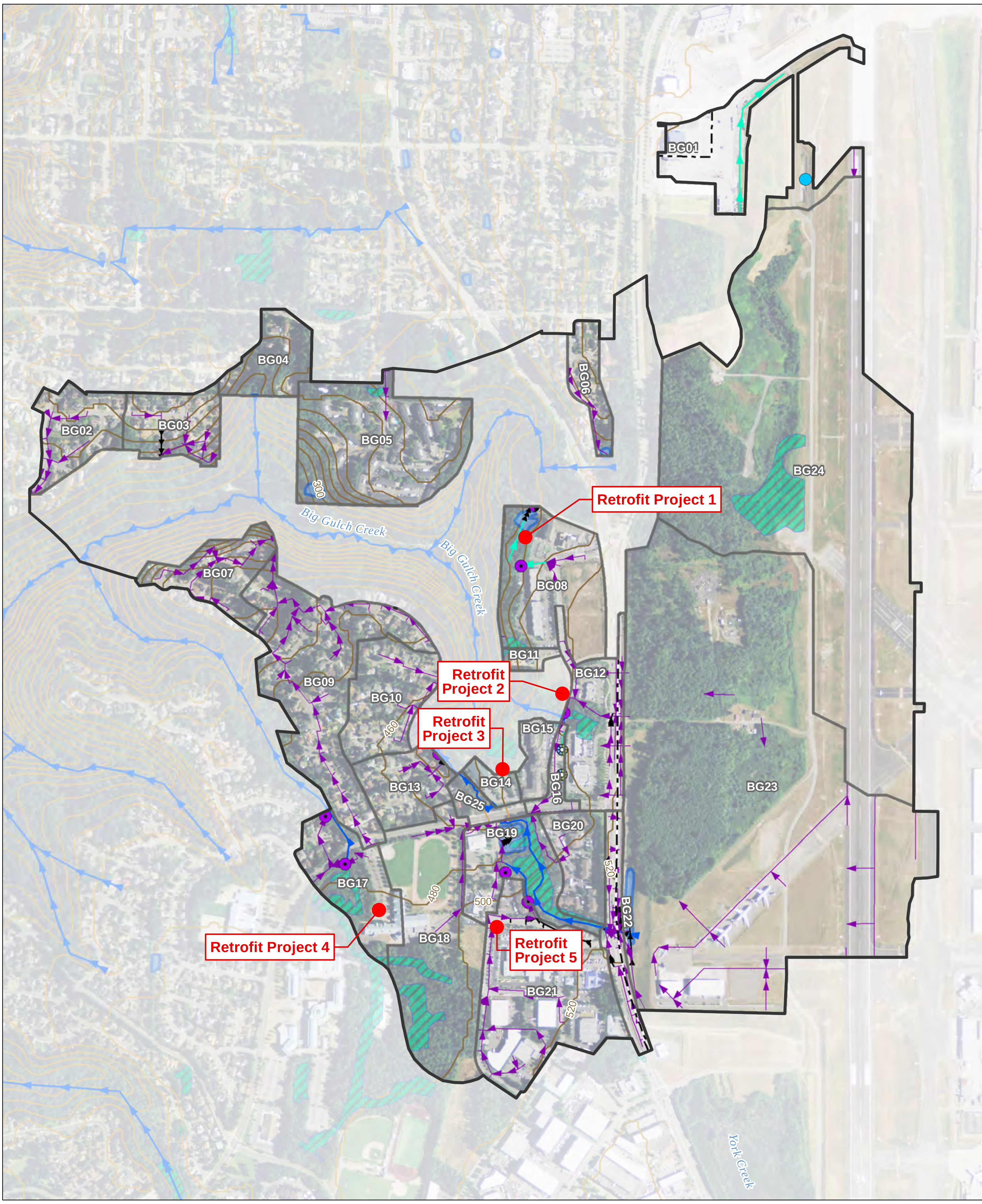
SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 2: Picnic Point Ravine Catchment Map
Picnic Point Ravine
City of Mukilteo, Washington



Legend

- Retrofit Project Location

Stormwater Drainage Network

- Bioswale
- Control Structure
- Detention Pond
- Stormwater Outfall
- Open Channel System
- Stormwater Drainage Network
- Connection Network
- Stream
- Detention Pond
- Dual Function
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
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- Annexation Area

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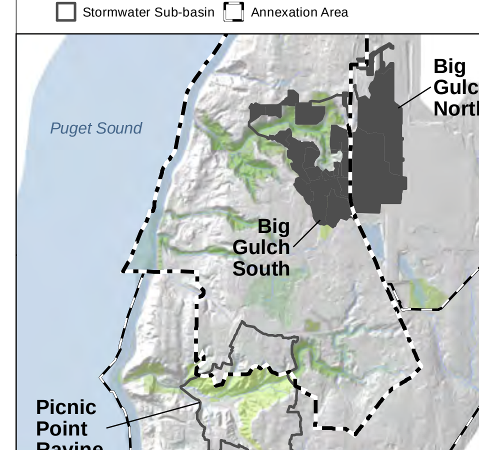
Stormwater Sub-basin Index Map

- Mapped Catchments
- Stormwater Sub-basin
- Mukilteo City Limits
- Annexation Area



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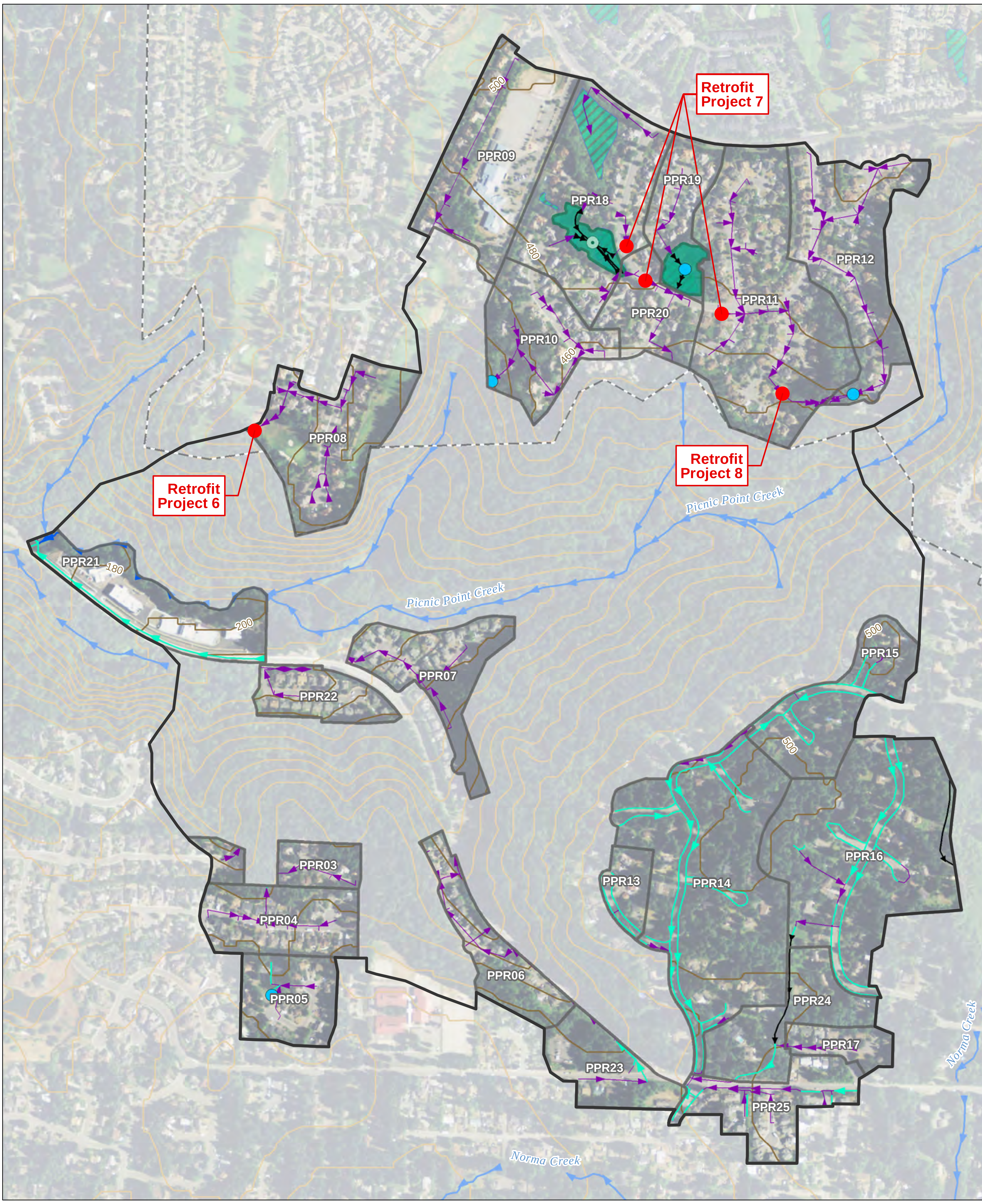
SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 3: Big Gulch North and South Priority Catchments and Stormwater Retrofit Project Locations

Big Gulch North and South

City of Mukilteo, Washington



Legend

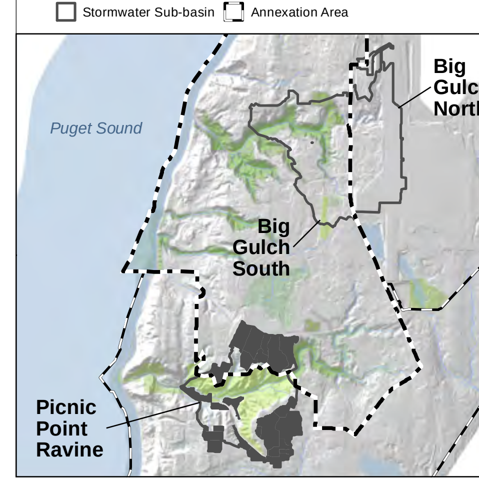
- Retrofit Project Location

Stormwater Drainage Network

- Detention Pond
- Dual Function
- Vault
- Open Channel System
- Stormwater Drainage Network
- Connection Network
- Stream
- Dual Function
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

Stormwater Sub-basin Index Map

- Mapped Catchments
- Stormwater Sub-basin
- Mukilteo City Limits
- Annexation Area



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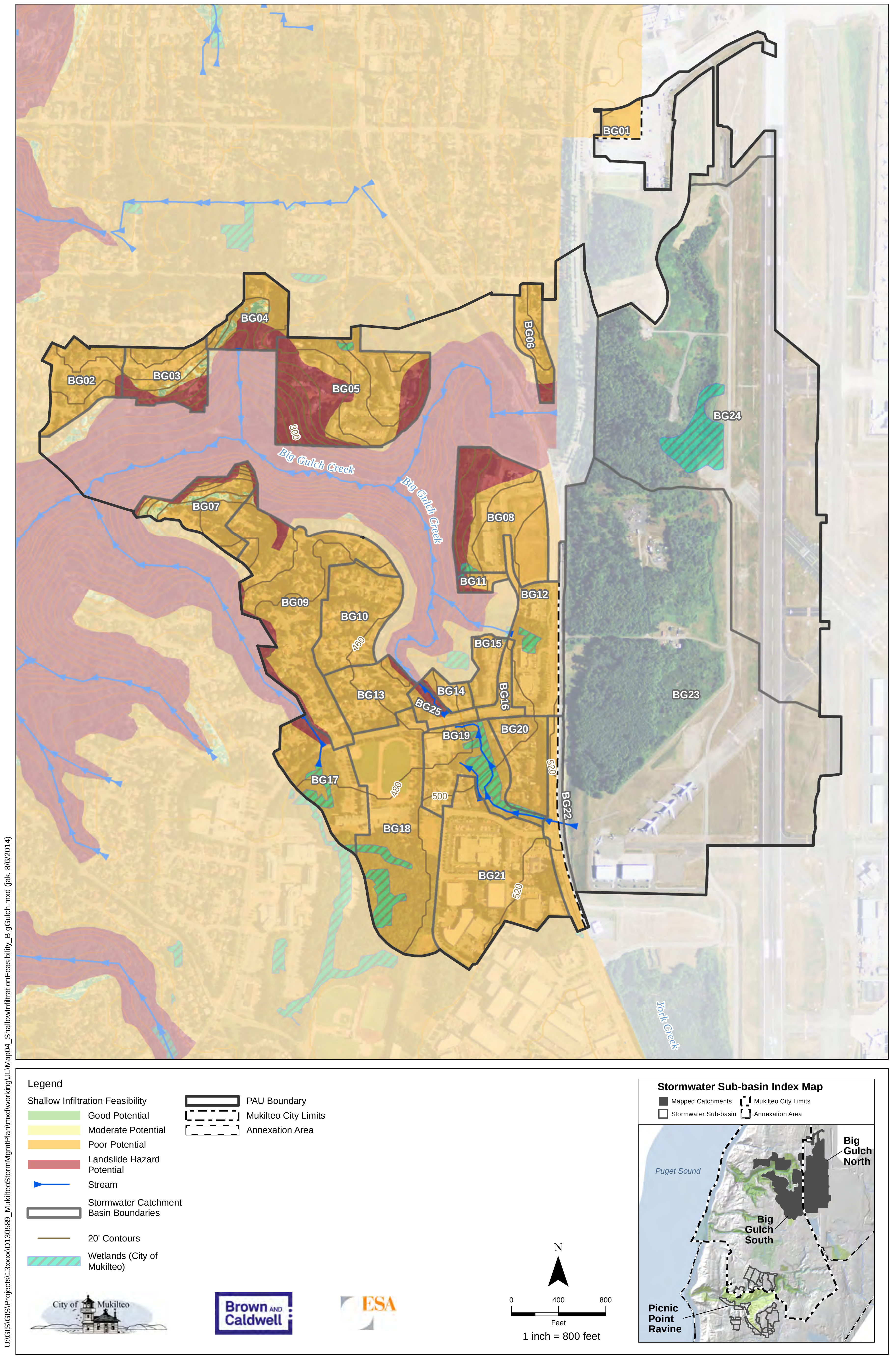
City of Mukilteo Stormwater Management Plan . 130589

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 4: Picnic Point Ravine Catchments and Stormwater Retrofit Project Locations
Picnic Point Ravine
City of Mukilteo, Washington

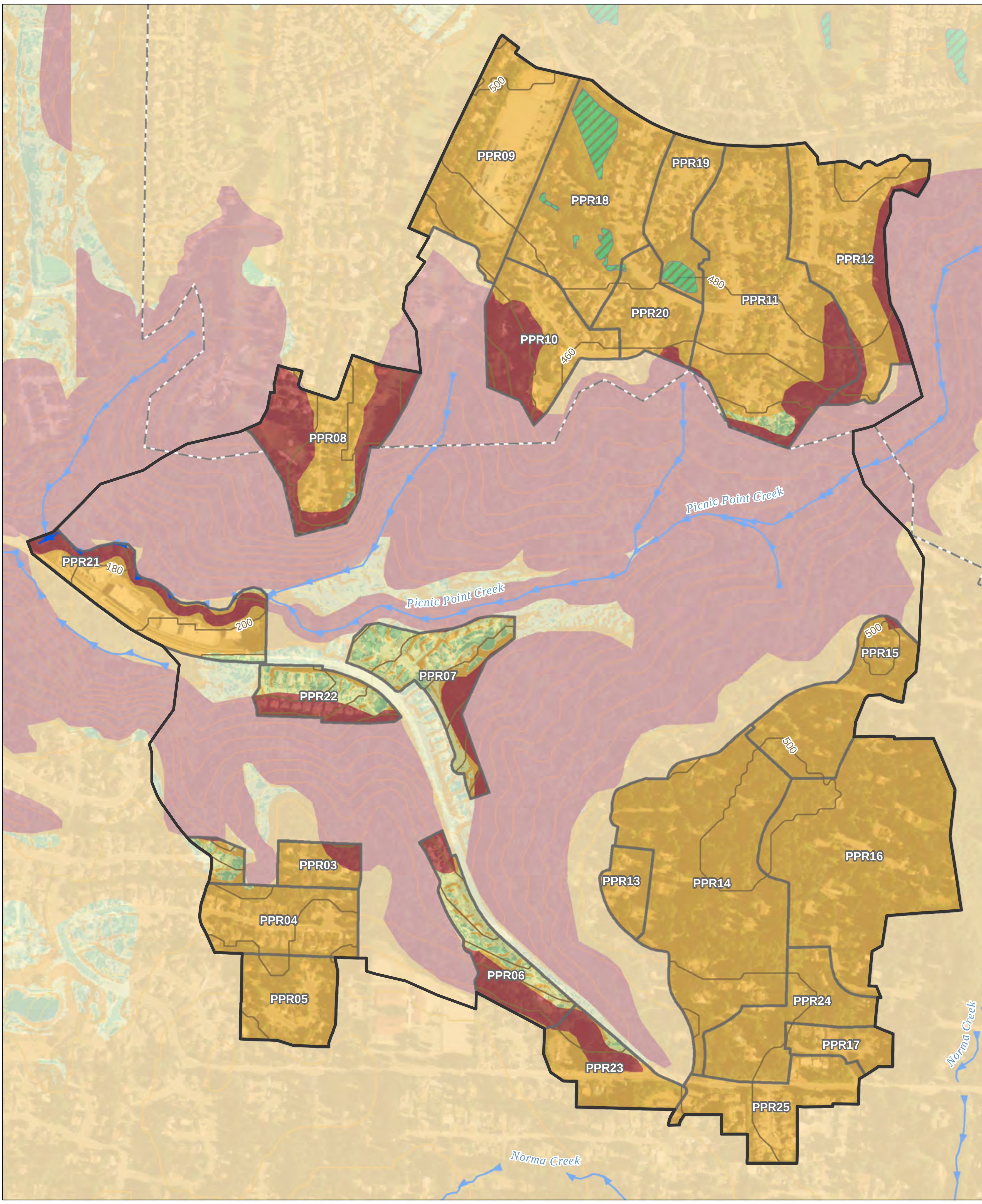


City of Mukilteo Stormwater Management Plan . 130589

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 5: Big Gulch North and South Shallow Infiltration Feasibility

Big Gulch North and South
City of Mukilteo, Washington



Legend

Shallow Infiltration Feasibility

- Good Potential
- Moderate Potential
- Poor Potential
- Landslide Hazard Potential
- Stream
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

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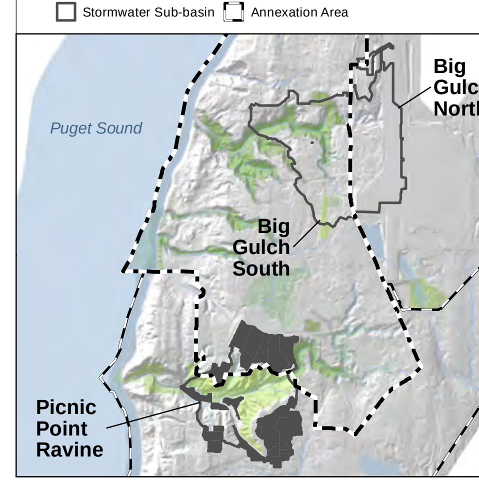
1 inch = 600 feet

Stormwater Sub-basin Index Map

Mapped Catchments | Mukilteo City Limits | Stormwater Sub-basin | Annexation Area



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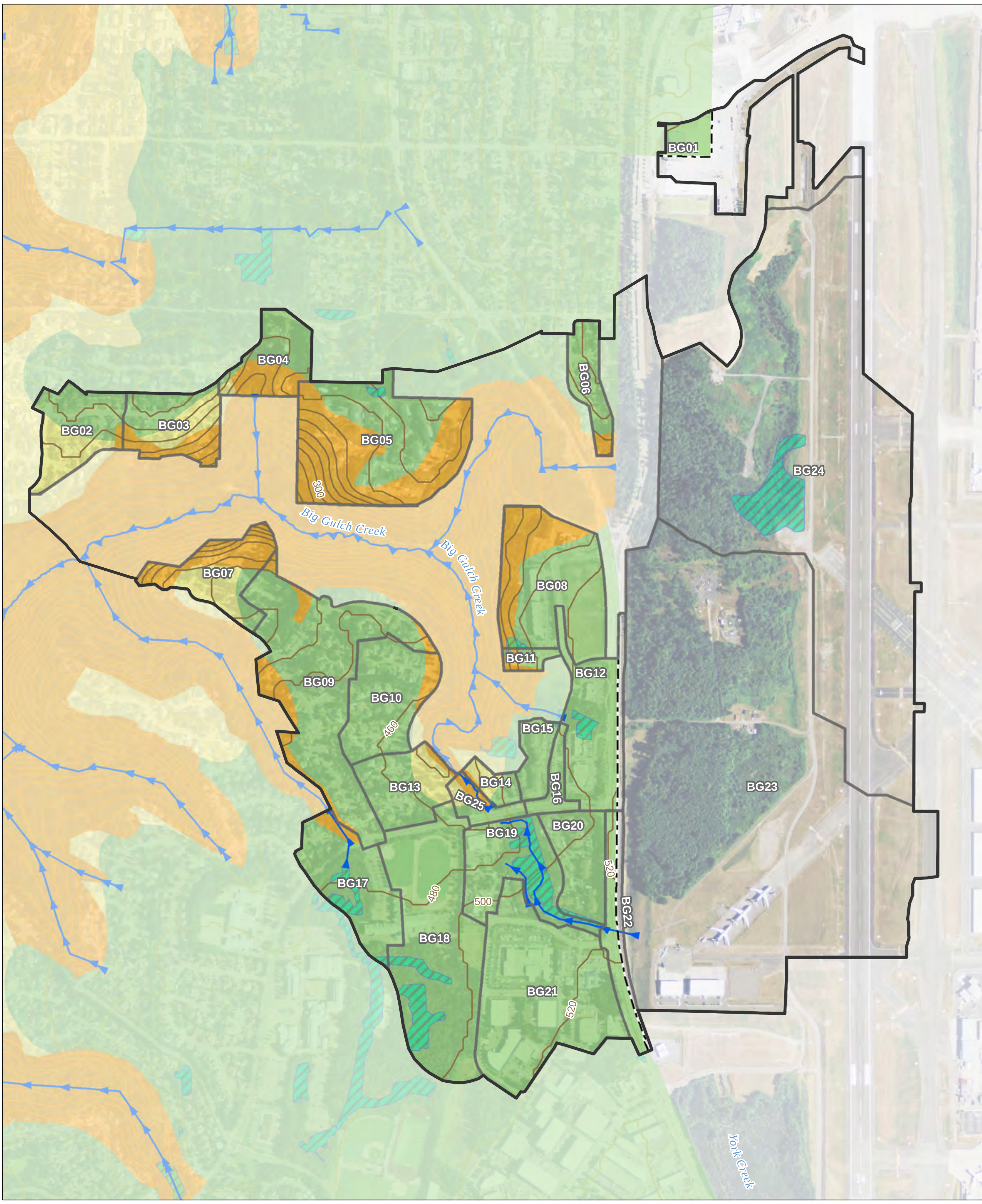
City of Mukilteo Stormwater Management Plan . 130589

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 6: Picnic Point Ravine Shallow Infiltration Feasibility

Picnic Point Ravine

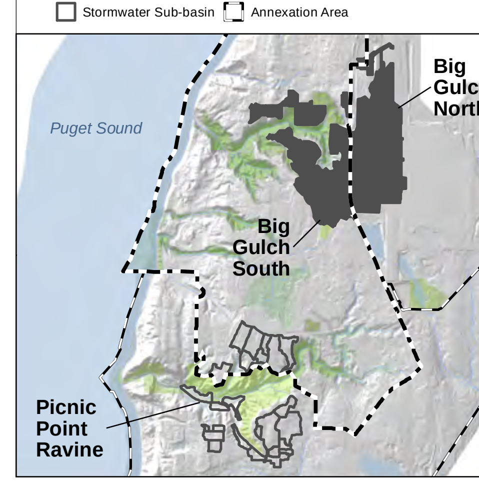
City of Mukilteo, Washington



Legend

Deep Infiltration Feasibility
- Good Potential
- Moderate Potential
- Poor Potential
- Stream
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

Stormwater Sub-basin Index Map



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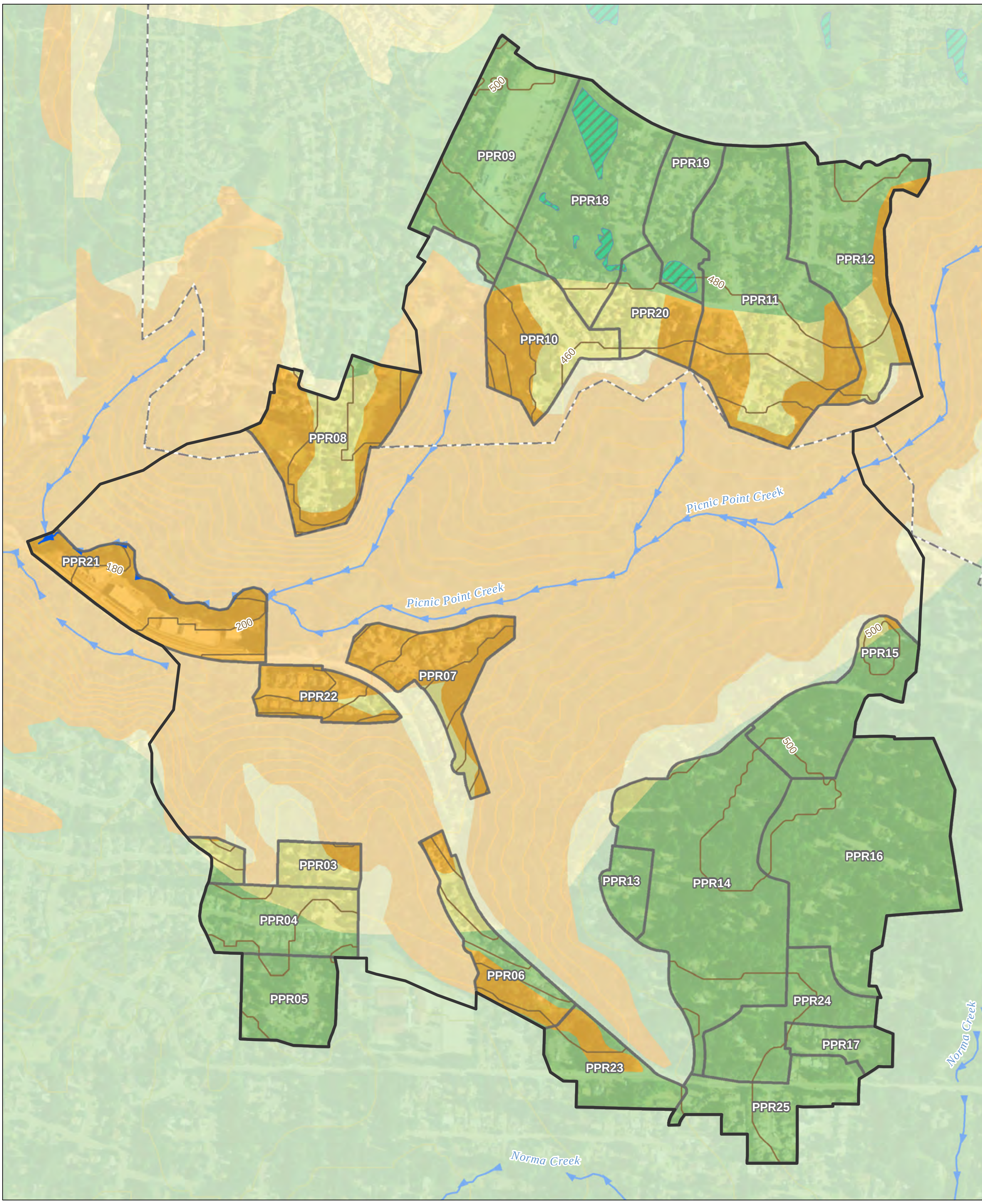
SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 7: Big Gulch North and South Deep Infiltration Feasibility

Big Gulch North and South
City of Mukilteo, Washington



Legend

Deep Infiltration Feasibility
- Good Potential
- Moderate Potential
- Poor Potential
- Stream
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- PAU Boundary
- Mukilteo City Limits
- Annexation Area

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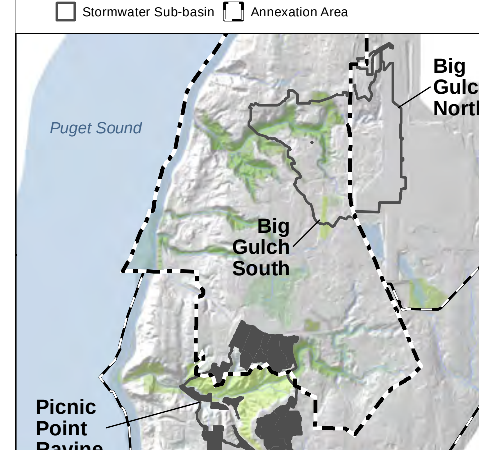
Feet
1 inch = 600 feet

Stormwater Sub-basin Index Map

Mapped Catchments / Mukilteo City Limits / Stormwater Sub-basin / Annexation Area



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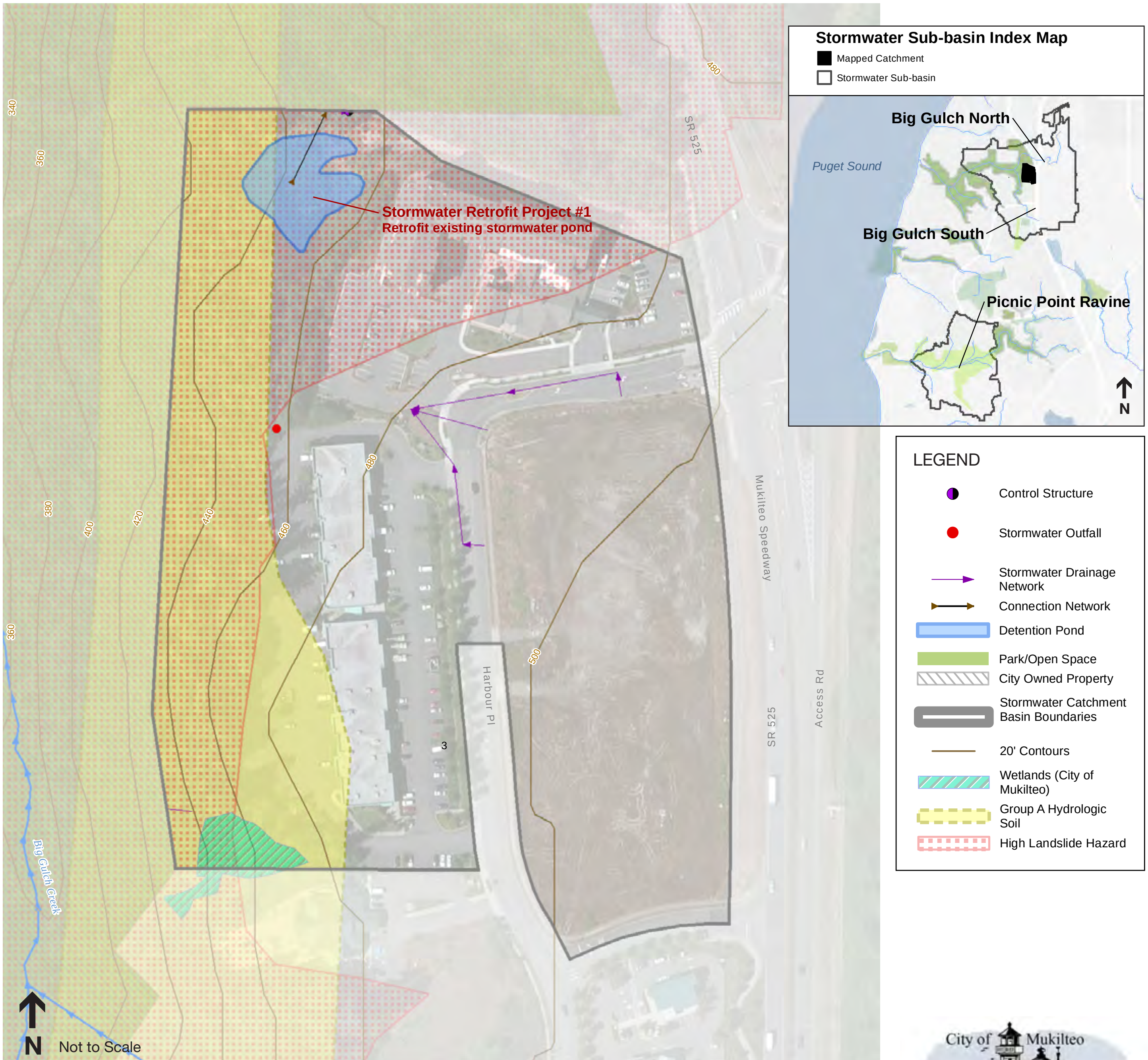
City of Mukilteo Stormwater Management Plan . 130589

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-13

Map 8: Picnic Point Ravine Deep Infiltration Feasibility

Picnic Point Ravine
City of Mukilteo, Washington

Attachment B: Stormwater Retrofit Project Fact Sheets



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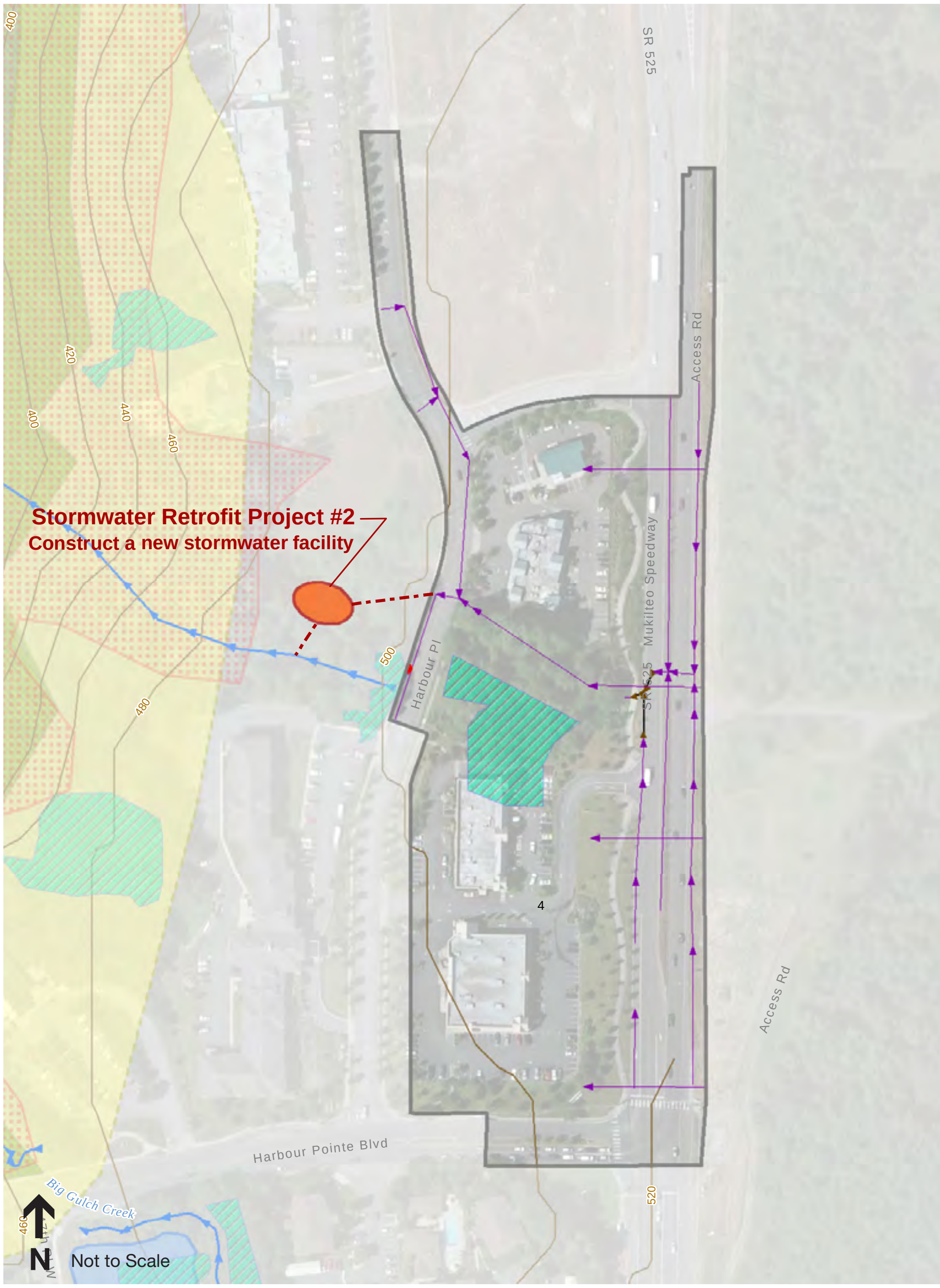
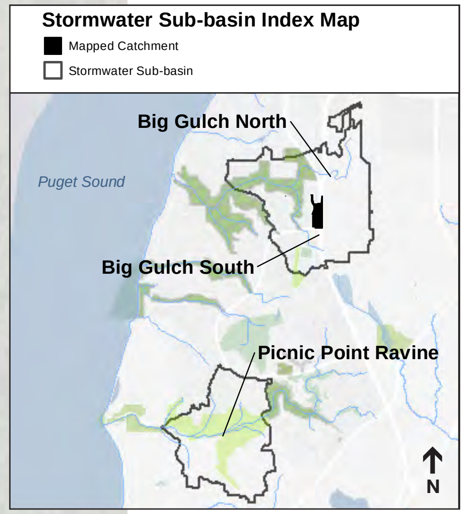
Stormwater Retrofit Project #1 Summary	
Staybridge Suites Pond	
PAU Name	Big Gulch North
Catchment Name	BG08
Existing Stormwater Facility	yes
Estimated Contributing Area (acres)	12.0
Priotization Score	3.4
Project Rank (1-8)	3

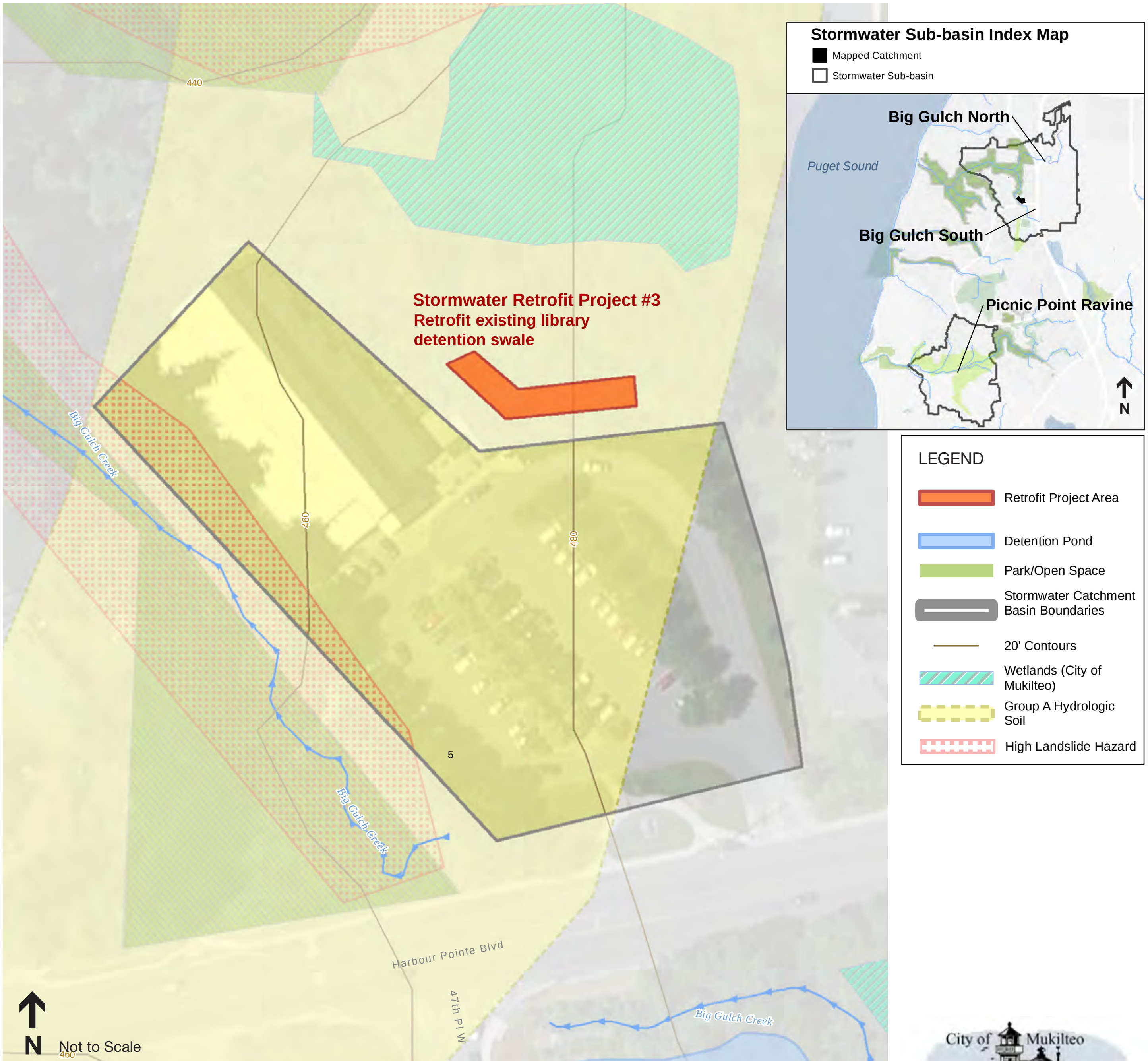
Stormwater Retrofit Project Fact Sheet : Project #1

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013





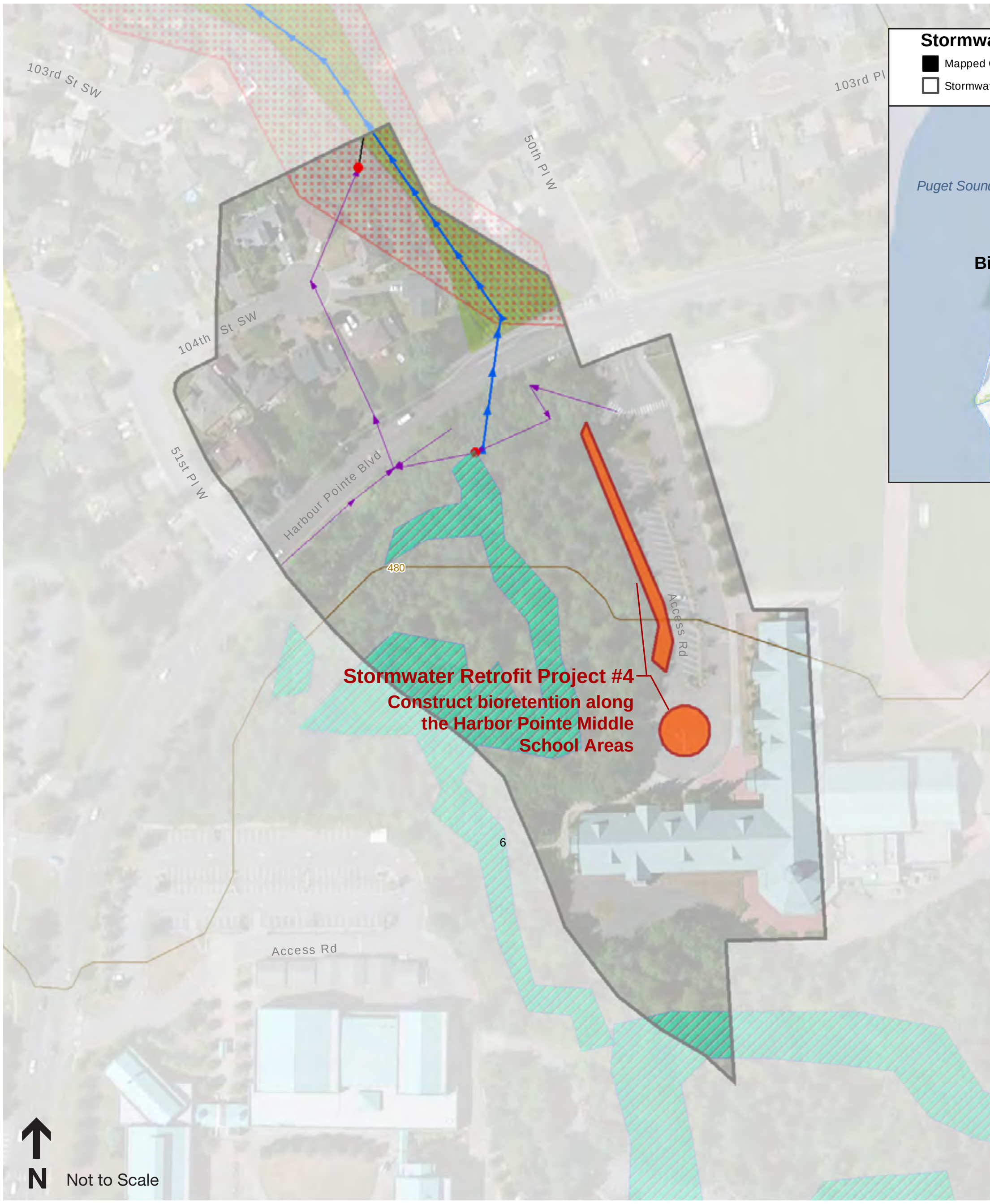
Stormwater Retrofit Project #2 Summary	
Harbor Pointe	
PAU Name	Big Gulch South
Catchment Name	BG12
Existing Stormwater Facility	no
Estimated Contributing Area (acres)	3.5
Priotization Score	2.9
Project Rank (1-8)	7



Stormwater Retrofit Project #3 Summary	
Sno-Isle Library	
PAU Name	Big Gulch South
Catchment Name	BG14
Existing Stormwater Facility	yes
Estimated Contributing Area (acres)	2.0
Priotization Score	2.4
Project Rank (1-8)	8

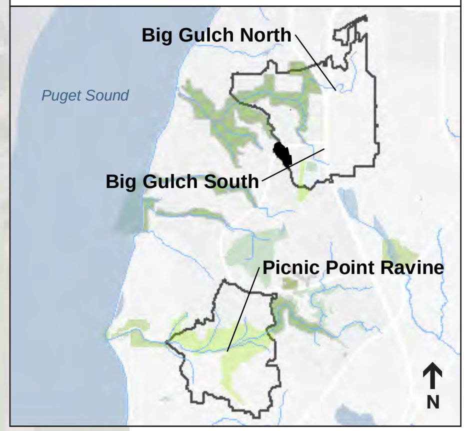
Stormwater Retrofit Project Fact Sheet : Project #3

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013



Stormwater Sub-basin Index Map

- Mapped Catchment
- Stormwater Sub-basin



LEGEND

- Retrofit Project Area
- Stormwater Outfall
- Stormwater Drainage Network
- Connection Network
- Stream
- Park/Open Space
- City Owned Property
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Wetlands (City of Mukilteo)
- Group A Hydrologic Soil
- High Landslide Hazard

Stormwater Retrofit Project #4 Summary	
Harbor Pointe Middle School	
PAU Name	Big Gulch South
Catchment Name	BG17
Existing Stormwater Facility	no
Estimated Contributing Area (acres)	1.7
Priotization Score	3.6
Project Rank (1-8)	2

City of Mukilteo

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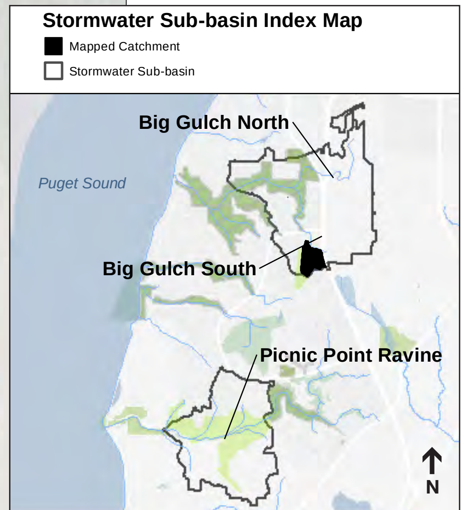
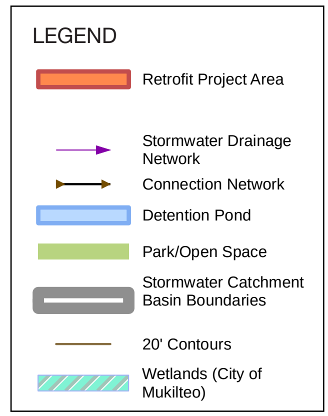
ESA

Stormwater Retrofit Project Fact Sheet : Project #4

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013





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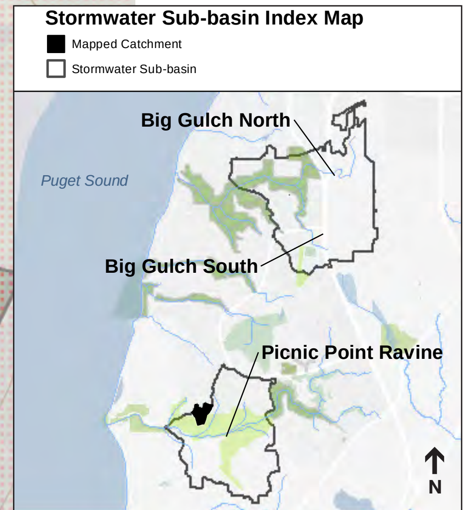
Stormwater Retrofit Project #5 Summary	
YMCA/47th Place West	
PAU Name	Big Gulch South
Catchment Name	BG21
Existing Stormwater Facility	no
Estimated Contributing Area (acres)	15.1
Priotization Score	3.3
Project Rank (1-8)	4

Stormwater Retrofit Project Fact Sheet : Project #5

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013



LEGEND

- Retrofit Project Area
- Stormwater Drainage Network
- Park/Open Space
- Stormwater Catchment Basin Boundaries
- 20' Contours
- Group A Hydrologic Soil
- High Landslide Hazard

Stormwater Retrofit Project #6 Summary	
Harbor Pointe Golf Course	
PAU Name	Picnic Point Ravine
Catchment Name	PPR08
Existing Stormwater Facility	no
Estimated Contributing Area (acres)	11.8
Priotization Score	3.1
Project Rank (1-8)	5

City of Mukilteo

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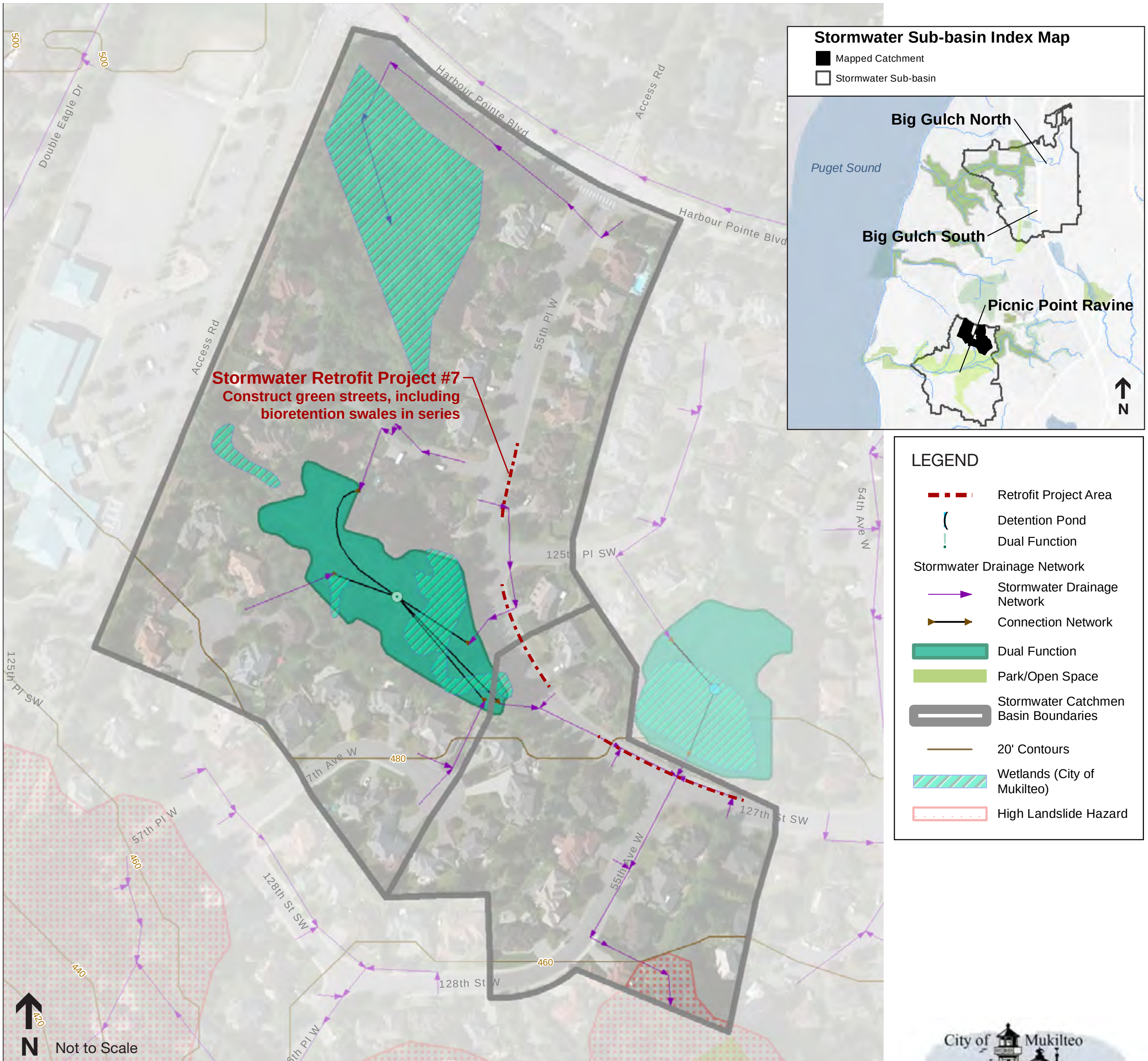
Stormwater Retrofit Project Fact Sheet : Project #6

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013



City of Mukilteo

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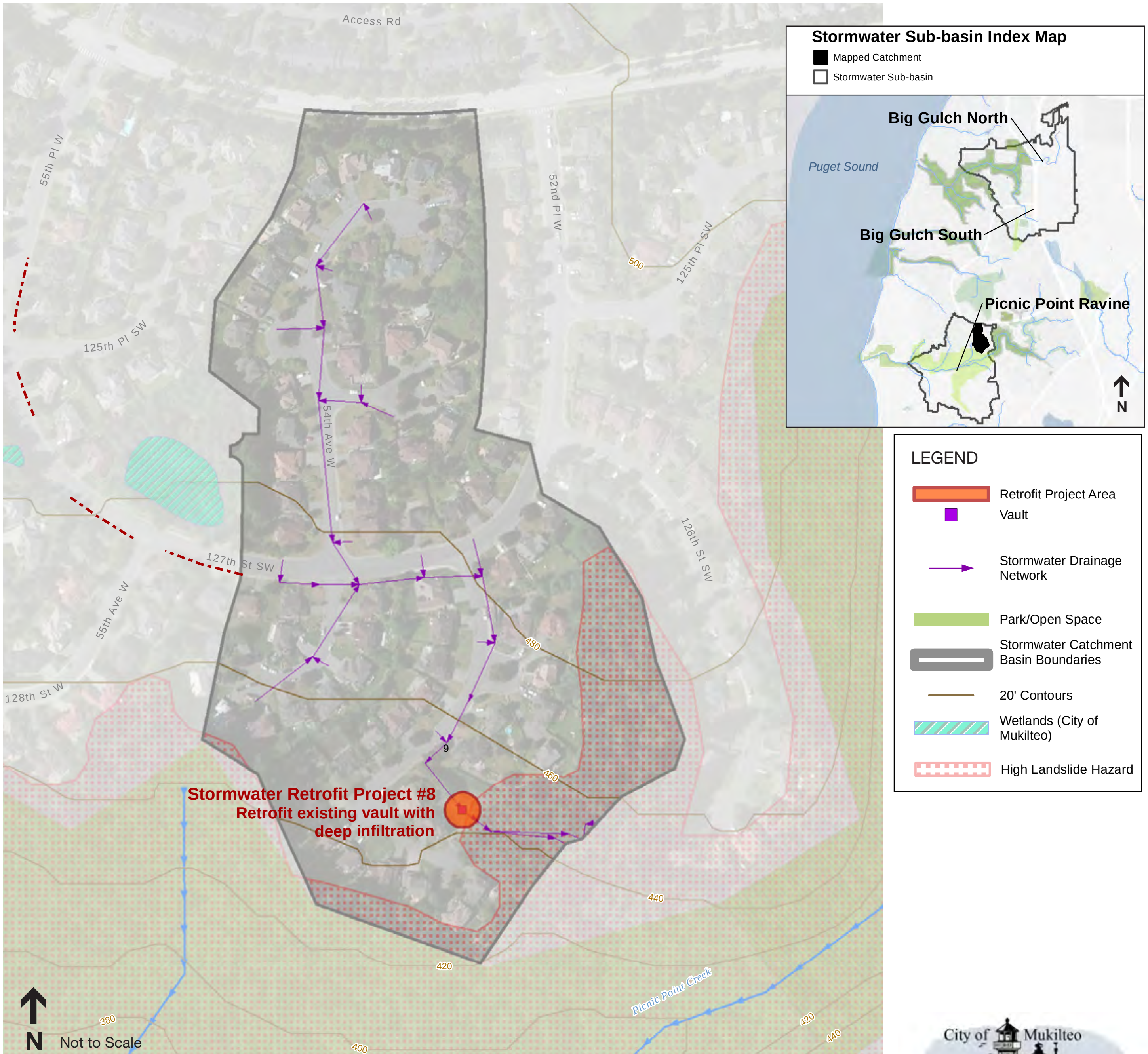
Stormwater Retrofit Project #7 Summary	
55th Place West/127th Street Southwest	
PAU Name	Picnic Point Ravine
Catchment Name	PPR18/20
Existing Stormwater Facility	yes
Estimated Contributing Area (acres)	5.6
Priotization Score	3.6
Project Rank (1-8)	1

Stormwater Retrofit Project Fact Sheet : Project #7

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013



Stormwater Retrofit Project #8 Summary	
Private Stormwater Vault	
PAU Name	Picnic Point Ravine
Catchment Name	PPR11
Existing Stormwater Facility	yes
Estimated Contributing Area (acres)	3.5
Priotization Score	3.0
Project Rank (1-8)	6

Stormwater Retrofit Project Fact Sheet : Project #8

SOURCE: ESA, 2010-2012; City of Mukilteo, 2012-2013

Attachment C: Scoring Results

Table. C-1. Catchment Analysis Results

Catchment ID	Total Area (acres)	TIA (acres)	Normalized TIA Retrofit	Facility Type	Facility Year	Facility Score	Prioritization Score (TIA Retrofit + Facility Score)	City	#1 EIA = 0.1*TIA$^{1.5}$	#2 EIA = 0.4*TIA$^{1.2}$	#3 EIA = TIA	EIA (ac)
BG01	15.3	4.9	0.13	Detention Pond	Airport	0.5	0.63	no				
BG02	8.3	3.9	0.10	none		1	1.10	yes		X		2.7
BG03	8.1	2.8	0.07	none		1	1.07	yes		X		2.1
BG04	6.9	1.2	0.03	none		1	1.03	yes		X		1.3
BG05	24.5	10.1	0.26	Detention Pond	1980	0.9	1.16	yes			X	10.1
BG06	4.6	1.7	0.04	Detention Pond	1986	0.9	0.94	yes		X		0.8
BG07	8.3	3.0	0.08	none		1	1.08	yes	X	X		2.4
BG08	17.5	4.3	0.11	Harbor Point Master Plan	2000	0.5	0.61	yes			X	4.3
BG09	26.5	11.4	0.30	none		1	1.30	yes	X	X		4.0
BG10	11.1	4.5	0.12	none		1	1.12	yes		X		2.5
BG11	1.4	0.6	0.02	Harbor Point Master Plan		0.5	0.52	yes		X		0.2
BG12	12.0	8.2	0.21	none		1	1.21	yes			X	8.2
BG13	7.6	3.5	0.09	none		1	1.09	yes		X		1.8
BG14	2.0	1.1	0.03	detention swale	1997	0.5	0.53	yes		X	X	1.1
BG15	3.2	2.1	0.06	none		1	1.06	yes			X	2.1
BG16	2.3	1.4	0.04	none		1	1.04	yes			X	1.4
BG17	11.0	3.8	0.10	none		1	1.10	yes			X	3.8
BG18	25.8	4.0	0.10	bioretention swale	between 1994 and 2002	0.5	0.60	yes			X	4.0
BG19	10.8	3.4	0.09	Detention Pond	1996	0.5	0.59	yes			X	3.4
BG20	6.9	4.4	0.12	none		1	1.12	yes			X	4.4
BG21	25.8	18.8	0.49	none		1	1.49	yes			X	18.8
BG22	5.6	4.7	0.12	none		1	1.12	yes				
BG23	136.5	30.3	0.79	Detention Pond; High Flow By-Pass Pipe	Airport	0.5	1.29	no				
BG24	112.9	38.5	1.00	Detention Pond	Airport	0.5	1.50	no				
BG25	2.6	0.8	0.02	none		1	1.02	yes				
PPR02	1.2	0.4	0.01	none		1	1.01	no				
PPR03	2.7	0.8	0.02	none		1	1.02	no				
PPR04	7.6	3.1	0.08	none		1	1.08	no				
PPR05	6.0	2.0	0.05	Detention Pond	between 1994 and 2002	0.5	0.55	no				
PPR06	6.0	1.9	0.05	none		1	1.05	no				
PPR07	8.0	3.5	0.09	Detention Pond	1996	0.5	0.59	no				
PPR08	11.8	2.8	0.07	none		1	1.07	50%		X		1.4
PPR09	14.0	7.3	0.19	Detention Pipe		1	1.19	yes		X		4.4
PPR10	9.0	2.6	0.07	Detention Pond	previous to 1990	0.9	0.97	yes		X		1.2
PPR11	23.2	7.7	0.20	Vault	previous to 1990	0.9	1.10	yes		X		4.6
PPR12	13.9	5.2	0.14	Detention Pond	previous to 1990	0.9	1.04	yes		X		2.9
PPR13	2.5	0.6	0.02	none		1	1.02	no				
PPR14	25.7	3.1	0.08	none		1	1.08	no				
PPR15	8.7	1.3	0.04	none		1	1.04	no				
PPR16	24.1	3.6	0.09	none		1	1.09	no				
PPR17	2.6	0.9	0.02	none		1	1.02	no				
PPR18	15.9	3.6	0.09	Dual Function	1988	0.9	0.99	yes		X		1.9
PPR19	5.6	1.6	0.04	Detention Pond	previous to 1990	0.9	0.94	yes		X		0.7
PPR20	5.5	1.9	0.05	none		1	1.05	yes		X		0.9
PPR21	9.5	2.1	0.05	none		0.5	0.55	no				
PPR22	4.5	2.1	0.05	none		1	1.05	no				
PPR23	5.8	1.4	0.04	none		1	1.04	no				
PPR24	7.7	0.6	0.02	none		1	1.02	no				
PPR25	7.4	4.1	0.11	none		1	1.11	no				

Table. C-2. City Wide Catchment Analysis Results

Catchment ID	Total Area (acres)	TIA (acres)	EIA (ac)	Normalized EIA Retrofit	Facility Score	Catchment Prioritization Score[1.]
BG02	8.32	3.94	2.07	0.11	1.00	1.11
BG03	8.12	2.75	1.35	0.03	1.00	1.03
BG04	6.91	1.19	0.49	0.54	1.00	1.54
BG05	24.49	10.12	10.12	0.04	0.90	0.94
BG06	4.56	1.72	0.77	0.04	0.90	0.94
BG07	8.34	3.03	2.36	0.13	1.00	1.13
BG08	17.51	15.00	15.00	1.00	0.50	1.50
BG09	26.52	11.37	3.96	0.21	1.00	1.21
BG10	11.05	4.55	2.46	0.13	1.00	1.13
BG11	1.38	0.60	0.22	0.01	0.50	0.51
BG12	11.96	8.17	8.17	0.54	1.00	1.54
BG13	7.57	3.51	1.81	0.10	1.00	1.10
BG14	2.00	1.14	1.14	0.08	0.50	0.58
BG15	3.16	2.13	2.13	0.08	1.00	1.08
BG16	2.28	1.45	1.45	0.08	1.00	1.08
BG17	11.01	3.84	3.84	0.26	1.00	1.26
BG18	25.76	4.02	4.02	0.21	0.50	0.71
BG20	6.94	4.43	4.43	1.00	1.00	2.00
BG21	25.76	18.77	18.77	1.25	1.00	2.25
BG22	5.62	4.69	4.69	0.25	1.00	1.25
BG25	2.57	0.76	0.29	0.07	1.00	1.07
PPR08	11.84	2.83	1.39	0.09	1.00	1.09
PPR09	13.98	7.33	4.36	0.23	1.00	1.23
PPR10	8.95	2.57	1.24	0.07	0.90	0.97
PPR11	23.16	7.69	4.63	0.31	0.90	1.21
PPR12	13.86	5.24	2.92	0.19	0.90	1.09
PPR18	15.92	3.59	1.86	0.12	0.90	1.02
PPR19	5.63	1.58	0.69	0.05	0.90	0.95
PPR20	5.46	1.91	0.87	0.06	1.00	1.06

1. Normalized EIA Retrofit Score + Facility Score

Table. C-3. Field Screening Results

Catchment ID	space feasilibity/access	
BG21	high	1.0
BG14	high	1.0
PPR20	high	1.0
PPR11	high	1.0
BG08	high	1.0
PPR18	high	1.0
BG17	high	1.0
BG12	high	1.0
PPR19	high	1.0
PPR08	high	1.0
Catchments screened out by space/feasiblity qualitative score		
BG10	low	0.0
BG22	low	0.0
BG02	low	0.0
BG13	low	0.0
BG16	low	0.0
BG09	low	0.0
BG07	low	0.0
PPR10	low	0.0
BG06	low	0.0
PPR09	low	0.0
BG18	low	0.0
BG11	low	0.0
PPR12	low	0.0
BG20	low	0.0
BG04	low	0.0
BG15	low	0.0
BG03	low	0.0
BG25	low	0.0
BG05	low* (no access, poor safety)	0.0

Table. C-4. Stormwater Retrofit Project Evauation Results

			Retrofit	Cost					Benefit Score				Engineering Suitability Score					Geotechnical Suitability Score			Permitting Score					Partnership Score		Other Considerations Score	
Project Name		Catchment ID	Project Score	Land Acquisitio	Score	O&M	Score	Cost Score	Existing Facility	Total Area Treated	Raw Score	Normalized Benefit Score	Connection to existing storm	Score	High Traffic	Score	Engineering Score	Shallow infiltration	Deep infiltration (aspect)	Geotechnical Score	Proximity to Critical Areas/buffers	Score	Cultural Resouces	Score	Permitting Score	Ease of partnership	Partnership Score	Notes	Score
1	Staybridge Suites Pond	BG08	2.0	No	3	pond/infiltration vault	2	2.5	Yes	12.0	7.2	1.4	high	3	low	3	3	low	low	1	no impacts	3	low/moderate risk	3	3	high: public facility	3		
2	Harbor Pointe Pl.	BG12	1.5	Yes	1	pond/infiltration vault	2	1.5	No	3.5	3.5	0.7	medium	2	low	3	3	low	good	3	buffer impacts	2	high risk	1	2	low: private	1		
3	Sno-Ilse Library	BG14	1.4	No	3	pond/infiltration vault	2	2.5	Yes	2.0	1.2	0.2	high	3	low	3	3	low	good	3	buffer impacts	2	moderate/high risk	2	2	medium: library	2	known project	-3
4	Harbor Point Middle School	BG17	2.2	No	3	bioretention	1	2.0	No	1.7	1.7	0.3	high	3	mid	2	3	low	good	3	buffer impacts	2	low/moderate risk	3	3	medium: school	2	Education opportunities	3
5	YMCA/47th Pl. W	BG21	1.6	No	3	bioretention	1	2.0	No	15.1	15.1	3.0	medium	2	High Traffic	1	2	low	good	3	no impacts	3	moderate/high risk	2	3	medium: YMCA	2	Big Gulch By-pass pipe	-3
6	Harbor Pointe Golf Course	PPR08	1.8	No	3	pond/wetland	2	2.5	No	11.8	11.8	2.4	medium	2	low	3	3	low	low	1	no impacts	3	low/moderate risk	3	3	low: golf course	1		
7	55thPl. W/127th St. SW	PPR18/20	2.3	No	3	bioretention	1	2.0	Yes	5.6	3.4	0.7	high	3	mid	2	3	low	moderate	2	no impacts	3	low/moderate risk	3	3	high: public street	3	public outreach/water quality	3
8	Private vault	PPR11	1.6	No	3	infiltration vault	2	2.5	Yes	3.5	2.1	0.4	high	3	low	1	2	low	good	3	buffer impacts	2	low/moderate risk	3	3	low: private	1		

Table. C-5. Overall Stormwater Retrofit Project Priority Scores

Stormwater Retrofit Project		Catchment ID	Normalized PAU Score	Normalized Catchment Score	Project Specific Score	Total Score	Rank
1	Staybridge Pond	BG08	0.9	0.7	2.0	3.5	3
2	Harbor Pointe Pl.	BG12	0.8	0.7	1.5	2.9	7
3	Library	BG14	0.8	0.3	1.4	2.4	8
4	Middle School	BG17	0.8	0.6	2.2	3.6	2
5	YMCA/47th Pl. W	BG21	0.8	1.0	1.6	3.3	4
6	Golf Course	PPR08	0.8	0.5	1.8	3.1	5
7	55thPl. W/127th St. SW	PPR18/20	0.8	0.5	2.3	3.6	1
8	Private vault	PPR11	0.8	0.6	1.6	3.0	6

Attachment D: Hydrologic Analysis

Appendix D. Hydrologic Analysis: Land Use Scenarios

Unit Analysis Scenario 1			2 ac, 20% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	35%	2.00	0.70
C, Lawn	79	45%		0.90
Impervious	98	20%		0.40
Total			*2.00*	*2.00*
			70	75

Unit Analysis Scenario 2			2 ac, 30% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	25%	2.00	0.50
C, Lawn	79	45%		0.90
Impervious	98	30%		0.60
Total			*2.00*	*2.00*
			70	76

Unit Analysis Scenario 3			2 ac, 40% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	15%	2.00	0.30
C, Lawn	79	45%		0.90
Impervious	98	40%		0.80
Total			*2.00*	*2.00*
			70	77

Unit Analysis Scenario 4			5 ac, 20% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	35%	5.00	1.75
C, Lawn	79	45%		2.25
Impervious	98	20%		1.00
Total			*5.00*	*5.00*
Wtd CN			70	75

Unit Analysis Scenario 5			5 ac, 30% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	25%	5.00	1.25
C, Lawn	79	45%		2.25
Impervious	98	30%		1.50
Total			*5.00*	*5.00*
Wtd CN			70	76

Unit Analysis Scenario 6			5 ac, 40% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	15%	5.00	0.75
C, Lawn	79	45%		2.25
Impervious	98	40%		2.00
Total			*5.00*	*5.00*
Wtd CN			70	77

Unit Analysis Scenario 7			10 ac, 20% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	35%	10.00	3.50
C, Lawn	79	45%		4.50
Impervious	98	20%		2.00
Total			*10.00*	*10.00*
Wtd CN			70	75

Unit Analysis Scenario 8			10 ac, 30% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	25%	10.00	2.50
C, Lawn	79	45%		4.50
Impervious	98	30%		3.00
Total			*10.00*	*10.00*
Wtd CN			70	76

Unit Analysis Scenario 9			10 ac, 40% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	15%	10.00	1.50
C, Lawn	79	45%		4.50
Impervious	98	40%		4.00
Total			*10.00*	*10.00*
Wtd CN			70	77

Unit Analysis Scenario 10			20 ac, 20% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	35%	20.00	7.00
C, Lawn	79	45%		9.00
Impervious	98	20%		4.00
Total			*20.00*	*20.00*
Wtd CN			70	75

Unit Analysis Scenario 11			20 ac, 30% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	25%	20.00	5.00
C, Lawn	79	45%		9.00
Impervious	98	30%		6.00
Total			*20.00*	*20.00*
Wtd CN			70	76

Unit Analysis Scenario 12			20 ac, 40% TIA	
Land Cover	**CN**	**%Cover**	**pre-dev**	**dev**
C, Forest	70	15%	20.00	3.00
C, Lawn	79	45%		9.00
Impervious	98	40%		8.00
Total			*20.00*	*20.00*
Wtd CN			70	77

Appendix D. Hydrologic Analysis: Predicted Pond Sizes
WWHM, Everett Gage 0.8 SF
optimize pond with 1-hr timestep (appx. 100 interations)

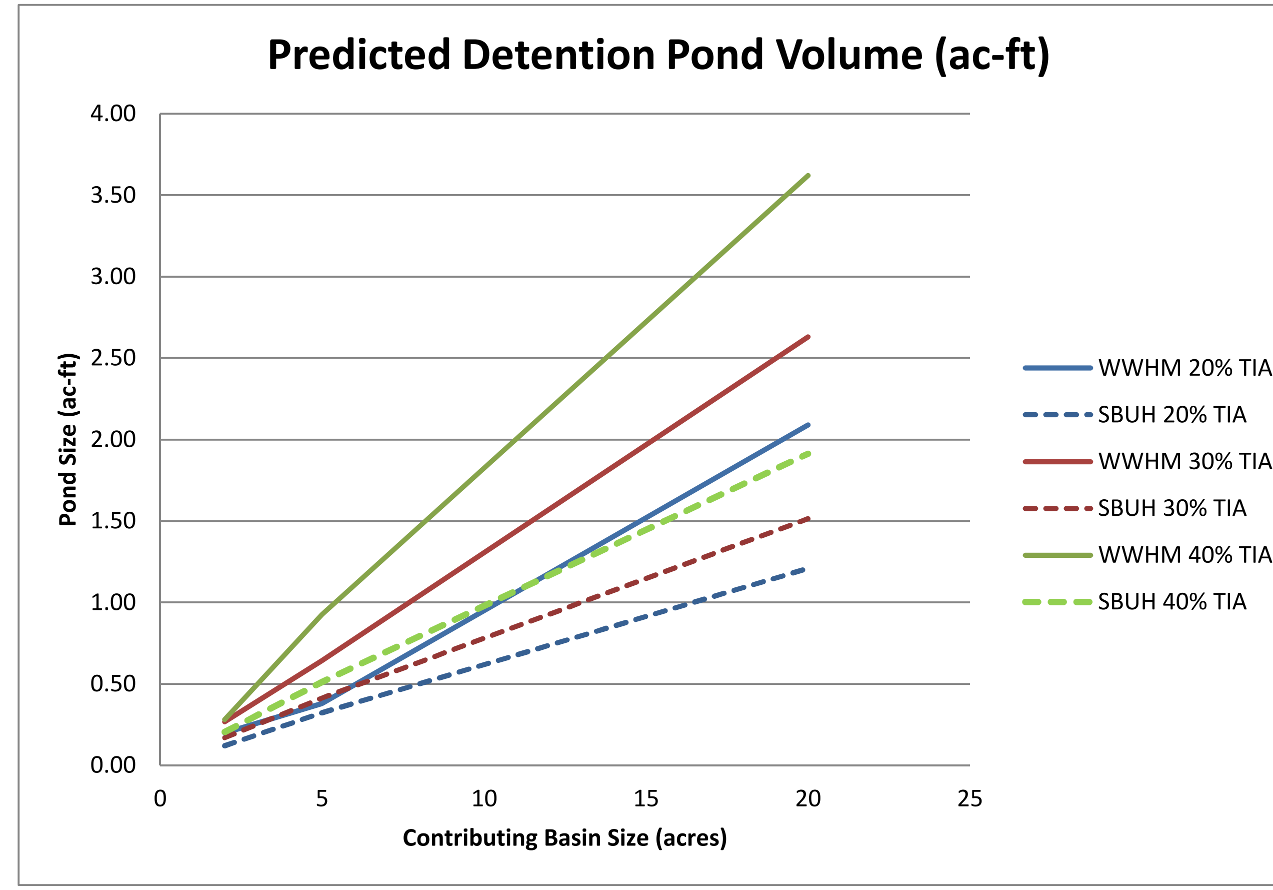
WWHM Pond Size (acre-ft)			
Area	WWHM 20% TIA	WWHM 30% TIA	WWHM 40% TIA
2	0.20	0.27	0.28
5	0.38	0.64	0.93
20	2.09	2.63	3.62

SBUH Pond Size (acre-ft)			
Area	SBUH 20% TIA	SBUH 30% TIA	SBUH 40% TIA
2	0.12	0.17	0.20
5	0.32	0.41	0.51
20	1.21	1.51	1.91

WWHM Pond Size (acre-ft)/Area			
Area	20% TIA	30% TIA	40% TIA
2	0.10	0.13	0.14
5	0.08	0.13	0.19
20	0.10	0.13	0.18
Average	0.09	0.13	0.17

SBUH Pond Size (acre-ft)/Area			
Area	20% TIA	30% TIA	40% TIA
2	0.06	0.09	0.10
5	0.06	0.08	0.10
20	0.06	0.08	0.10
Average	0.06	0.08	0.10

Relative Difference (SBUH/ WWHM)			
Area	20% TIA	30% TIA	40% TIA
2	0.60	0.64	0.72
5	0.85	0.64	0.55
20	0.58	0.58	0.53
		Average	0.63



Appendix B: Geohydrologic Studies and Soil Analysis

INFILTRATION FEASIBILITY ASSESSMENT

Stormwater Management Plan, Mukilteo, Washington

Prepared for: Brown and Caldwell

Project No. 130212 • January 29, 2015

earth + water

Aspect CONSULTING

INFILTRATION FEASIBILITY ASSESSMENT

Stormwater Management Plan, Mukilteo, Washington

Prepared for: Brown and Caldwell

Project No. 130212 • January 29, 2015

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Contents

List of Tables

List of Figures

List of Appendixes

Executive Summary

The City of Mukilteo is updating its 2001 Comprehensive Surface Water Management Plan. This plan will address the use of Low Impact Development (LID) approaches for stormwater management in order to reduce stormwater runoff. Since LID often incorporates stormwater infiltration, a City-wide assessment of infiltration feasibility was performed to provide the City a baseline for screening future LID approaches.

The feasibility of both shallow and deep infiltration was evaluated in this report. Shallow infiltration generally relies on vertical infiltration directly from the LID facility (typically a bioretention swale, tree-box, or pervious pavement) and is generally suitable in relatively flat areas with permeable surface soils. For this assessment, shallow infiltration feasibility was considered a function of surficial permeability, surface slope gradient, and steep slope hazards factors.

Deep infiltration is considered suitable when a permeable, unsaturated soil zone (referred to as a receptor horizon) exists beneath low-permeability surface soils. Deep infiltration systems use a deep well or trench to convey treated stormwater from the LID facility to the deeper permeable soils. For this assessment, deep infiltration feasibility was considered a function of steep slope hazards and potential for deep infiltration receptor horizon factors.

For each factor of shallow and deep infiltration feasibility, geographic information system (GIS) maps were created and the infiltration feasibility of combinations of the factors described above (referred to as hydrogeomorphic units) was evaluated. Maps of infiltration feasibility were created for the City and the results are summarized below:

- **Shallow Infiltration Feasibility**: Most of the City is not suitable for shallow infiltration due to the presence of low-permeability glacial till soils at the surface and/or proximity to steep slope hazards including landslides. There are small areas considered moderate or good for shallow infiltration scattered throughout the City.

- **Deep infiltration Feasibility**: Assessment of deep infiltration feasibility is uncertain in any specific City area because of the limited availability of reliable subsurface information. However, recently acquired regional data on the geology of the City’s ravine slopes and deep explorations conducted for the City’s Stormwater Retrofits program suggest a low potential for deep infiltration below most uplands portions of the City. Because of the potential for steep slope hazards including landslides, deep infiltration is generally not feasible along the City’s shoreline and within or near the steep ravines and gulches found in the City.

The feasibility assessments provided in this report are suitable for identification and evaluation of potential stormwater infiltration solutions. Site-specific geologic and geomorphic mapping and subsurface explorations, infiltration testing, and additional analysis are recommended to verify the information that provides the basis for the assessments included in this report.

1 Introduction

The City of Mukilteo (City) is updating its 2001 Comprehensive Surface Water Management Plan. This plan will address the use of Low Impact Development (LID) approaches for stormwater management in order to reduce stormwater runoff. Since LID often incorporate stormwater infiltration, Aspect Consulting LLC (Aspect) conducted a City-wide analysis of infiltration feasibility and the potential effects of LID facilities on slope stability. The infiltration feasibility assessment provided in this report is intended to support stormwater management planning that will provide a baseline for screening potential LID approaches.

This City-wide infiltration feasibility assessment was initially based on readily available, pre-existing information. The assessment was then revised based on the results of a geomorphic investigation of four ravines (Altaterra and Aspect, 2014) that provided new data on regional geology, hydrostratigrahy, and steep slope hazards, and results of a subsurface hydrogeologic investigation completed for a stormwater retrofit program (Aspect, 2015) that provided new data on the depth and composition of deep hydrostratigraphic units.

The feasibility of both shallow and deep infiltration were evaluated in this assessment. Shallow infiltration generally relies on vertical infiltration directly from the LID facility (typically a bioretention swale, tree-box, or pervious pavement) and is generally suitable in relatively flat areas with permeable surface soils. If surface soils are relatively impermeable but underlain by a sufficiently thick unsaturated zone of permeable soils (referred to as a receptor horizon), the LID facility may be equipped with a deep well or trench that conveys treated stormwater to a deep infiltration drain. Deep infiltration drains convey water to the deeper unsaturated soils and improve the flow control (reduction in peak runoff) provided by the LID facility. Deep infiltration may be accomplished using dug drains (typically less than 20 feet deep) or drilled drains (typically between 20 and 150 feet deep). Deep infiltration drains may require permitting under the Washington State underground injection control (UIC) program.

Due to the history of landslides within the City, the proximity of potential infiltration facilities to steep slopes and landslide hazard areas is considered in this study.

1.1 Study Area

The location of the City of Mukilteo is shown on Figure 1. The study area for this assessment includes the City of Mukilteo and annexation areas (Study Area) shown on Figure 2. As shown on Figure 3 and the colorized topographic map in Figure A-1, the Study Area is generally a high plateau with elevations ranging from 400 to 600 feet above mean sea level (amsl) with steep bluffs dropping to Puget Sound along the northern and western boundaries of the City. The plateau is incised by a number of deep gulches or ravines, the primary ones being Big Gulch and Picnic Point Gulch.

2 Study Area Geology and Hydrogeology

This section summarizes the geology and hydrogeology of the Study Area. An understanding of the Study Area's surficial geology and hydrogeology is necessary to estimate soil properties and is a major factor in assessing the feasibility of potential infiltration approaches.

2.1 Geology

The surficial geology of the Puget Sound basin results from long periods of erosion and non-glacial sedimentation in depositional environments similar to those present today, punctuated by multiple glacial advances into the Puget Sound lowland. The most recent glaciation, the Vashon Stade of the Fraser glaciation, ended only about 13,000 years ago, and the resulting landform consists of glacially sculpted uplands composed of north to south elongated glacial drumlins and flutes, and waterways of Puget Sound. Post-glacial erosion has locally incised the uplands and created steep-sided ravines and steep bluffs near coastal areas and river valleys. Alluvial soils have been deposited in river and stream valleys since the end of the Vashon glaciation.

Figure 3 illustrates the surficial geology of the Study Area as presented by the Washington Department of Natural Resources (DNR; Washington DNR, 2014a) based on original geologic mapping by Smith (1976) and Minard (1982 and 1983). The geologic units that are present at the surface and in the shallow surface are divided into the following general categories (older to younger):

- **Older Glacial and Non-glacial Deposits:** The Possession Drift (Qpd), the Whidbey Formation (Qw) and the Double Bluff Drift (Qdb) are pre-Fraser in age and include both glacial and non-glacial deposits. In the Study Area, these deposits are found near sea level along the coastline and in low-lying areas of the ravines. Due to a relatively high percentage of fine soil particles and cementation, they are generally considered poor for infiltration.

- **Undifferentiated Units and Transitional Beds:** There are a number of geologic units of indeterminate age and origin (undifferentiated deposits) in the Study Area that include both Fraser and pre-Fraser deposits, including marine glacial drift (Qmg) and undifferentiated glacial till (Qtu). Also included in this group is the Transitional beds (Qtb), the geologic unit that marks the transition from Olympia non-glacial deposition to Vashon Stade glacial deposition. These units are found in the City's downtown area near the ferry dock and in the deeper portions of the ravines. Due to a relatively high percentage of fine soil particles and cementation, they are generally considered poor for infiltration.

- **Vashon Deposits:** Deposited during the Vashon Stade glaciation, these deposits include the following units (from oldest to youngest): advance outwash (Qva), a subglacial meltout till (Qvtm), basal (also known as lodgment) glacial till (Qvt), and recessional outwash (Qvr). The advance outwash is a predominately sandy unit mapped in the ravines and beneath the glacial till, which is generally considered relatively permeable. Subglacial meltout till is a unit formed by water reworking of sediments at the base of the melting glacier. Subglacial meltout till deposits are composed of outwash-like silty sand and gravel, and sandy till. The silty outwash strata occur as layers and lenses within the sandy till. The outwash-like interbeds may be moderately permeable, but they are poorly interconnected due to the presence of surrounding tills. The bulk permeability is low. The basal glacial till covers much of the high plateau area and generally consists of a dense mixture of silt, sand, and gravel considered relatively impermeable. Although not mapped anywhere within the Study Area, Vashon-age recessional outwash is often found above the glacial till and typically consists of relatively permeable sand and gravel.

- **Post-glacial (Recent) Deposits:** Deposited since the most recent glaciation, these deposits include alluvium (Qal), landslide deposits (Qls) and modified land (ml). The alluvial deposits occur in depositional areas of the gulches and can range from predominately silt to predominately sand with variable infiltration properties. The landslide deposits are considered unstable and not suitable for infiltration. Modified land generally refers to artificial fill and is primarily mapped along the Puget Sound shoreline within the Study Area.

Additional geologic and hydrogeologic information was obtained from the Washington Department of Natural Resources subsurface database (formerly GeoMap NW; Washington DNR, 2014a), over 100 geotechnical reports provided by the City, multiple reports provided by the Washington State Department of Transportation (WSDOT), and a number of reports describing explorations completed in the vicinity of the Boeing Plant north of Paine Field (Boeing Plant). Most of the reports found on the DNR database and provided by the City were for residential developments or minor infrastructure project and were primarily based on shallow explorations that did not extend more than 15 feet below the ground surface. Reports provided by WSDOT generally discussed shallow explorations. The explorations located north of Paine Field were generally deeper but were located outside the Study Area.

2.2 Study Area Glacial Till

One of the important parameters for determining the feasibility of deep infiltration is the thickness of the surficial glacial till. The thickness of this low-permeability deposit not only determines the depth of a deep filtration drain but also factors into the thickness of permeable unsaturated zone between the bottom of the glacial till and the water table in the advance outwash. Unfortunately, very few explorations within the Study Area penetrate the entire thickness of the glacial till in the upper plateau area. Regional data shows that glacial till rarely exceeds 50 feet in thickness, but there are borings outside the Study Area and generally associated with the Boeing Plant that suggest the glacial till is up to 200 feet thick. To help resolve this till thickness data gap and discrepancy and to assess specific sites for deep infiltration potential, several new borings were completed for the stormwater retrofit hydrogeologic investigation (Aspect, 2015). Based on the new hydrogeologic boring data, the basal till was observed to be anomalously thick (generally corroborating the data from the Paine field and Boeing borings), and it was found to locally grade downward and transition into the subglacial meltout till unit. Although the Aspect borings did not fully penetrate the subglacial meltout till, this unit may in turn grade down and lie above advance outwash, or any older deposits.

Based on the Washington DNR (2014b) mapping of the contact between the glacial till and the advance outwash, it appeared that the bottom of the glacial till would be generally encountered at an elevation of approximately 300 feet above mean sea level (amsl) in the northern portion of the Study Area and approximately 500 feet amsl in the southern portion of the Study Area. Data from the ravine geomorphic reconnaissance (Altaterra and Aspect, 2014) however showed that advance outwash is both thinner and more laterally restricted than indicated on the maps. It appears that the Qvtm unit was included as part of the Qva unit by the original mappers (Smith, 1976, Minard, 1982, and Minard, 1983). It should be noted that the advance outwash appears to be missing or quite thin in the northern portion of the Study Area between 12th Street and 88th Street SW, and is elsewhere generally thinner and lower in elevation than indicated by the geologic maps.

2.3 Hydrogeology

Based on our review of existing information, two hydrostratigraphic units of importance have been identified in the Study Area: near surface perched groundwater and the advance outwash aquifer. This section summarizes the characteristics and implications of these hydrostratigraphic units within the Study Area.

2.3.1 Near-Surface Perched Groundwater

The uppermost hydrostratigraphic unit in the Study Area consists of low-permeability surface and shallow subsurface soils that perch water. In particular, perched groundwater frequently occurs on the glacial till that covers most of the upland area of the Study Area. Depending on a variety of factors, such as facility size and horizontal permeability, groundwater mounding on glacial till can reduce the infiltration capacity of an LID facility by an order of magnitude or more in comparison with short term infiltration testing.

Perched groundwater may occur at any depth within the stratigraphic column where a low-permeability material is encountered. These perched units are typically thin and discontinuous. The uppermost groundwater aquifer of regional extent and importance for deep infiltration occurs in the advance outwash (Qva), which, where present, lies beneath the low-permeability glacial till and subglacial meltout till.

2.3.2 Advance Outwash Aquifer

There are very few wells within the Study Area that appear to intersect this Qva regional aquifer, and the elevation of the water table is poorly defined. A number of explorations east of the northern portion of the Study Area suggest the water table is located at an elevation of approximately 350 feet amsl. Perennial creeks and other natural water bodies are often a reflection of the groundwater table. Since many of the creeks found in the incised gulches within the City limits are mapped with headwaters at an elevation of 350 to 400 feet amsl, this evidence suggests that groundwater occurs near or above this elevation. Some streams are mapped with headwaters at higher elevations but generally are mapped as glacial till and may reflect runoff from till covered uplands and drainage of perched groundwater. Our initial analysis regarding the feasibility of deep infiltration assumed based on map units that the advance outwash groundwater table generally occurs in the range of 350 to 400 feet amsl beneath the high plateau and drops steeply to sea level near the shoreline. Based on new ravine reconnaissance and hydrogeologic boring data (Altaterra and Aspect, 2014, and Aspect 2015), our revised analysis assumed that the advance outwash is deeper and/or saturated or not present below much of the high plateau area.

3 Infiltration Feasibility Assessment

Aspect assessed infiltration feasibility by evaluating factors that affect infiltration potential and identifying hydrogeomorphic units defined by unique combinations of these factors. The infiltration feasibility assessment included the following factors:

- Surficial geology/gross unit permeability;
- Surface slope gradient;
- Proximity to steep slope hazard areas; and
- Potential for deep infiltration receptor horizon.

These factors are described in more detail in the sections that follow. Different combinations of these factors were used to define shallow and deep hydrogeomorphic units and each unique hydrogeomorphic unit was evaluated for infiltration feasibility. Maps of deep and shallow infiltration feasibility were created based on the geographic distribution of the hydrogeomorphic units.

3.1 Evaluation of Infiltration Factors

This section summarizes the evaluation of the infiltration factors used in the assessment.

3.1.1 Surficial Geology/Permeability

Mapped surficial geology is important as it helps assess the permeability of the surface soils and is a major factor in the feasibility of shallow infiltration. Surficial geology for the Study Area is discussed in Section 2.1. Each of the geologic units included within the Study Area were categorized into broad permeability[1] categories, as follows:

Moderate permeability (2-10 inches/hour):

- Alluvium (Qal)
- Vashon Advance outwash (Qva)

Poor permeability (0-2 inches/hour):

- Modified Land/Artificial Fill (ml)
- Landslide deposits (Qls)
- Vashon Glacial Till (Qvt)
- Transitional beds (Qtb)
- Marine glacial drift (Qmg)
- Till, undivided (Qtu)
- Possession Drift (Qpd)
- Whidbey Formation (Qw)
- Double Bluff Drift (Qdb)

[1] Permeability is a measurement of the ability of a porous geologic unit to transmit water, expressed here as velocity in inches per hour.

These categories were based on experience with similar soil and rock units in the Puget Sound lowlands. None of the geologic units mapped in the Study Area are deemed to possess good permeability (greater than 10 inches/hour).

Based on the geologic mapping discussed in Section 2.1 and the permeability categories discussed above, a map of surface permeability is provided on Figure A-2. As shown on the figure, most of the Study Area has poor surficial permeability due to the presence of glacial till across most of the high plateau and older geologic units along the shoreline. Portions of the high plateau and gulches are underlain by advance outwash and are mapped as having moderate permeability.

3.1.2 Surface Slope Gradient

Surface slope is a factor in determining the potential for shallow infiltration to migrate along a perching layer and daylight at the ground surface or in a crawl space/basement down slope from the infiltration facility. Potential adverse impacts include:

- Flooded or wet crawl spaces or basements;
- Standing water and/or flooding;
- Inundation of drain fields;
- Retaining wall failure due to saturation of soils; and
- Near field surface seepage.

In addition, LID facilities are generally more expensive to construct on steeper slopes due to the addition of check dams, embankments, and retaining structures.

Surface slope was calculated based on LiDAR elevation data (Puget Sound LiDAR Consortium, 2004). The Study Area was divided into the following surface slope gradient categories:

- **Good:** Less than 8 percent;
- **Moderate:** Between 8 percent and 20 percent;
- **Poor:** Greater than 20 percent.

The definition of these categories is generally based on our observations of slopes that typically have water seepage issues. For the Study Area, as shown on Figure A-3, the high plateau area is predominately less than 20 percent gradient and the gulches are predominately greater than 20 percent gradient.

3.1.3 Steep Slope Hazard Areas

Increased groundwater recharge can, in some situations, increase the potential for slope movement. Therefore, infiltration facilities generally should not be located close to slopes that may be susceptible to accelerated slope movement processes including landslides (referred to as steep slope hazard areas). Ideally, a complete geotechnical analysis of slope stability, which typically includes consideration of slope geometry, geology, and groundwater elevations, would be conducted before locating an infiltration facility near a sensitive slope.

Since this is a general scoping study and specific infiltration facility locations are not known, a complete geotechnical assessment is not warranted at this time. Instead, this assessment relied on mapping of slopes that have been found to be steep enough to be generally sensitive to increased water loading and may possess elevated landslide hazards. In general, this steep slope hazard area was defined as slopes steeper than 20 percent plus a buffer of 50 feet adjacent to those slopes. The steep slope determination used a smoothed topographic model to eliminate the very low height slopes that are not believed to be significant hazard areas for this regional analysis.

For this analysis, the Study Area was divided into the following Steep Slope Hazard categories:

- **Steep Slope Areas:** Slopes of 20 percent or greater, plus a 50-foot buffer, and any mapped landslide areas.
- **Other Areas:** All areas that do not fall within the above Steep Slope classification.

The resulting steep slope hazard area map (Figure A-4) was compared to the City of Mukilteo's Geologic Sensitive Areas map (City of Mukilteo, 2015) to confirm that it incorporates the general areas identified by the City as very high or high landslide hazard. It also includes areas mapped by Washington DNR (2014b) as landslides. These Steep Slope and Other Areas categories should be considered guidelines that generally identify the potential steep slope hazard associated with increased infiltration. The actual risk depends on the amount of infiltration and site-specific geology and groundwater conditions. Any proposed infiltration facility should be evaluated by a qualified geotechnical professional regarding the potential impacts on landslide hazard areas. Site-specific explorations and slope stability modeling may be necessary to evaluate the landslide hazard.

For the Study Area, as shown on Figure A-4, most of the high plateau area is mapped as Other Areas indicating low potential for slope hazards while the ravines and bluffs above Puget Sound are mapped as Steep Slopes, having greater potential for slope movement hazards. It should be noted that this assessment does not account for the potential for groundwater increase that might result if stormwater infiltration was significantly increased within a particular area. Because of the uncertainty regarding the potential rise in groundwater elevations and the potential to impact the slope hazard zones, slope stability evaluations are recommended if significant infiltration facilities are planned.

3.1.4 Potential for Deep Infiltration Receptor Horizon

Deep infiltration is suitable when a permeable, unsaturated soil horizon exists beneath low-permeability surface soils. Given the geologic setting of the Study Area, this permeable unsaturated zone generally occurs in the advance outwash deposits beneath the glacial till and above the advance outwash aquifer (i.e., the unsaturated portion of the advance outwash). The potential for a suitable thickness of unsaturated advance outwash depends on the elevation of the aquitard units that lie below the advance outwash, the thickness of the glacial till and subglacial meltout till that lies above advance outwash, and the depth to groundwater at each location within the Study Area.

As discussed in Section 2, the thickness of the Study Area's glacial till has been found to be greater than normal for the region, the advance outwash has been found to be thinner and less extensive than indicated by geologic maps, and the depth to groundwater is highly uncertain due to the limited availability of reliable deep subsurface information within the Study Area.

Therefore, the approach used in this assessment is based on the assumption that the glacial till is on the order of 100 feet thick, lies above subglacial meltout till, and the water table is at an elevation of approximately 400 feet amsl beneath the high plateau area and approximately 350 feet amsl near discharge zones such as the gulches and ravines and Puget Sound Shoreline. Based on these assumptions, the Study Area was divided into the following zones (refer to Figure A-5):

- **Moderate potential for a deep infiltration receptor horizon:** Plateau areas that are above an elevation of approximately 400 feet amsl near discharge zones and above 450 feet amsl further from discharge zones were mapped as having a moderate potential for a deep infiltration receptor horizon;
- **Low potential for a deep infiltration receptor horizon:** Plateau areas near discharge zones below an elevation of approximately 400 feet amsl were mapped as having a low potential for a deep infiltration receptor horizon, and areas that appear to be groundwater discharge areas based on elevation and or the presence of streams were mapped as having a lower potential for a deep infiltration receptor horizon.

Based on the new site data (Altaterra and Aspect, 2014, and Aspect, 2015) and criteria described above, we did not identify any areas that were considered high potential for deep infiltration receptor horizon. These deep infiltration receptor horizon category definitions were developed for planning level purposes. For specific sites, they would require adjustment based on actual site surface and subsurface information, and potentially, results of site-specific mounding analysis.

3.2 Hydrogeomorphic Units

Each unique combination of the infiltration feasibility factors defines a hydrogeomorphic unit, as listed in Tables 1 (shallow infiltration) and 2 (deep infiltration). As discussed below, different factors were used to define hydrogeomorphic units for the shallow and deep infiltration feasibility assessments. The infiltration feasibility for each hydrogeomorphic unit was evaluated and then categorized based on a combination of infiltration potential surface slopes, and potential hazard. Based on the geographic distribution of the hydrogeomorphic units, Figures 4 and 5 were created to show the deep and shallow infiltration feasibility, respectively, throughout the Study Area.

3.2.1 Shallow Infiltration Hydrogeomorphic Units

Shallow infiltration feasibility is a function of the following factors:

- Surficial geology/permeability;
- Surface slope gradient;
- And proximity to steep slope hazard areas.

Table 1 identifies each of the hydrogeomorphic units and the respective infiltration feasibility for shallow infiltration. There is a potential for up to 12 unique hydrogeomorphic units. Each of the hydrogeomorphic units was assigned to one of the following shallow infiltration classifications:

Good: Hydrogeomorphic units were categorized as good if shallow infiltration is considered both feasible and unlikely to pose any significant hazards. Generally, LID facilities located on relatively flat areas with effective infiltration rates greater than 2 inches/hour are generally considered feasible. (Note that the effective infiltration rate can be a function of both soil permeability and groundwater mounding.)

The only hydrogeomorphic unit categorized as good for shallow infiltration met the following criteria:

- Low steep slope hazard;
- Good surface slopes (less than 8 percent); and
- Good or moderate surface soil permeability.

Moderate: Hydrogeomorphic units were categorized as moderate if infiltration was considered feasible but may be less effective and/or there was a slight potential for adverse impacts. This classification was generally applied to hydrogeomorphic units that do not meet the criteria for the "good" classification but do meet all of the following criteria:

- Low steep slope hazard;
- Good or moderate surface slopes (less than 20 percent); and
- Good or moderate surface soil permeability.

Poor: Hydrogeomorphic units were categorized as poor if the infiltration feasibility is likely to be low or there are potential adverse impacts. This classification was generally applied to hydrogeomorphic units with elevated steep slope hazard that met one or more of the following criteria:

- Poor surface slope (greater than 20 percent); and
- Poor surface soil permeability.

As shown on Figure 4, many areas were determined to be infeasible for shallow infiltration due to proximity to steep slope hazards, which may result in elevated landslide hazards. Although infiltration is not recommended in these areas, lined LID facilities may be feasible to provide water quality treatment.

3.2.2 Deep Infiltration Hydrogeomorphic Units

Deep infiltration feasibility is a function of the following factors:

- Steep slope hazard areas; and
- Potential for a deep infiltration receptor horizon.

Table 2 identifies each of the deep infiltration hydrogeomorphic units and the respective deep infiltration feasibility. There is a potential for up to six unique hydrogeomorphic units.

Each of the hydrogeomorphic units were assigned to one of the following deep infiltration classifications:

Good: Hydrogeomorphic units would be categorized as good if deep infiltration is likely to be both feasible due to the higher potential for a deep infiltration receptor horizon and low potential for impacting steep slope hazard areas. Generally, deep infiltration drains are considered effective if they have a capacity of at least 50 gallons/minute (0.11 cubic feet/second) and are less than 100 feet deep or a capacity of at least 20 gallons/minute (0.045 cubic feet/second) and are less than 20 feet deep.

The "good" classification would be applied to hydrogeomorphic units that meet the following criteria:

- Low steep slope hazard; and
- Higher potential for a deep infiltration receptor horizon.

Moderate: Hydrogeomorphic units were categorized as moderate if deep infiltration may be feasible and there is a low potential for impacting steep slope hazard areas. This classification was generally applied to hydrogeomorphic units that do not meet the criteria for the "good" classification but do meet the following criteria:

- Low steep slope hazard; and
- Moderate potential for a deep infiltration receptor horizon.

Poor: Hydrogeomorphic units were categorized as poor if deep infiltration is unlikely to be feasible or there is the potential for adversely impacting steep slope hazard areas. This classification was generally applied to hydrogeomorphic units that meet one or more of the following criteria:

- Elevated steep slope hazard; and
- Low potential for a deep infiltration receptor horizon.

The feasibility for deep infiltration in the City is limited, as shown on Figure 5. The upland areas of the City were determined to mostly have a moderate feasibility for deep infiltration. Mapped wetland areas should be considered as infeasible for deep infiltration. In addition, areas near steep slope hazards were determined to be infeasible for deep infiltration.

4 Summary of Results

This section presents the results of the infiltration feasibility assessment for the City of Mukilteo and the annexation area (i.e., the Study Area). Maps of infiltration feasibility were created and the results are summarized below:

- **Shallow Infiltration Feasibility:** As shown on Figure 4, most of the City is not suitable for shallow infiltration due to the presence of low-permeability glacial till soils at the surface and/or proximity to steep slope hazards. There are small areas considered moderate or good for shallow infiltration scattered throughout the city.
- **Deep infiltration Feasibility:** Although the assessment of deep infiltration feasibility is made less certain due to the limited availability of reliable subsurface information, available data suggest that there are no areas of high potential. As shown on Figure 5, deep infiltration has moderate potential in upland portions of the City. It is unlikely that deep infiltration is feasible along the Study Area's shoreline, within wetland areas, and within or near the steep ravines and gulches in the City.

The feasibility assessments provided in this report are suitable for identification and evaluation of potential infiltration solutions. Additional subsurface explorations, infiltration testing, and analysis are recommended to verify the information that provides the basis for the assessments included in this report and to refine the analysis for site-specific infiltration target areas of interest.

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Limitations

Work for this project was performed and this report prepared in accordance with generally accepted professional practices for the nature and conditions of work completed in the same or similar localities, at the time the work was performed. It is intended for the exclusive use of Brown and Caldwell and the City of Mukilteo for specific application to the referenced study area. This report does not represent a legal opinion. No other warranty, expressed or implied, is made.

TABLES

Table 1. Shallow Infiltration Hydrogeomorphic Units

Project #130129, City of Mukilteo
Mukilteo, Washington

Geology/Permeability
G2 = Moderate Permeability
G3 = Poor permeability

Proximity to Steep Slope Hazard Area
SH1 = Low Hazard
SH2 = Elevated Hazard

Surface Slope
S1 = Good: <8%
S2 = Moderate: 8-20%
S3 = Poor: >20%

Hydrogeomorphic Unit	Geology/ Permeability	Surface Slope	Proximity to Steep Slope Hazard Area	Shallow Infiltration Feasibility
G2-S1-SH1	G2	S1	SH1	Good
G2-S1-SH2	G2	S1	SH2	Poor
G2-S2-SH1	G2	S2	SH1	Moderate
G2-S2-SH2	G2	S2	SH2	Poor
G2-S3-SH1	G2	S3	SH1	Poor
G2-S3-SH2	G2	S3	SH2	Poor
G3-S1-SH1	G3	S1	SH1	Poor
G3-S1-SH2	G3	S1	SH2	Poor
G3-S2-SH1	G3	S2	SH1	Poor
G3-S2-SH2	G3	S2	SH2	Poor
G3-S3-SH1	G3	S3	SH1	Poor
G3-S3-SH2	G3	S2	SH2	Poor

Table 2. Deep Infiltration Hydrogeomorphic Units

Project #130129, City of Mukilteo

Mukilteo, Washington

Proximity to Steep Slope Hazard Area

SH1 = Low Hazard

SH2 = Elevated Hazard

Deep Unsaturated Receptor Potential

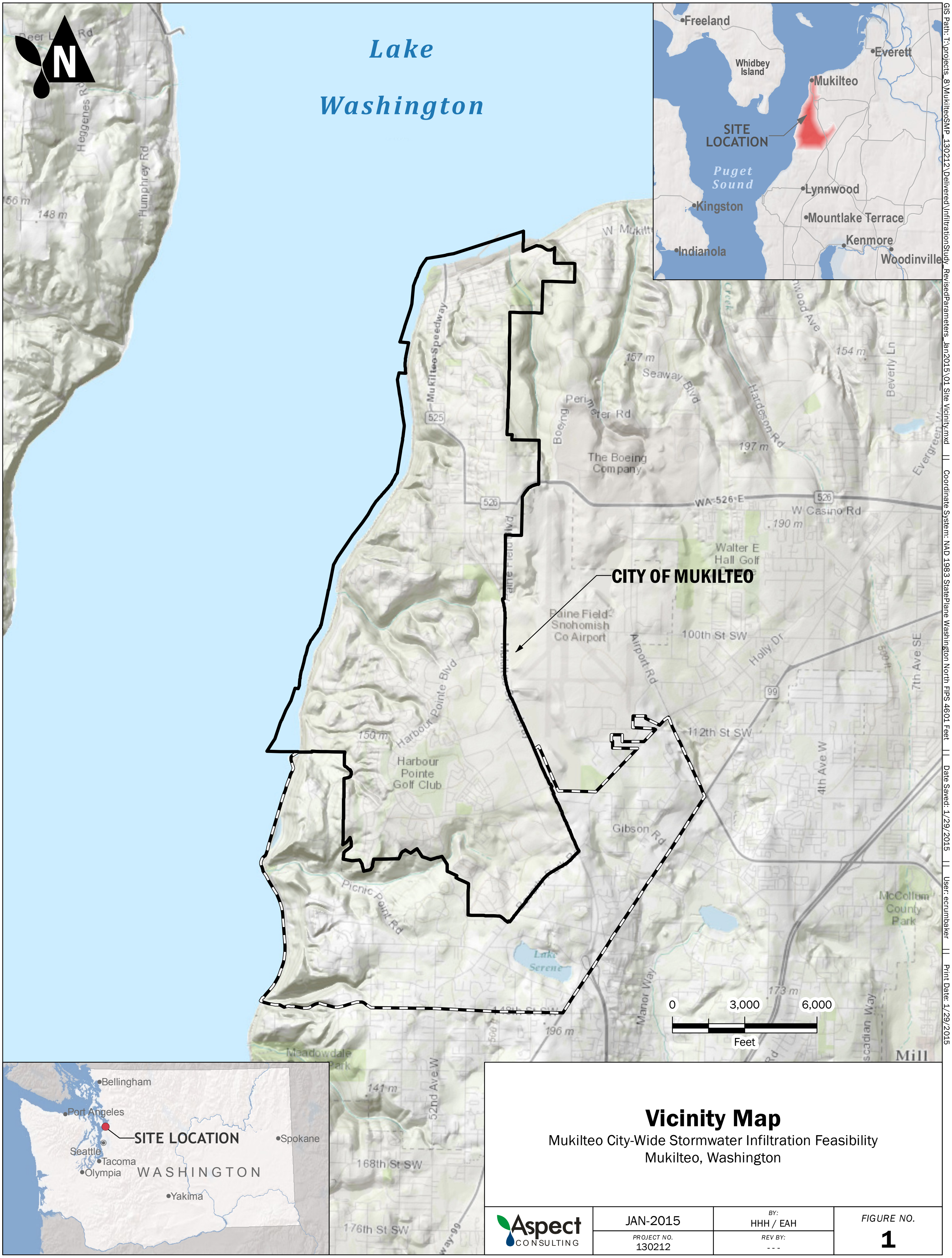
U1 = High Potential

U2 = Moderate Potential

U3 = Lower Potential

Hydrogeomorphic Unit	Proximity to Steep Slope Hazard Area	Deep Unsaturated Receptor Potential	Deep Infiltration Feasibility
SH1-U1	SH1	U1	Good
SH1-U2	SH1	U2	Moderate
SH1-U3	SH1	U3	Poor
SH2-U1	SH2	U1	Poor
SH2-U2	SH2	U2	Poor
SH2-U3	SH2	U3	Poor

FIGURES



Vicinity Map

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: - - -	1

Mukilteo City Limits

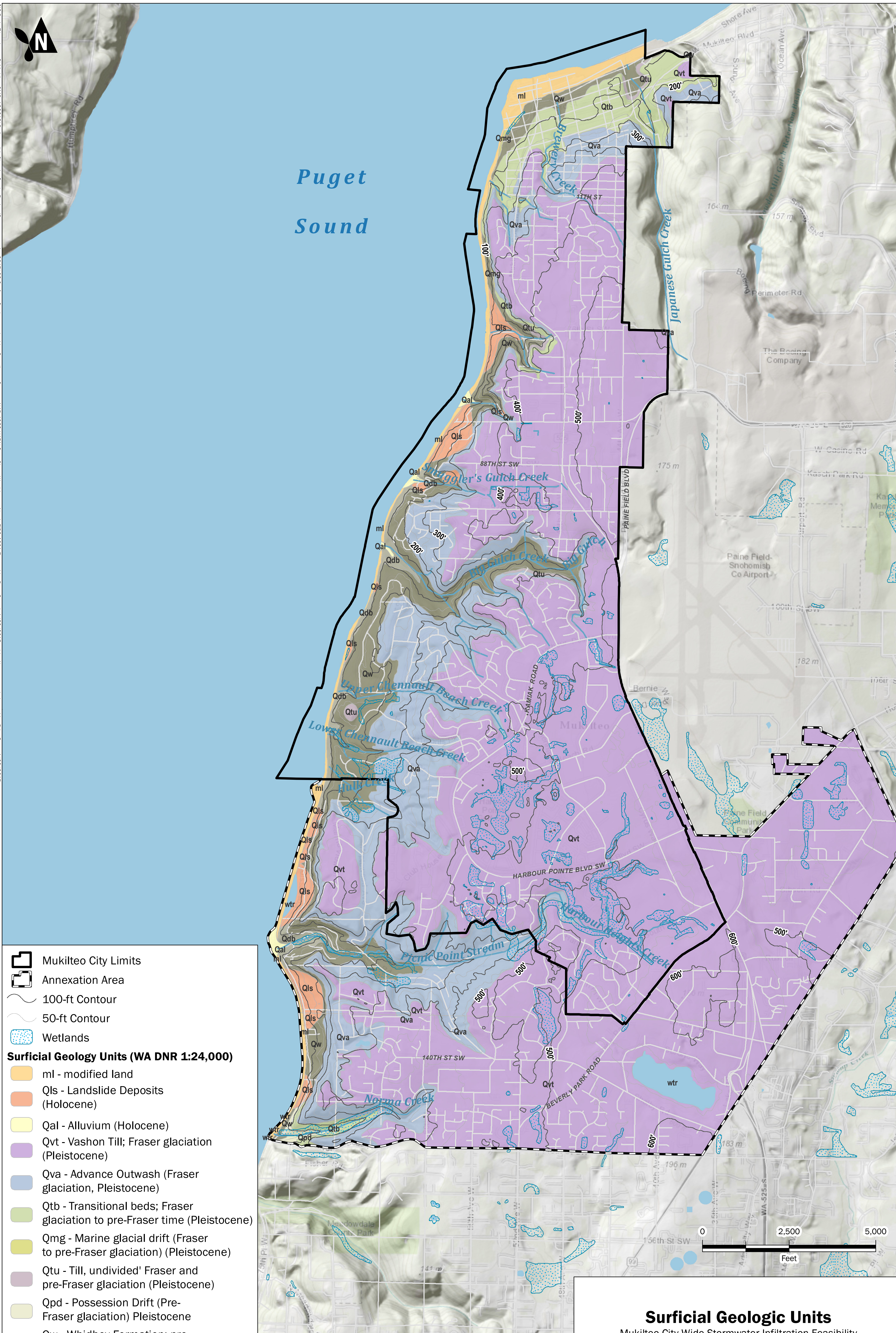
Annexation Area

Aerial Imagery
August 2011

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: - - -	2

Basemap Layer Credits || Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community



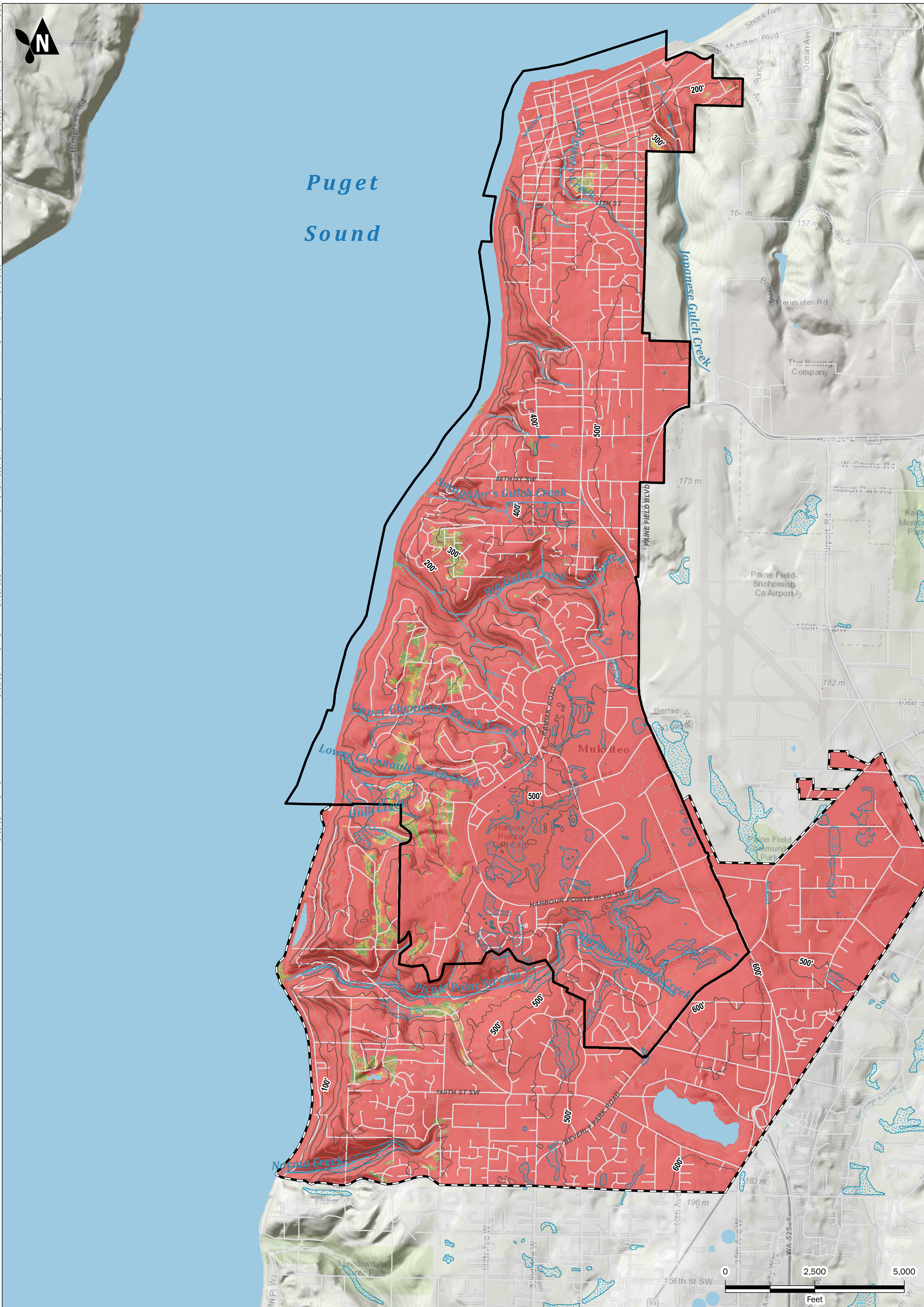
Surficial Geologic Units

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: - - -	3

GIS Path: T:\projects_8\MukilteoSMP_130212\Delivered\InfiltrationStudy_RevisedParameters_Jan2015\03 Surface Geology.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 1/29/2015 || User: ecrumbaker || Print Date: 1/29/2015

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community



- Mukilteo City Limits
- Annexation Area
- Wetlands
- 100-ft Contour
- 50-ft Contour

Shallow Infiltration Feasibility

- Good Potential
- Moderate Potential
- Poor Potential

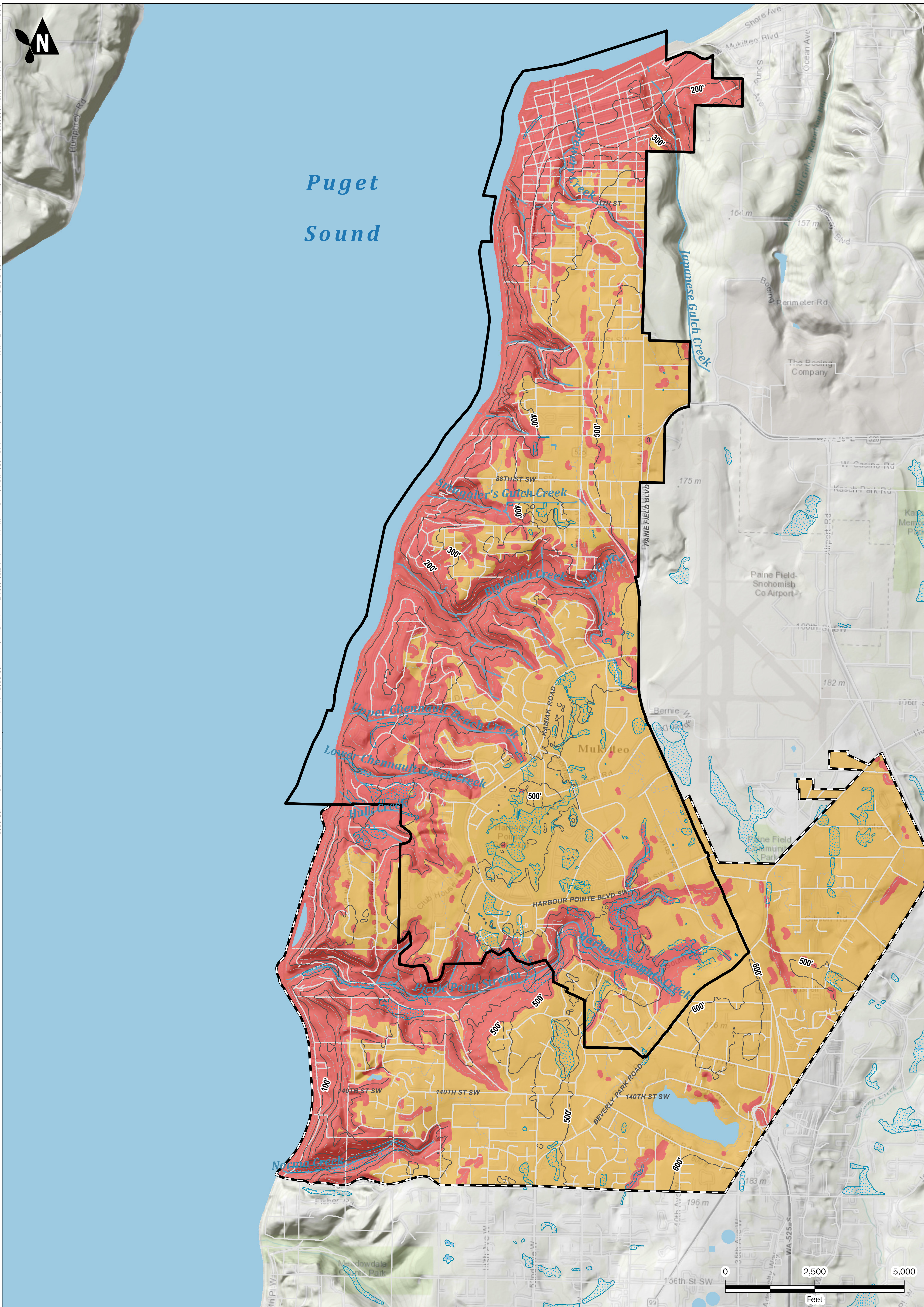
Shallow Infiltration Feasibility

City of Mukilteo Infiltration Study
Mukilteo, Washington

Aspect Consulting	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REVISED BY: EA / RAA	4

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

GIS Path: T:\projects_8\MukilteoSMP_130212\Delivered\InfiltrationStudy_RevisedParameters_Jan2015\04 Shallow Infiltration Feasibility.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 1/29/2015 || User: ecrumbaker || Print Date: 1/29/2015



Mukilteo City Limits
Annexation Area
Wetlands
100-ft Contour
50-ft Contour

Deep Infiltration Feasibility
Good Potential
Moderate Potential
Poor Potential

Note: No areas of good potential were found in the study area.

Deep Infiltration Feasibility

City of Mukilteo Infiltration Study
Mukilteo, Washington

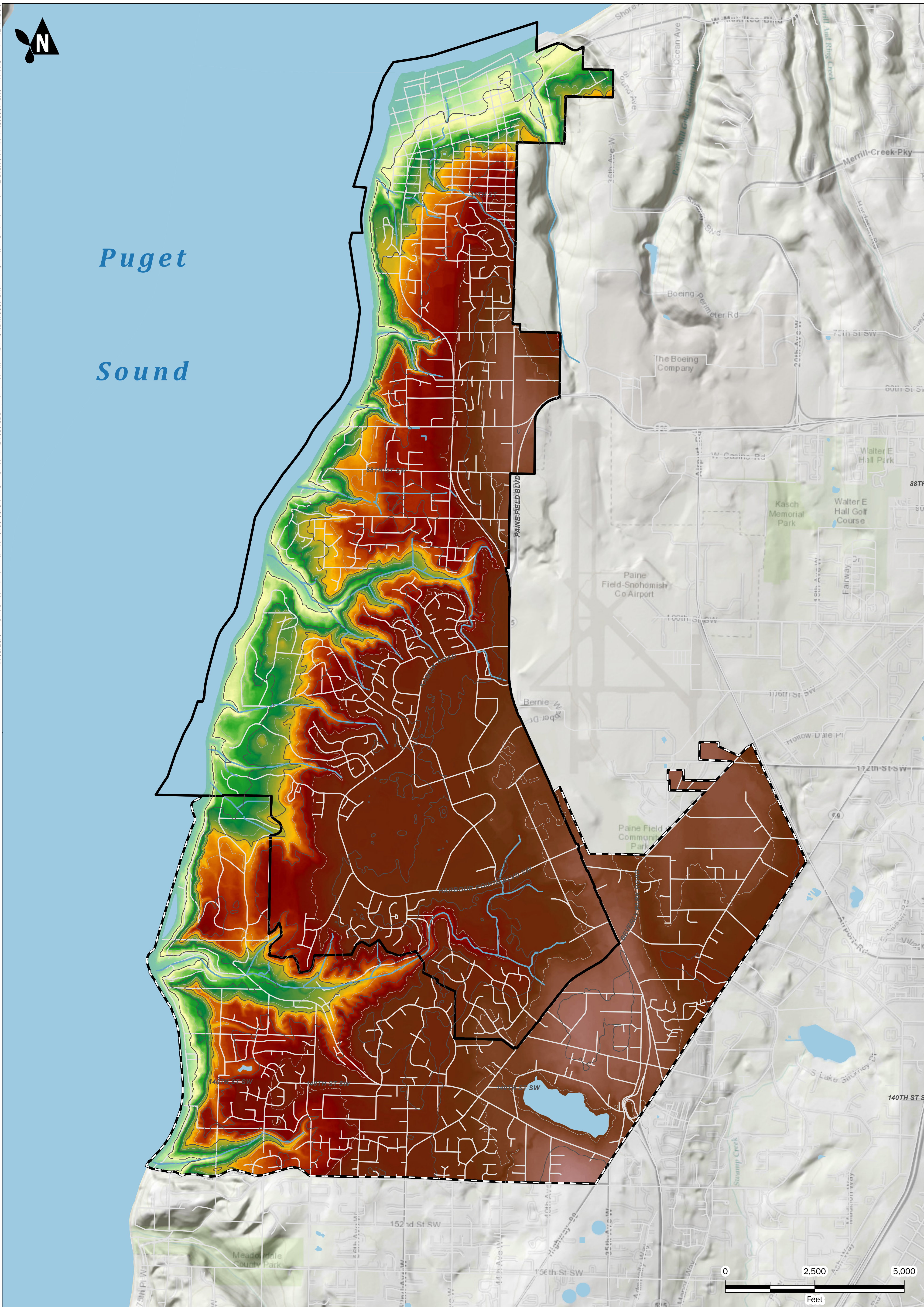
Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REVISED BY: EA / RAA	5

GIS Path: T:\projects_8\MukilteoSMP_130212\Delivered\InfiltrationStudy_RevisedParameters_Jan2015\05 Deep Infiltration Feasibility.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 1/28/2015 || User: ecrumbaker || Print Date: 1/28/2015

APPENDIX A

Infiltration Feasibility Factors

GIS Path: T:\projects_8\MukilteoSMP_130212\Working\A-1 LiDAR Elevation.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 2/24/2014 || User: ehealy || Print Date: 2/25/2014



Mukilteo City Limits
Annexation Area
100-ft Contour
50-ft Contour
Streets

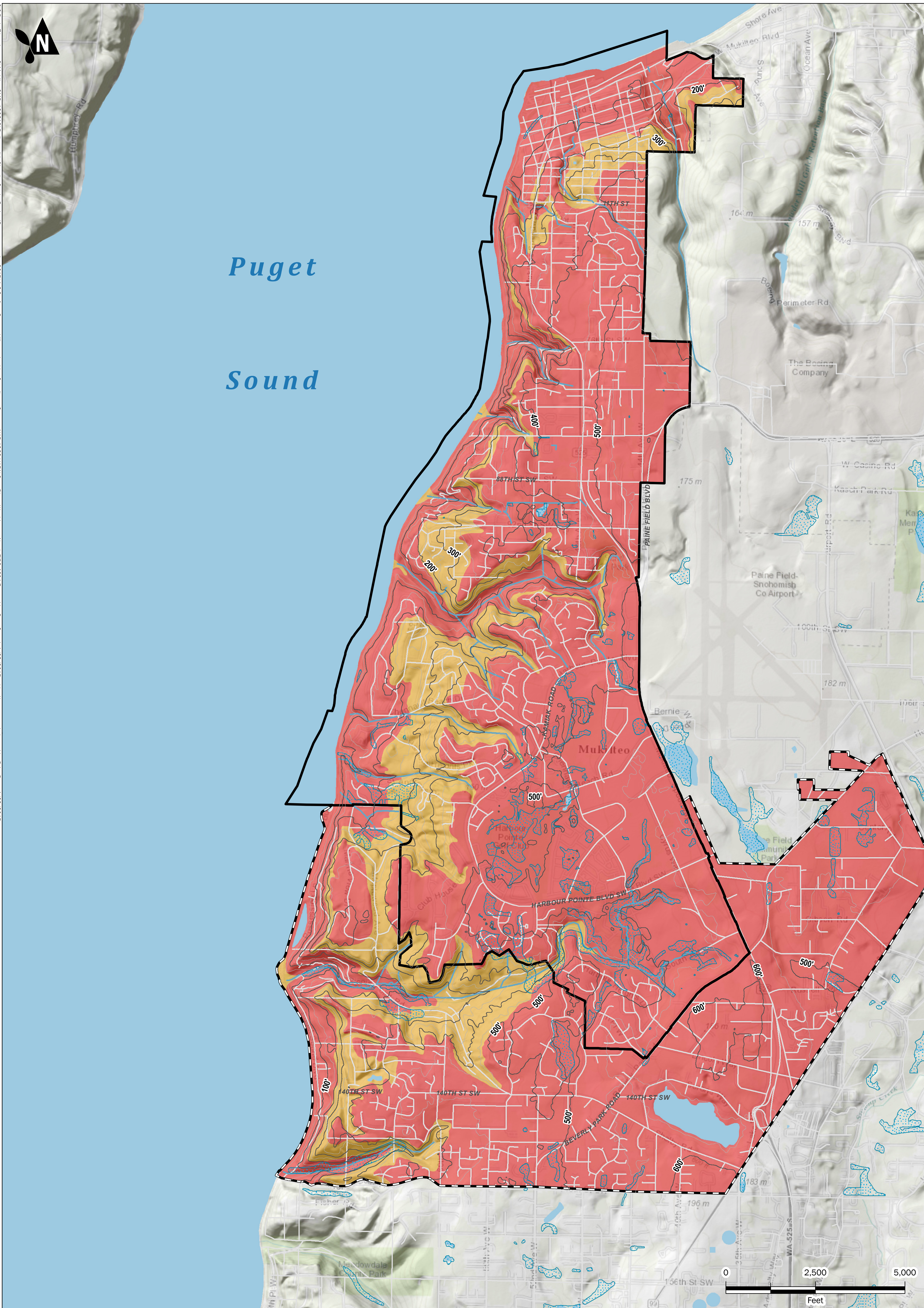
LiDAR Elevation (feet)
High : 639.56
Low : 2.81

LiDAR Elevation

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	FEB-2014	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: - - -	A-1

Basemap Layer Credits || Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, iPC, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), and the GIS User Community



Mukilteo City Limits

Annexation Area

100-ft Contour

50-ft Contour

Wetlands

Permeability

Good Permeability

Moderate Permeability

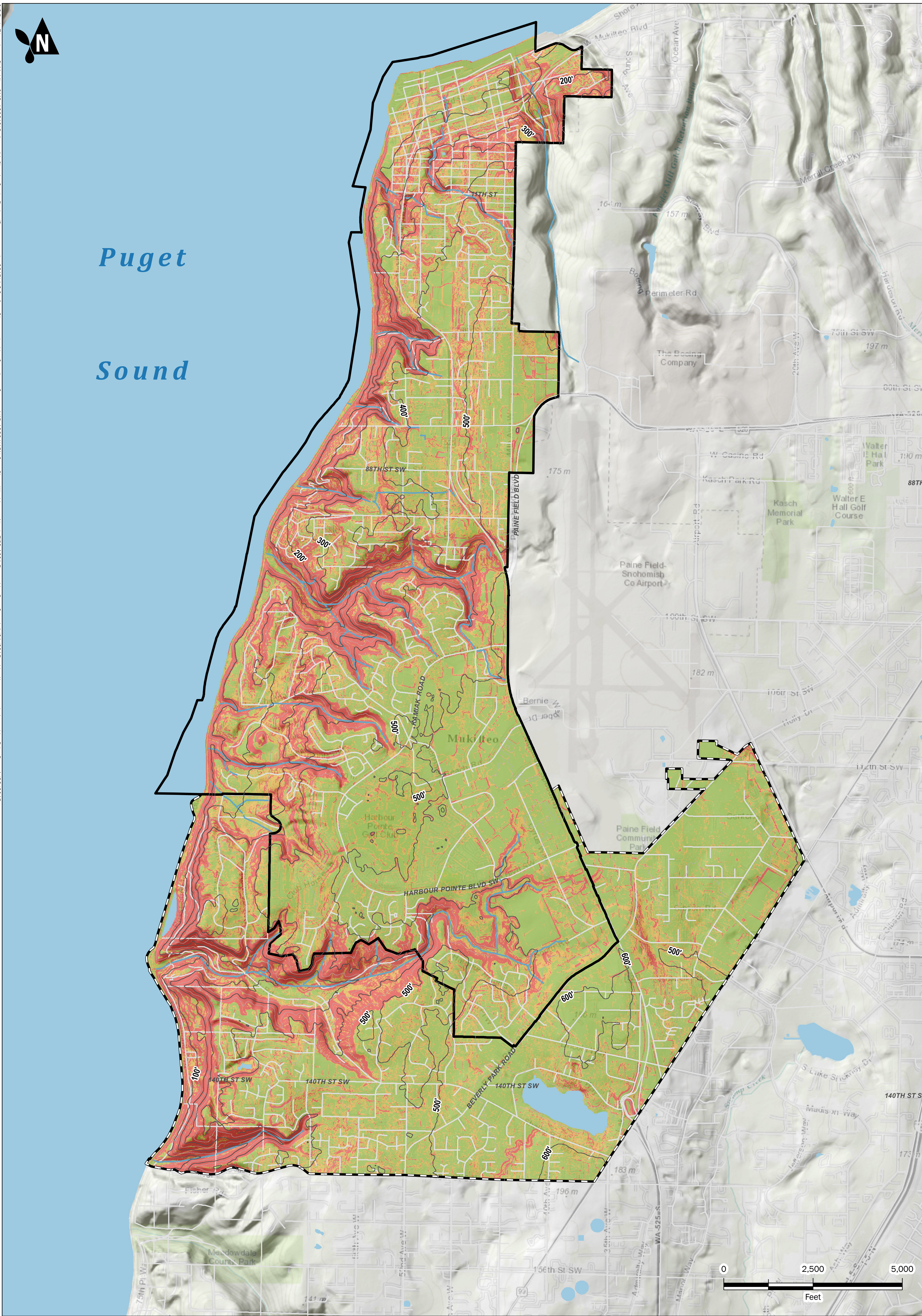
Poor Permeability

Note: No areas of good permeability were found in the study area.

Surface Permeability

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAC	FIGURE NO.
	PROJECT NO. 130212	REV BY: DHM / EAC	**A-2**



Mukilteo City Limits
Annexation Area
100-ft Contour
50-ft Contour

LiDAR-derived Percent Slope

- 0 to 8%
- 8 to 20%
- > 20%

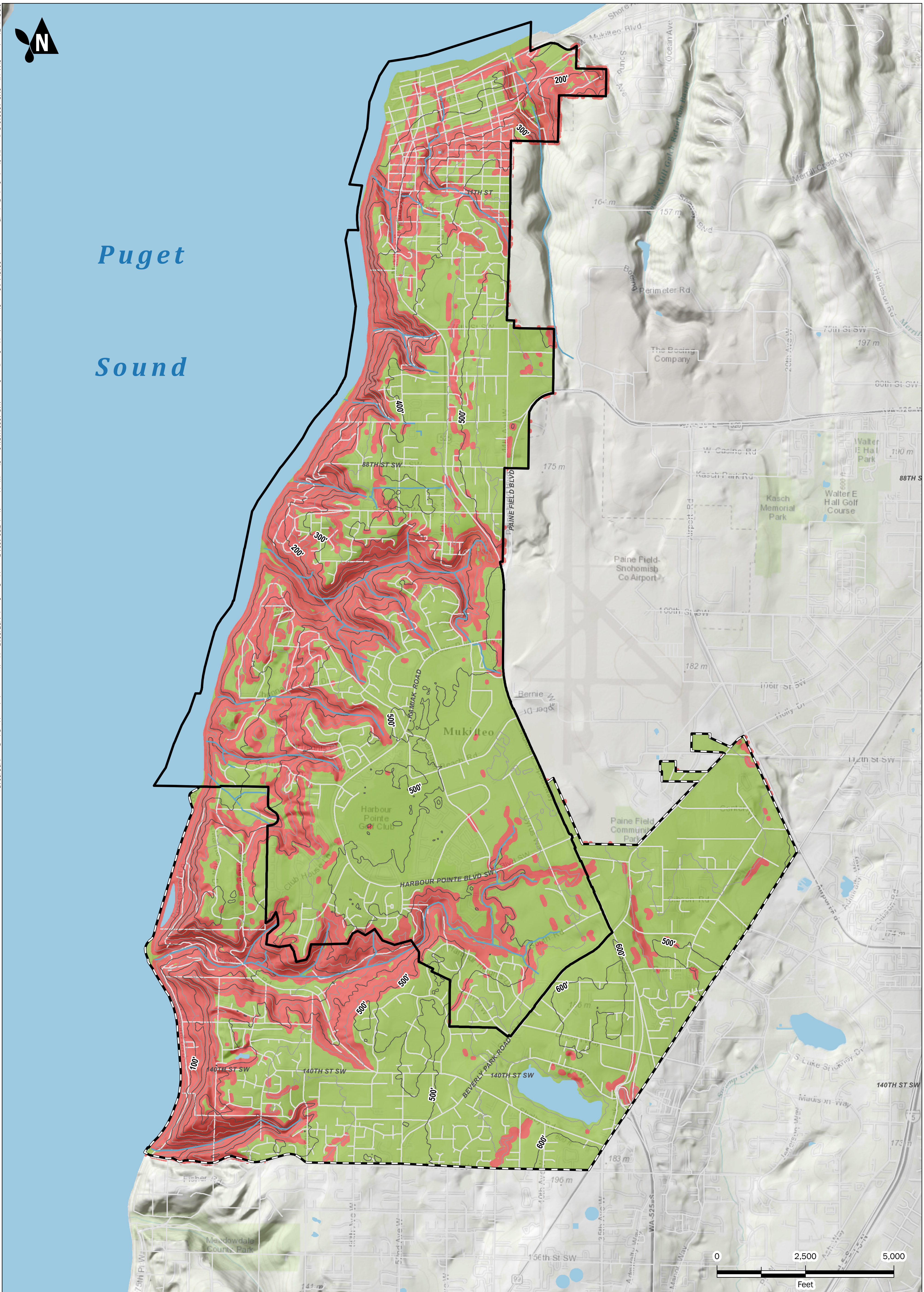
Surface Slope

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: DHM / EAC	A-3

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

GIS Path: T:\projects_8\MukilteoSMP_130212\Delivered\InfiltrationStudy_RevisedParameters_Jan2015\A-3 Surface Slope.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 1/21/2015 || User: ecrumbaker || Print Date: 1/28/2015



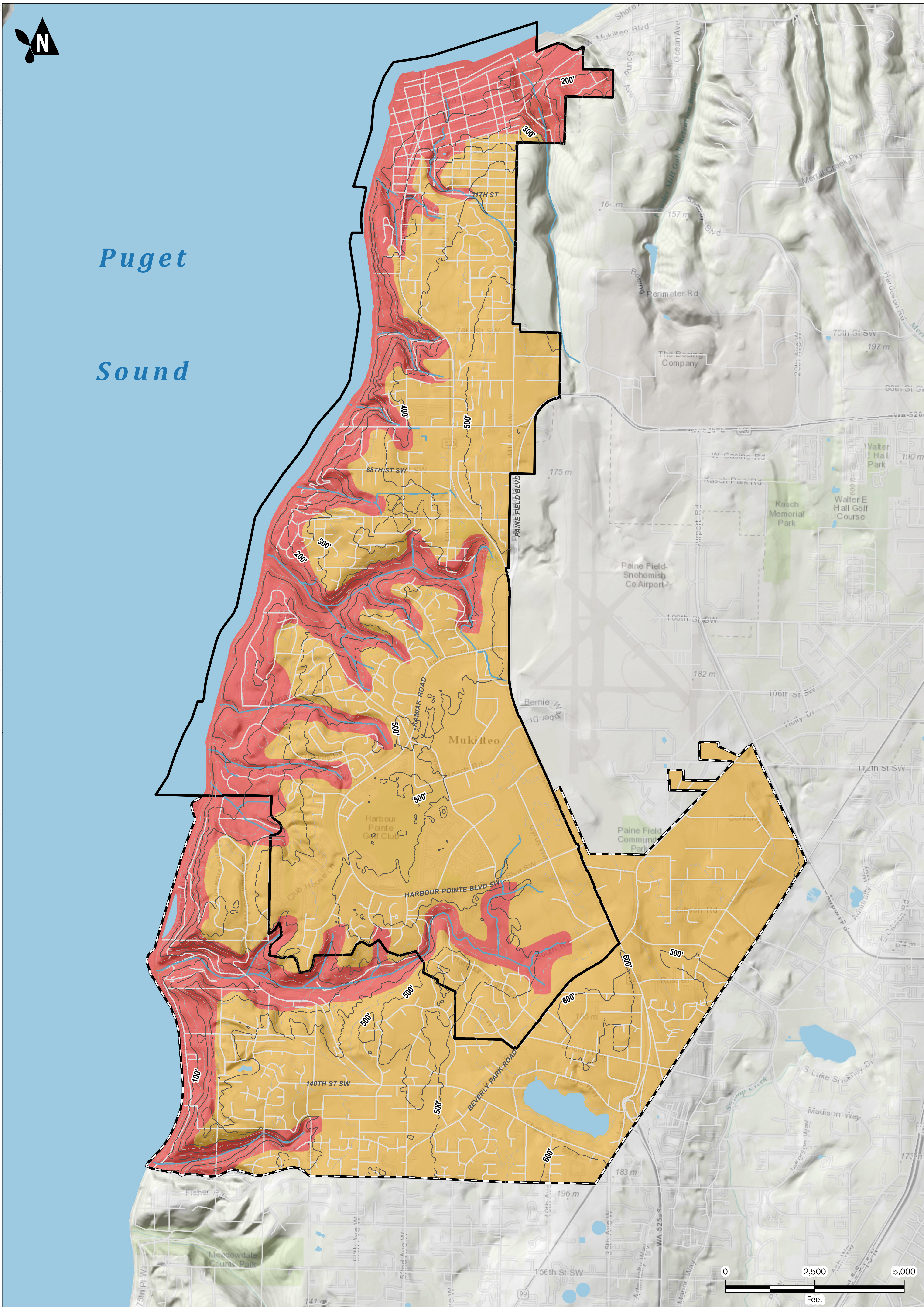
Mukilteo City Limits
Annexation Area
100-ft Contour
50-ft Contour

Steep Slope Areas
Steep Slopes
Other Areas

Steep Slope Areas

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: DHM / EAC	**A-4**



Mukilteo City Limits

Annexation Area

100-ft Contour

50-ft Contour

Deep Infiltration Receptor Horizon

High Potential for Deep Infiltration Receptor Horizon

Moderate Potential for Deep Infiltration Receptor Horizon

Low Potential for Deep Infiltration Receptor Horizon

Note: No areas of high potential were found in the study area.

Deep Infiltration Receptor Horizon

Mukilteo City-Wide Stormwater Infiltration Feasibility
Mukilteo, Washington

Aspect CONSULTING	JAN-2015	BY: HHH / EAH	FIGURE NO.
	PROJECT NO. 130212	REV BY: DHM / EAC	A-5

Basemap Layer Credits || Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

GIS Path: T:\projects_8\MukilteoSMP_130212\Delivered\InfiltrationStudy_RevisedParameters_Jan2015\A-5 Deep Infiltration Receptor.mxd || Coordinate System: NAD 1983 HARN StatePlane Washington North FIPS 4601 Feet || Date Saved: 1/28/2015 || User: ecrumbaker || Print Date: 1/28/2015

Appendix C: Preliminary Plans

NOT FOR CONSTRUCTION
CONCEPTUAL DESIGN PRE-DESIGN PHASE

Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: CLB
DRAWN: HDO
CHECKED:
CHECKED:
APPROVED:

FILENAME
145357-EXH-01.DWG
BC PROJECT NUMBER
145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT
G1300137

SITE 1
STAYBRIDGE SUITES
POND RETROFIT
PLAN - 1

DRAWING NUMBER
EXHIBIT 1

SHEET NUMBER
1 OF 7

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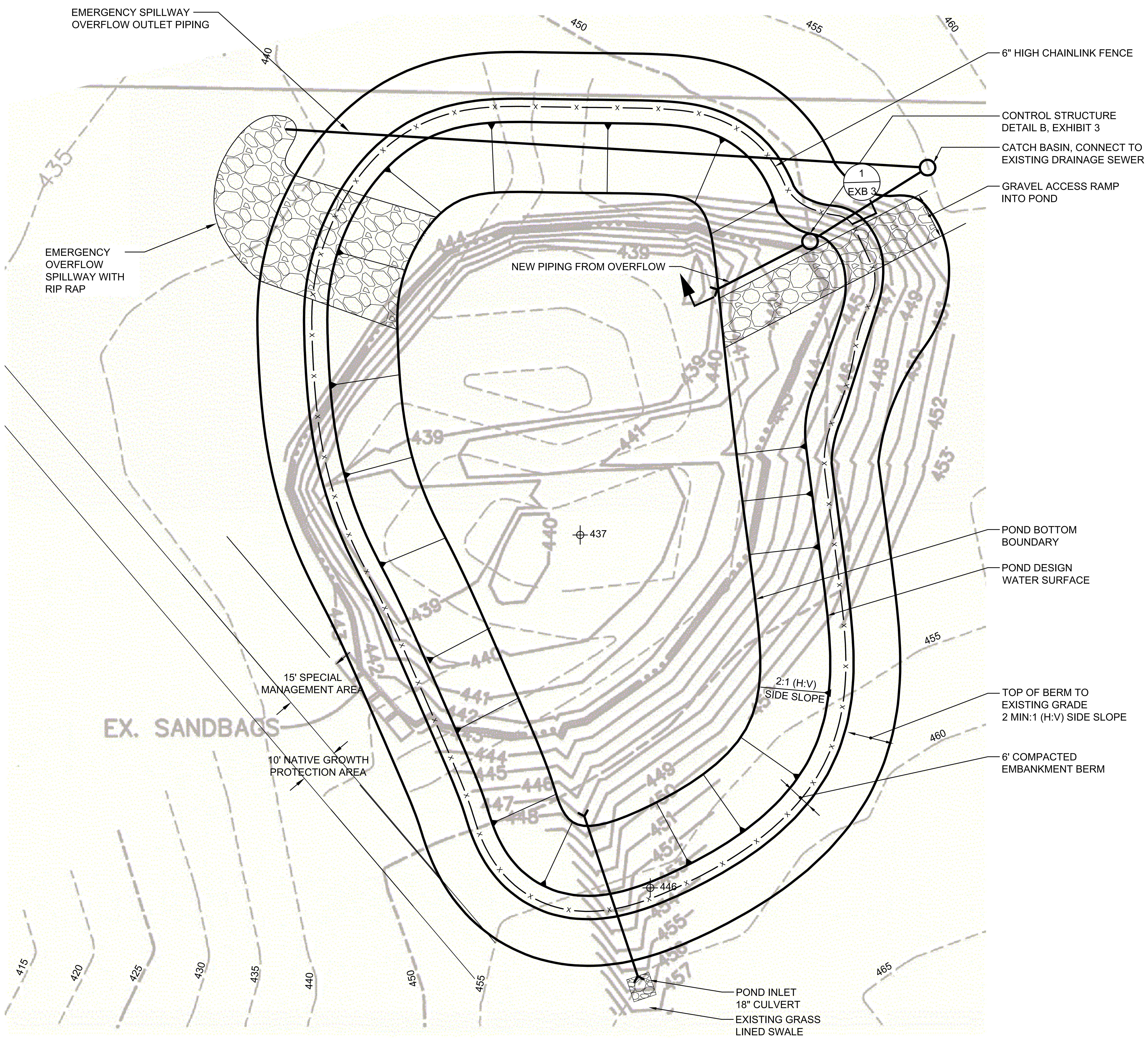
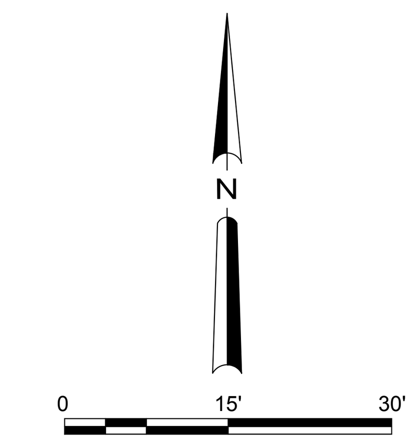
STAYBRIDGE.jpg
StaybridgeNear.jpg





NOTES:

1. HYDROSEED POND BOTTOM AND SIDE SLOPES.
2. PREDESIGN BASED ON ORIGINAL POND AS-BUILT INFORMATION. SURVEY DATA NEEDED FOR DETAILED DESIGN.

NOT FOR CONSTRUCTION
CONCEPTUAL DESIGN PRE-DESIGN PHASE

Brown AND Caldwell

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS

REV	DATE	DESCRIPTION

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DRAWN: HDO
CHECKED:
CHECKED:
APPROVED:

FILENAME 145357-EXH-02.DWG
BC PROJECT NUMBER 145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT G1300137

SITE 1 STAYBRIDGE SUITES POND RETROFIT PLAN - 2

DRAWING NUMBER
EXHIBIT 2

SHEET NUMBER 2 OF 7

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MUKILTEO LOGO 2.jpg
Detention Pond behind Staybridge 1_20140917_0001.jpg

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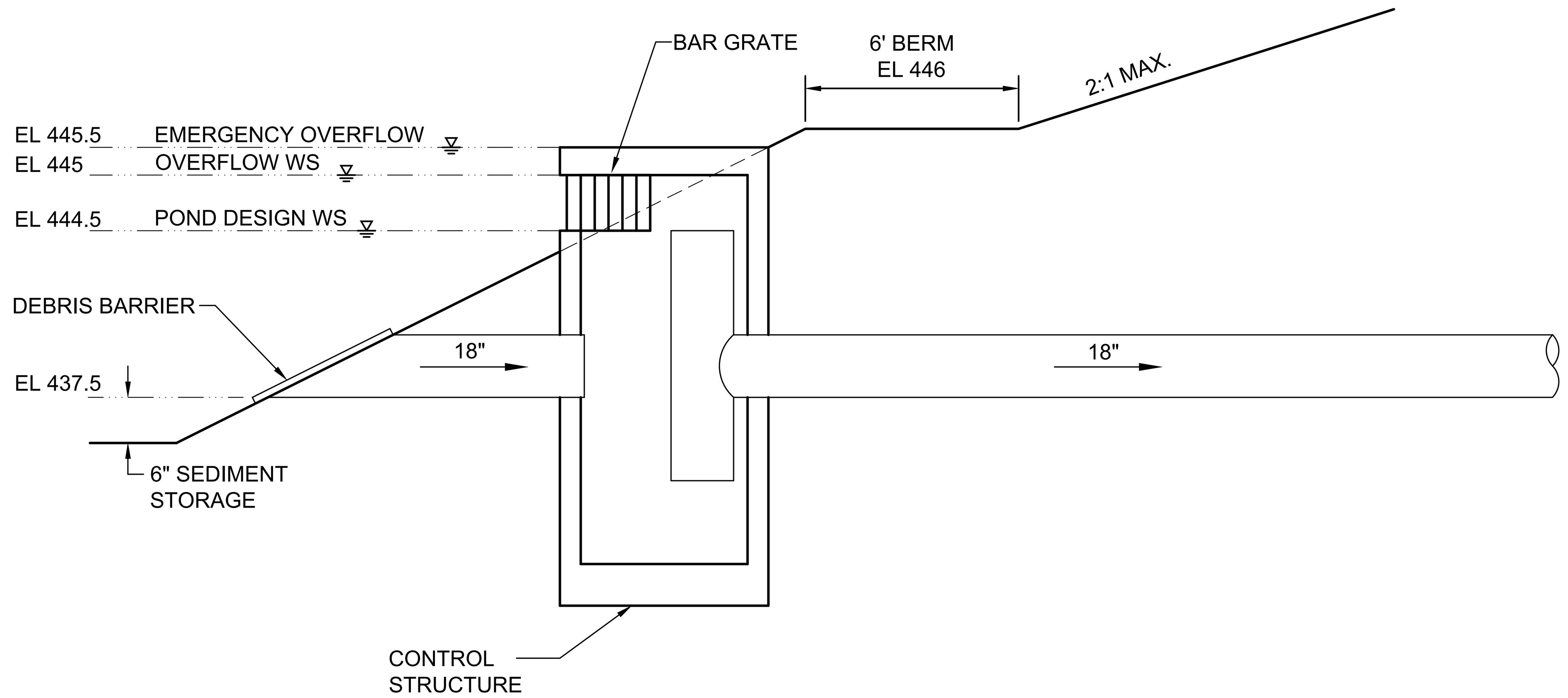
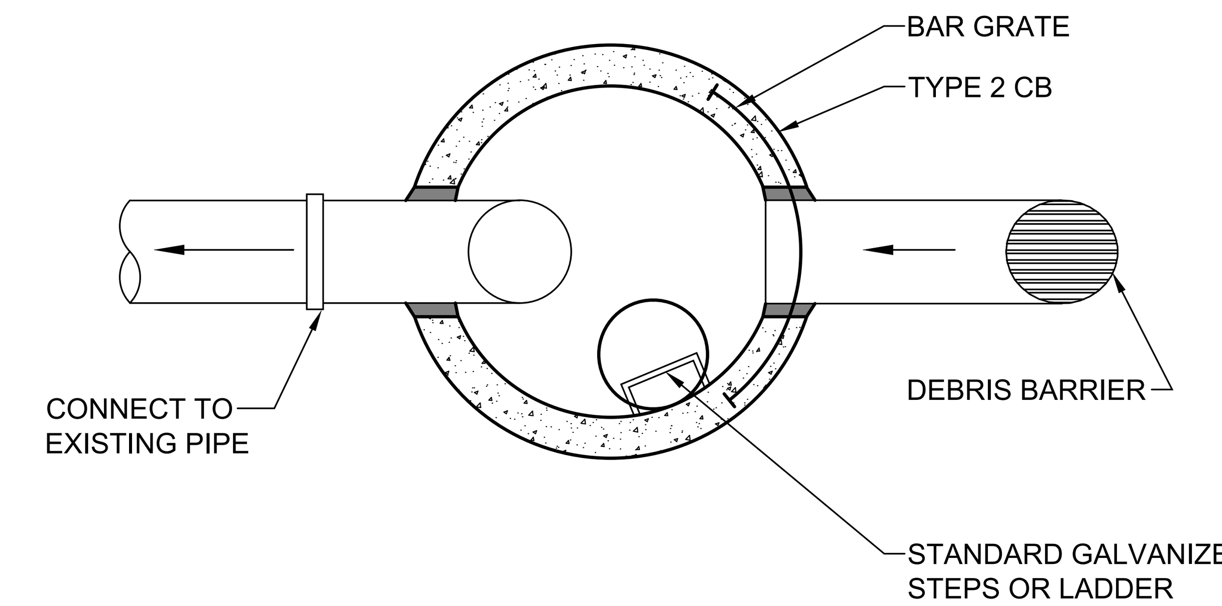
MUKILTEO LOGO 2.jpg

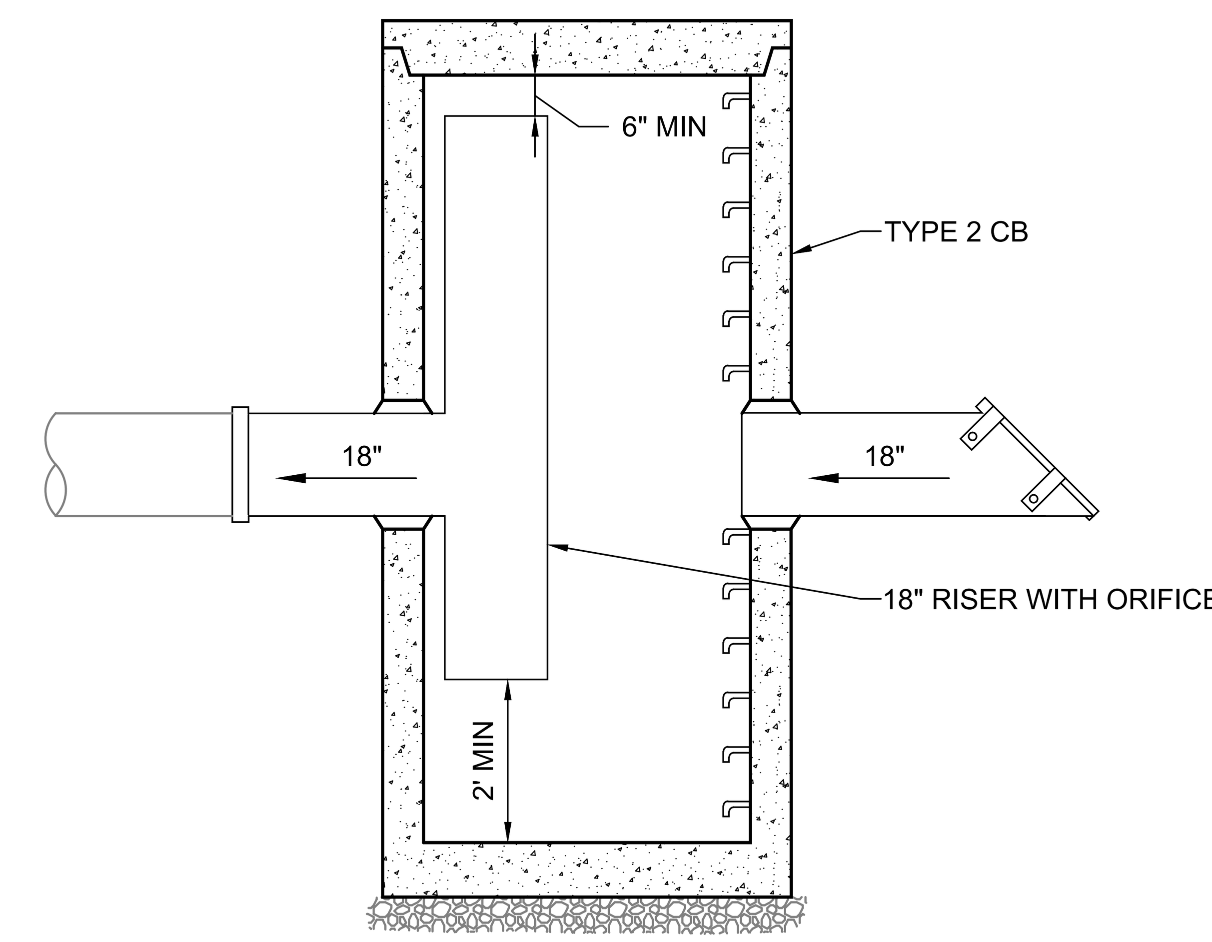


DETENTION POND SECTION

SECTION 1 / EXB 2

NO SCALE





CONTROL STRUCTURE

DETAIL A / EXB 2

NO SCALE

NOT FOR CONSTRUCTION
CONCEPTUAL DESIGN PRE-DESIGN PHASE

Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: KW
DRAWN: HDO
CHECKED: CLB
CHECKED:
APPROVED:

FILENAME
145357-EXH-03.DWG
BC PROJECT NUMBER
145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT
G1300137

SITE 1
STAYBRIDGE SUITES
POND RETROFIT
DETAILS

DRAWING NUMBER
EXHIBIT 3

SHEET NUMBER
3 OF 7

Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS

REV	DATE	DESCRIPTION

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DRAWN: HDO
CHECKED:
CHECKED:
APPROVED:

FILENAME
145357-EXH-04.DWG
BC PROJECT NUMBER
145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT
G1300137

SITE 2
HARBOUR POINTE M.S. BIORETENTION PLAN

DRAWING NUMBER
EXHIBIT 4

SHEET NUMBER
4 OF 7

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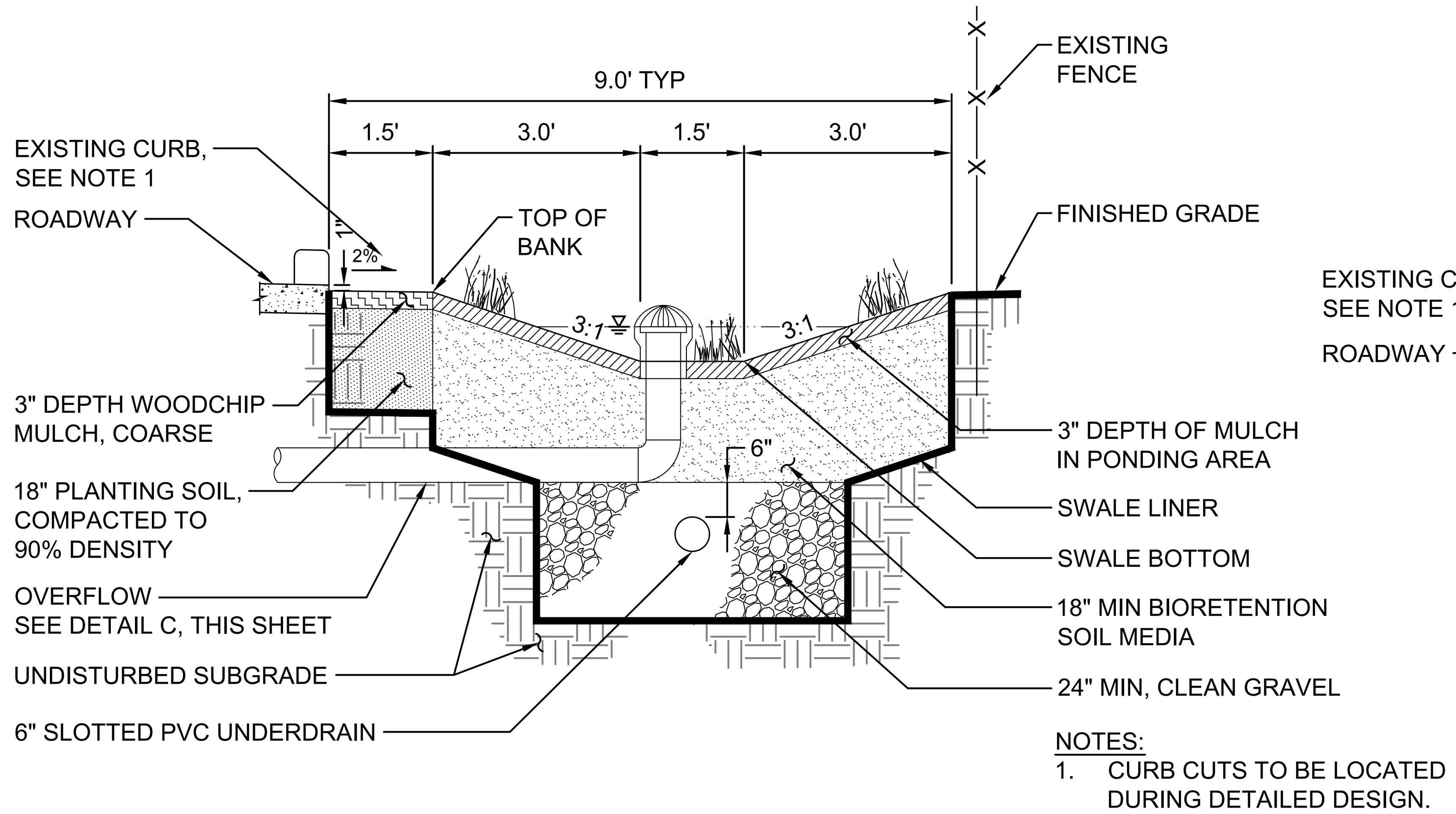
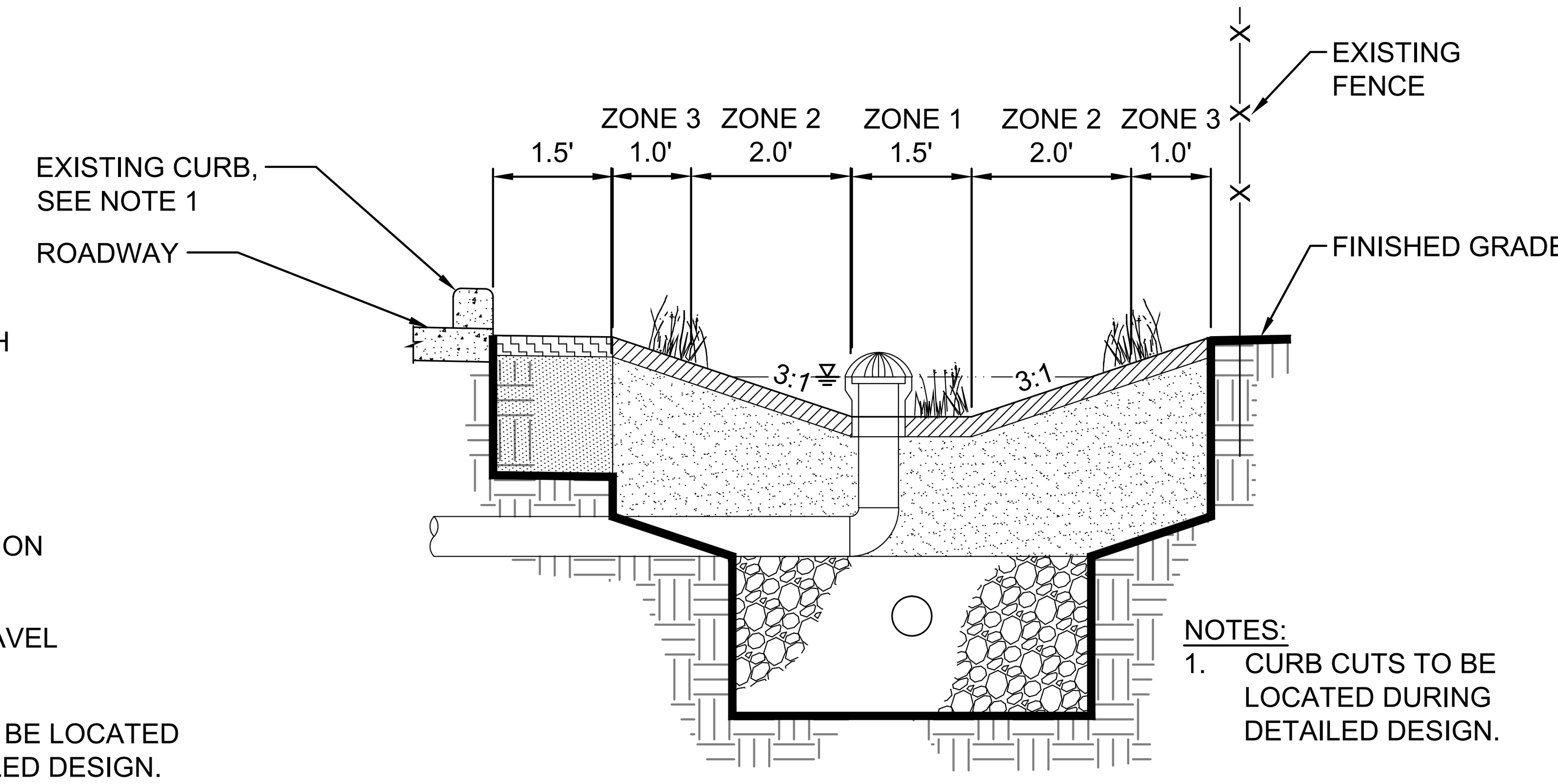
MUKILTEO LOGO 2.jpg



HARBOUR POINTE MIDDLE SCHOOL WB1
BIORETENTION SWALE TYPICAL SECTION

DETAIL A / EXB 4

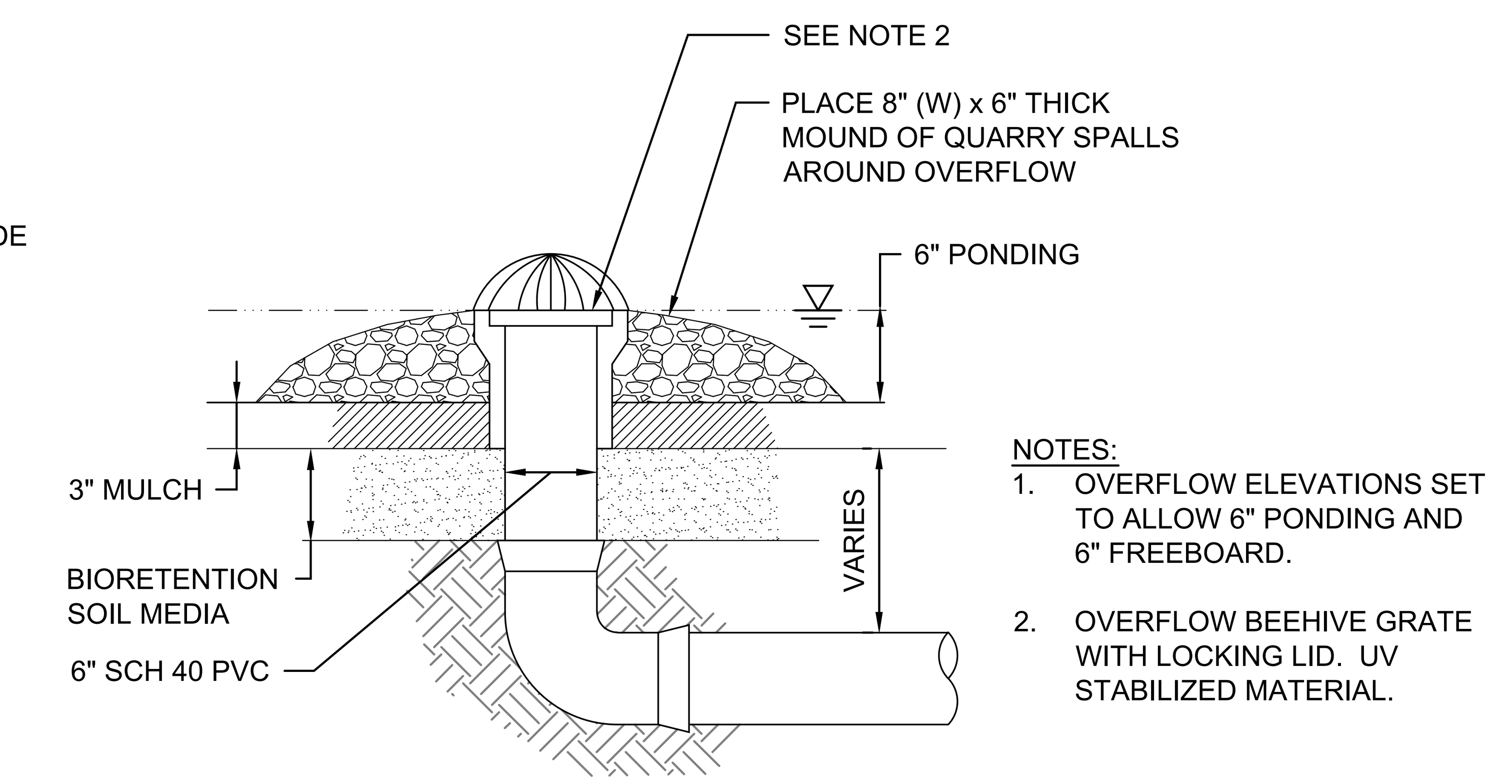
NO SCALE



HARBOUR POINTE MIDDLE SCHOOL WB1
TYPICAL PLANTING SECTION

DETAIL B / EXB 4

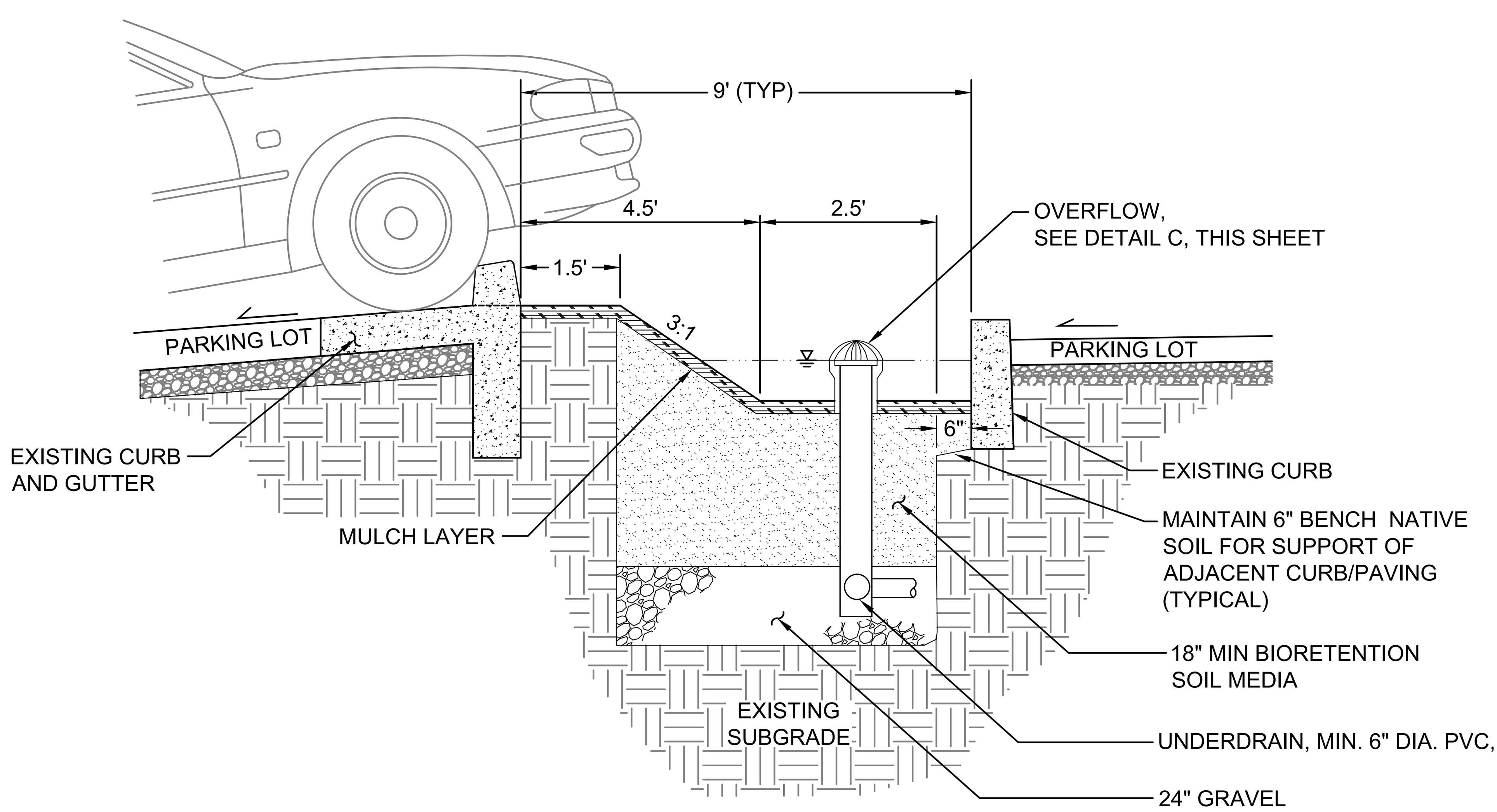
NO SCALE



OVERFLOW

DETAIL C / EXB 4

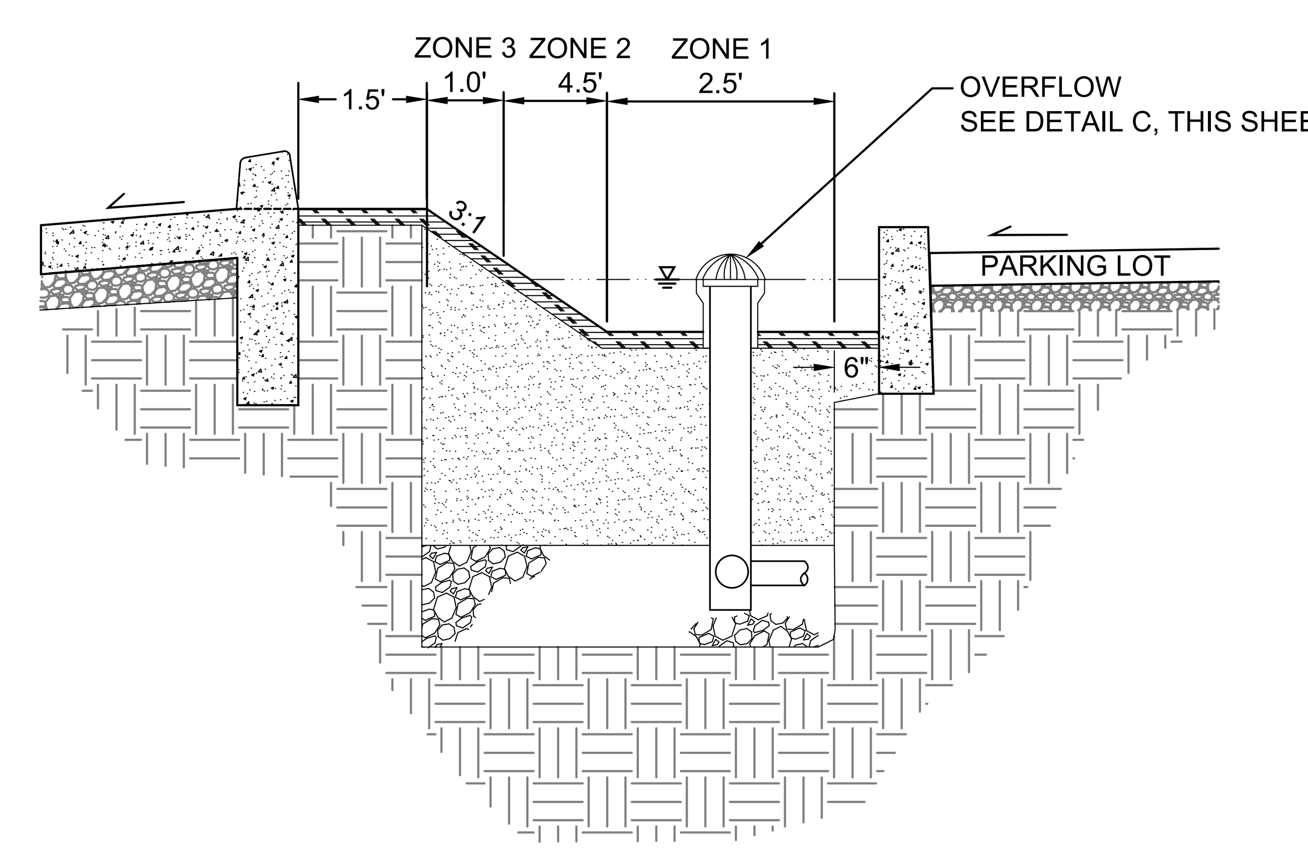
NO SCALE



HARBOUR POINTE MIDDLE SCHOOL EB1, EB2
BIORETENTION PLANTER TYPICAL SECTION

DETAIL D / EXB 4

NO SCALE



HARBOUR POINTE MIDDLE SCHOOL EB1, EB2
TYPICAL PLANTING SECTION

DETAIL E / EXB 4

NO SCALE

NOT FOR CONSTRUCTION
CONCEPTUAL DESIGN PRE-DESIGN PHASE

Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS

REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: KW
DRAWN: HDO
CHECKED: CLB
CHECKED:
APPROVED:

FILENAME 145357-EXH-05.DWG
BC PROJECT NUMBER 145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT G1300137

SITE 2
HARBOUR POINTE M.S. BIORETENTION DETAILS

DRAWING NUMBER
EXHIBIT 5

SHEET NUMBER 5 OF 7

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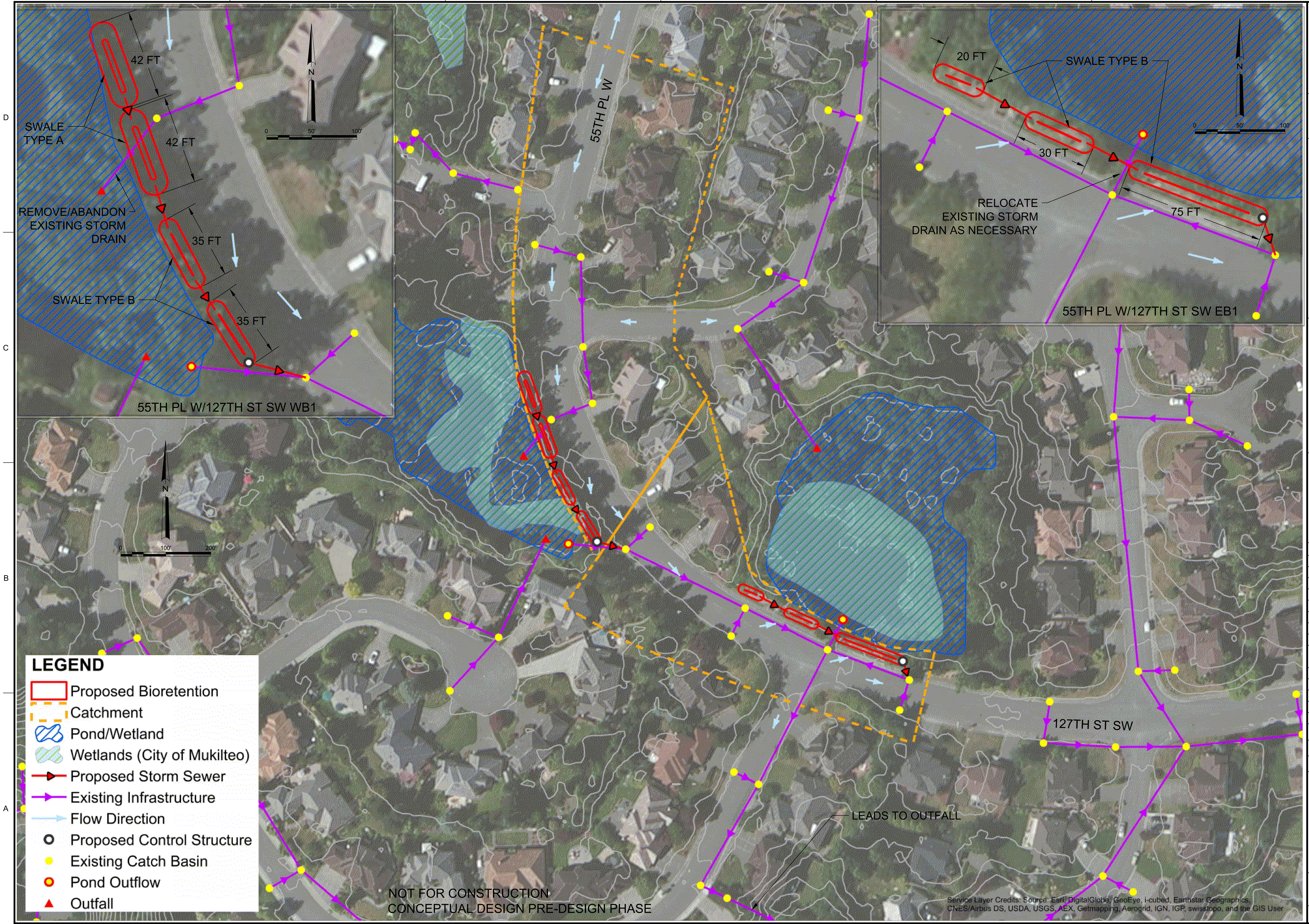
MUKILTEO LOGO 2.jpg



Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS		
REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: CLB
DRAWN: HDO
CHECKED:
CHECKED:
APPROVED:

FILENAME 145357-EXH-06.DWG
BC PROJECT NUMBER 145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT G1300137

SITE 3
55TH PL W /127TH ST SW BIORETENTION PLAN

DRAWING NUMBER
EXHIBIT 6

SHEET NUMBER
6 OF 7

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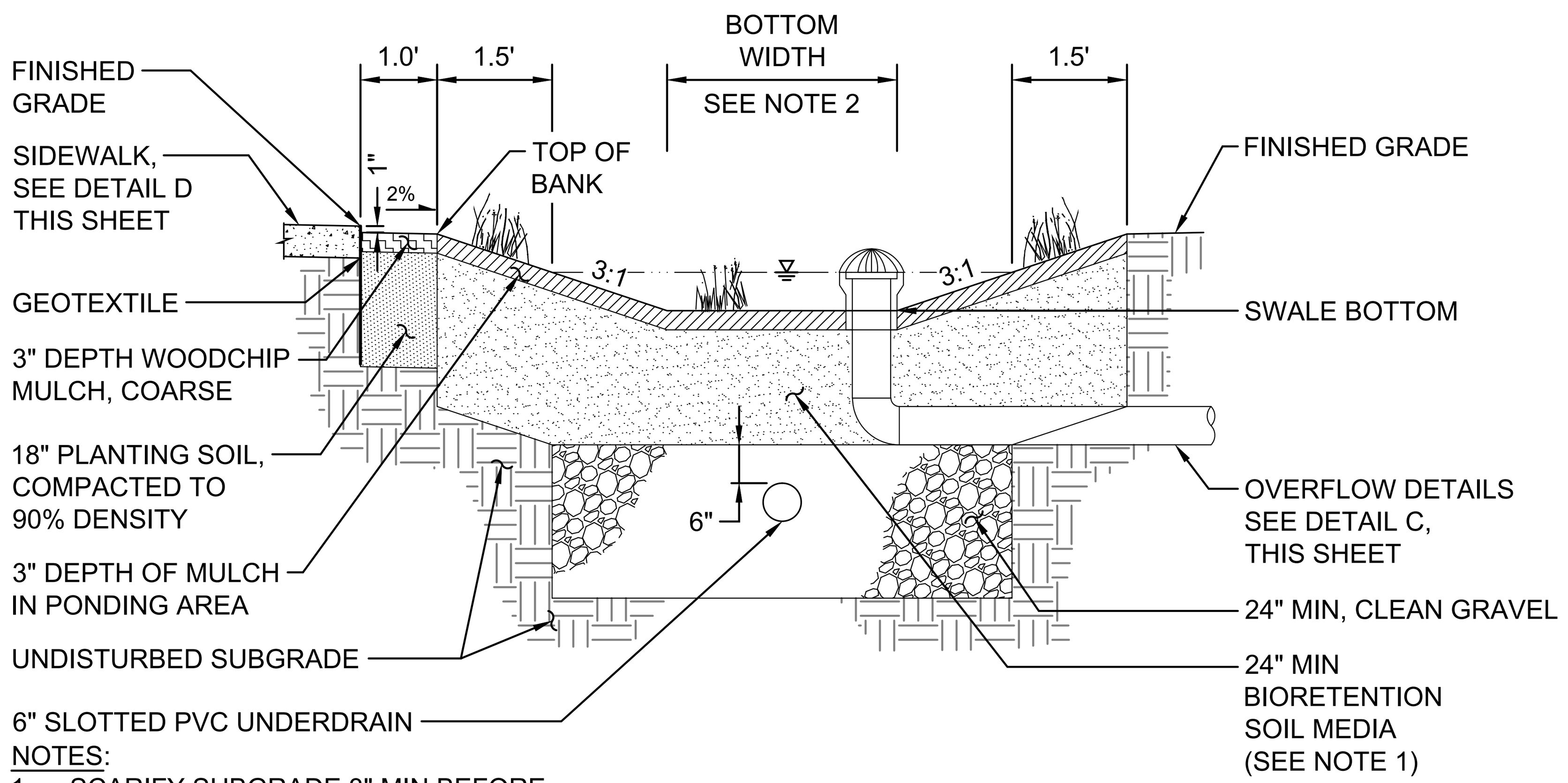
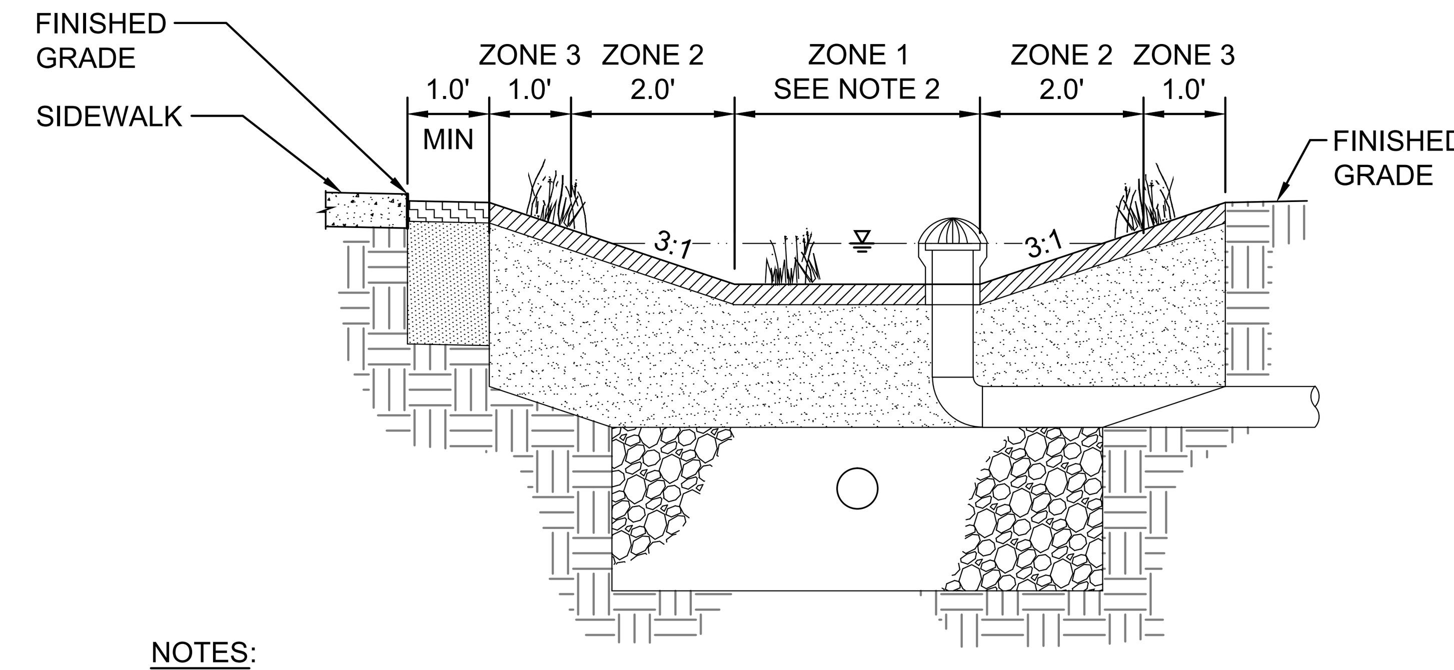


NOTES:
1. SCARIFY SUBGRADE 3" MIN BEFORE BIORETENTION SOIL MEDIA INSTALLATION.
2. SWALE TYPE A: 6.0 FT BOTTOM WIDTH
SWALE TYPE B: 3.0 FT BOTTOM WIDTH

55TH PL W/127TH ST SW
BIORETENTION SWALE SECTION TYPE A AND B

DETAIL A / EXB 6

NO SCALE

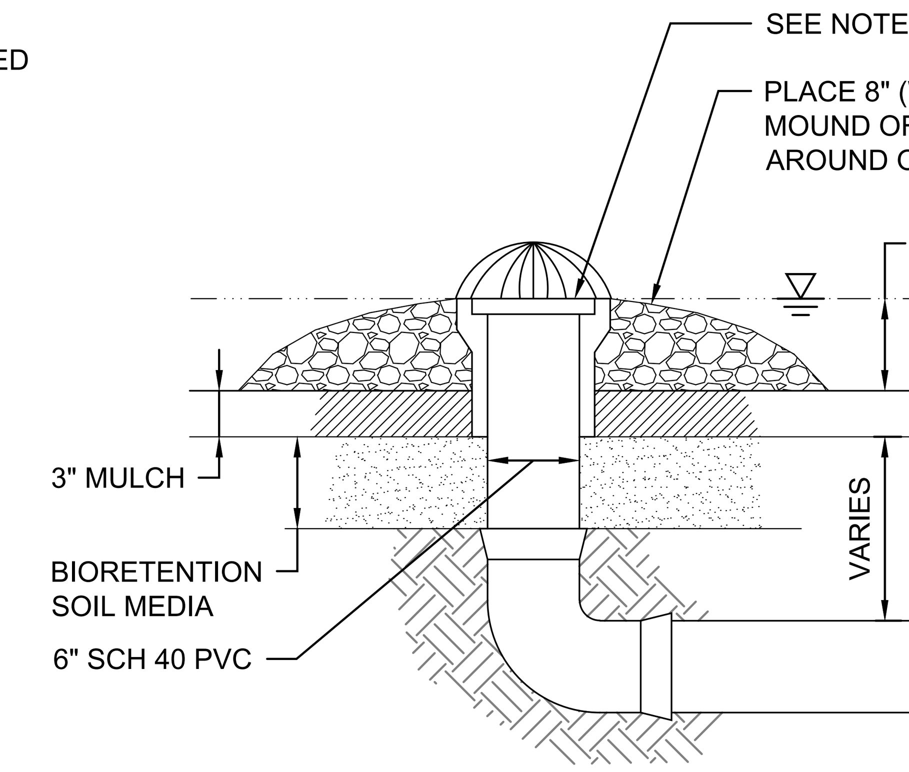


NOTES:
1. PLANTS SELECTED DURING DESIGN SHALL BE ACCORDING TO ZONE CHARACTERISTICS AND SITE LOCATION.
2. SWALE TYPE A: 6.0 FT BOTTOM WIDTH
SWALE TYPE B: 3.0 FT BOTTOM WIDTH

55TH PL W/127TH ST SW
PLANTING SECTION TYPE A AND B

DETAIL B / EXB 6

NO SCALE

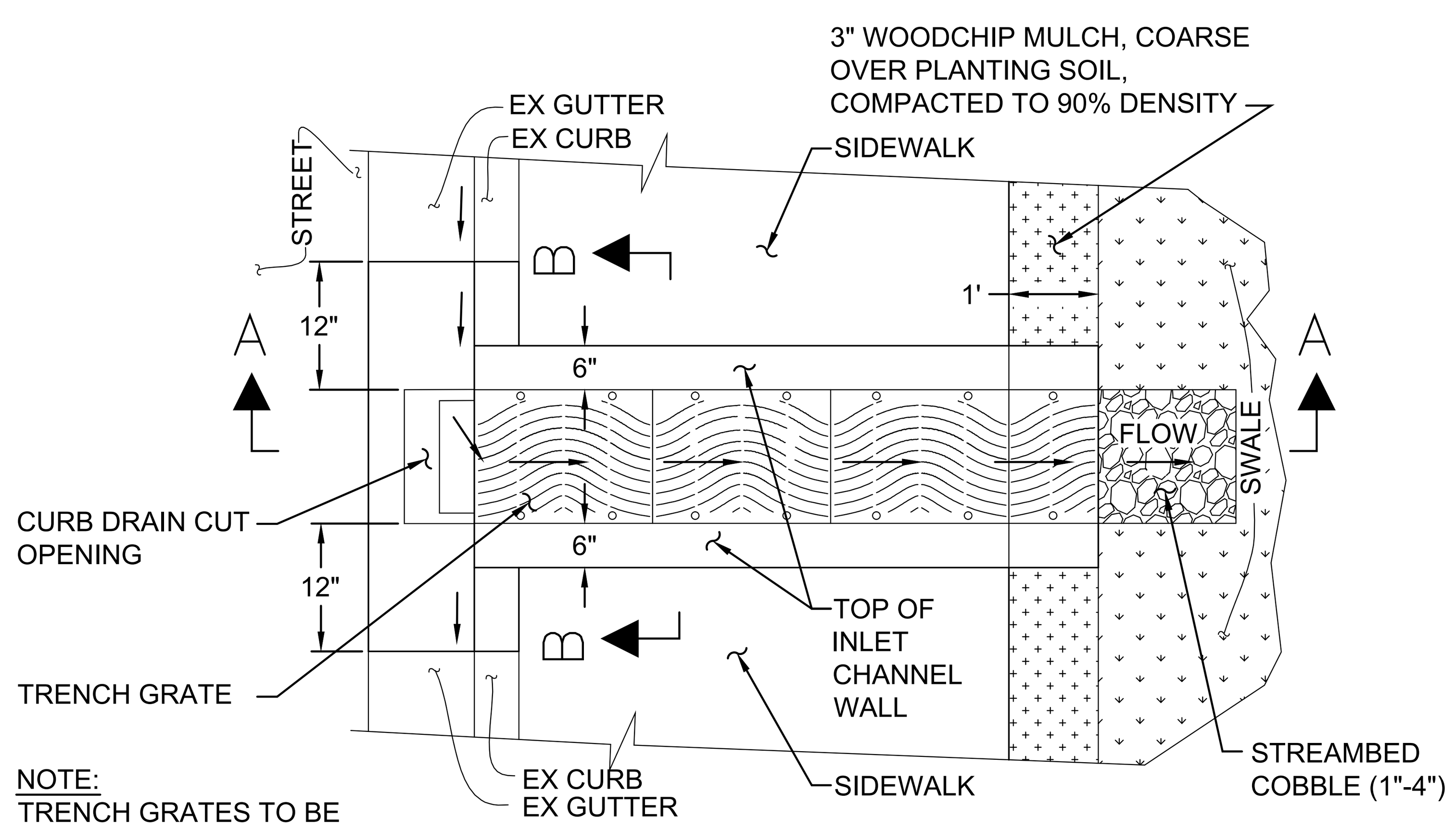


NOTES:
1. OVERFLOW ELEVATIONS SET TO ALLOW 6" PONDING AND 6" FREEBOARD.
2. OVERFLOW BEEHIVE GRATE WITH LOCKING LID. UV STABILIZED MATERIAL.

OVERFLOW

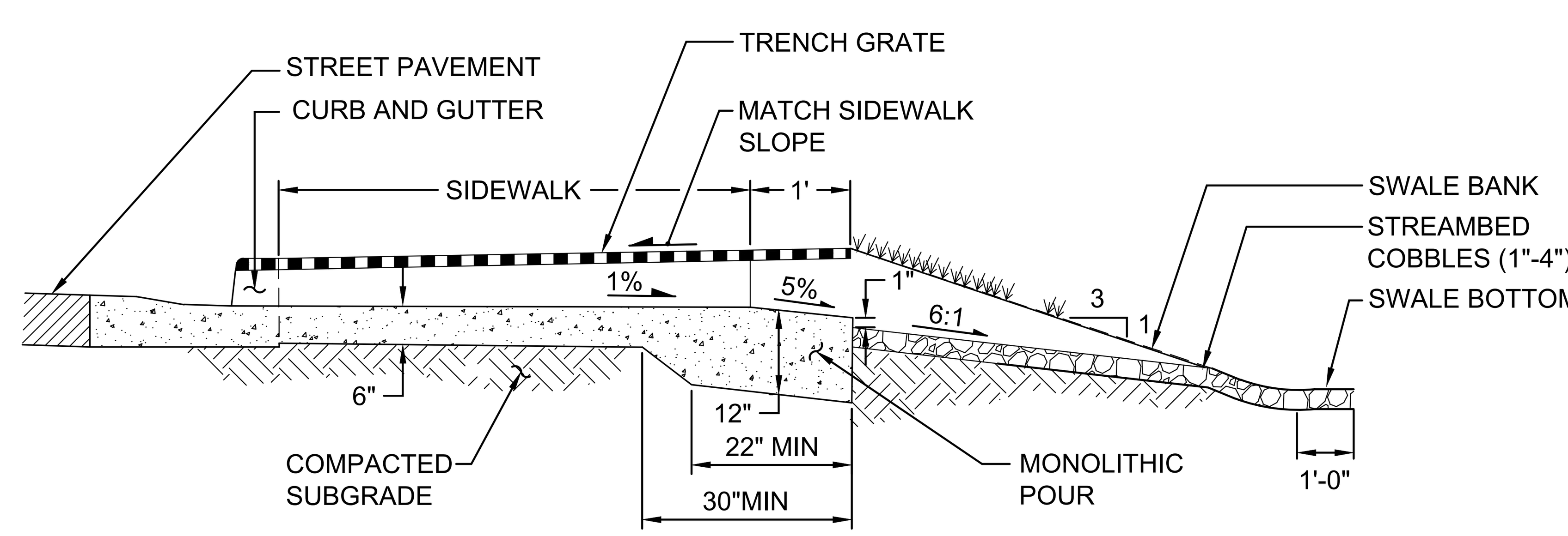
DETAIL C / EXB 6

NO SCALE

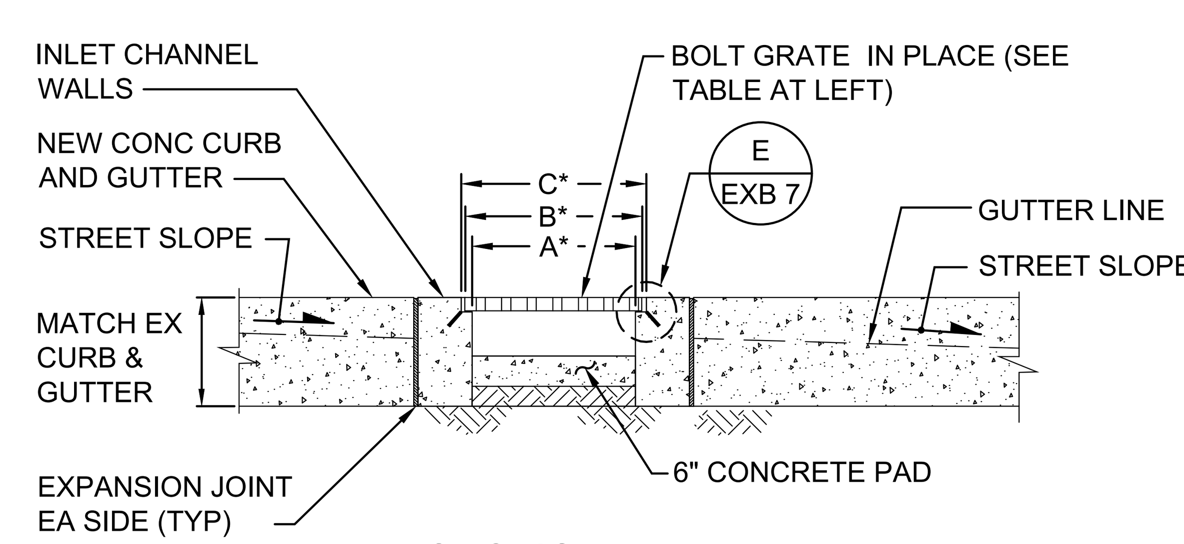


NOTE:
TRENCH GRATES TO BE LOCATED DURING DETAILED DESIGN

PLAN



SECTION A-A



SECTION B-B

*TRENCH GRATING

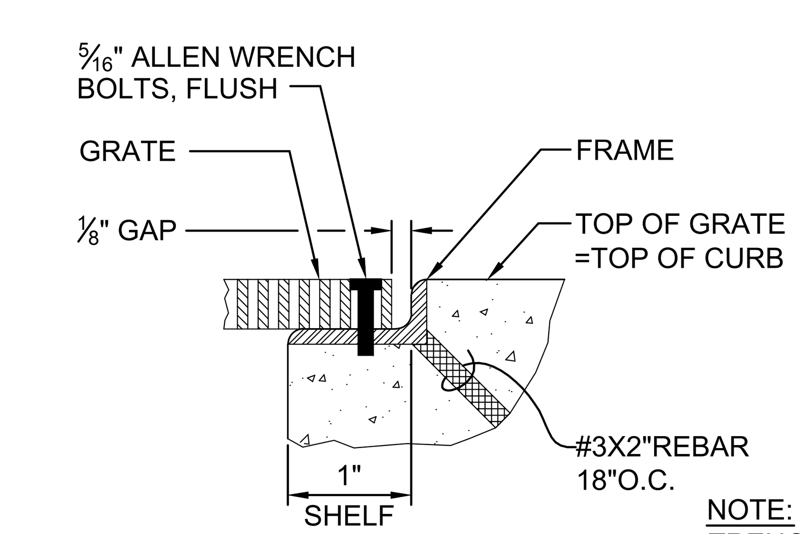
A* TRENCH WIDTH	B* GRATE WIDTH	C* FRAME WIDTH
16"	17⅞"	18⅛"

NOTE:
MAXIMUM GRATE HOLE WIDTH (OPEN) ¼". CAST IRON URBAN ACCESSORIES TRENCH GRATE AND FRAME. TIDAL WAVE MODEL OR EQUAL. SEE DETAIL E THIS SHEET.

CONCRETE INLET CHANNEL & GRATE

TYPICAL DETAIL D / EXB 7

NO SCALE



NOTE:
TRENCH GRATES TO BE LOCATED DURING DETAILED DESIGN

GRATING & FRAME

TYPICAL DETAIL E / EXB 7

NO SCALE

NOT FOR CONSTRUCTION
CONCEPTUAL DESIGN PRE-DESIGN PHASE

Brown AND Caldwell

City of Mukilteo

MUKILTEO WATERSHED-BASED STORMWATER RETROFIT PLAN

REVISIONS		
REV	DATE	DESCRIPTION

LINE IS 2 INCHES AT FULL SIZE

DESIGNED: KW
DRAWN: HDO
CHECKED: CLB
CHECKED:
APPROVED:

FILENAME 145357-EXH-07.DWG
BC PROJECT NUMBER 145357
CLIENT PROJECT NUMBER

ECOLOGY GRANT G1300137

SITE 3
55TH PL W /127TH ST SW BIORETENTION DETAILS

DRAWING NUMBER
EXHIBIT 7

SHEET NUMBER
7 OF 7

Path: \\BCSEA06\PROJECTS\MUKILTEO\145357 - MUKILTEO SW MGMT PLAN_CAD\2-SHEETS\C-CIVIL FILENAME: 145357-EXH-07.DWG PLOT DATE: 1:10 PM CAD USER: WOOD, KIRSTEN
MUKILTEO LOGO 2.jpg

Appendix D: Cost Estimate Details

Mukilteo Stormwater Retrofit Predesign | Prepared By: K Wood | Date: 12/5/2014
Site 1 - Staybridge Suites Pond | Checked By: C Boyle/J Paulson

Item No.	Bid Item	Unit	Quantity	Unit Cost*	Total Cost
1	Mobilization	LS	1	$22,046	$22,046
2	Erosion/Water Pollution Control	LS	1	$5,000	$5,000
3	Project Temporary Traffic Control	LS	1	$1,000	$1,000
4	SPCC Plan	LS	1	$1,000	$1,000
5	Clearing and Grubbing	LS	1	$10,000	$10,000
6	Removal of Structures and Obstructions	LS	1	$8,000	$8,000
7	Excavation Incl. Haul	CY	5500	$24	$132,000
8	Common Borrow Incl. Haul	CY	1620	$8	$12,960
9	Chain Link Fence, Type 3, 6'	LF	820	$20	$16,400
10	Schedule A Storm Sewer Pipe 18 In. Diam.	LF	60	$80	$4,800
11	Catch Basin Type 2 60 In. Diam.	EA	1	$7,000	$7,000
12	Catch Basin Type 2 48 In. Diam. With Flow Contrl	EA	1	$5,000	$5,000
13	Riprap for Overflow	TON	30	$55	$1,650
14	Hydroseed	AC	1	$3,000	$3,000
15	Plain Conc. Culv. Pipe 18 In. Diam.	LF	50	$50	$2,500
16	Stormwater Bypass	LS	1	$5,000	$5,000
17	Stone Inlet Protection	CY	5	$200	$1,000
18	Crushed Surfacing Top Course (for Access Road)	CY	105	$30	$3,150
19	Restoration	LS	1	$1,000	$1,000
	SUBTOTAL				$242,506

*Unit costs include materials, labor, equipment, contractor overhead and profit, bonds, permits and liability insurance.

Sub-Total:			$242,506
WA State Sales Tax	9.5%	$23,038	
Sub-Total:			$265,544
Contingency	40%	$106,218	
Sub-Total:			$371,762
Environmental Permitting	20%		$74,352
Engineering Design and Administration	35%		$130,120
TOTAL			**$577,000**

Mukilteo Stormwater Retrofit Predesign
Site 2 - Harbour Point Middle School

Prepared By: K Wood   Date: 12/5/2014
Checked By: C Boyle/J Paulson

Item No.	Bid Item	Unit	Quantity	Unit Cost*	Total Cost
1	Mobilization	LS	1	$13,171	$13,171
2	Erosion/Water Pollution Control	LS	1	$5,000	$5,000
3	SPCC Plan	LS	1	$1,000	$1,000
4	Project Temporary Traffic Control	LS	1	$2,000	$2,000
5	Clearing and Grubbing	LS	1	$2,000	$2,000
6	Removal of Structures and Obstructions	LS	1	$5,000	$5,000
7	Solid Wall PVC Storm Sewer Pipe 6 In. Diam. (overflow)	LF	200	$25	$5,000
8	Underdrain Pipe 6" Diam. (slotted pvc sch 40)	LF	600	$20	$12,000
9	6" Beehive Grate on Overflow	EA	6	$160	$960
10	Schedule A Storm Sewer Pipe 12 In. Diam.	LF	100	$40	$4,000
11	Quarry Spalls	CY	10	$100	$1,000
12	Bioretention Soil Media	CY	215	$50	$10,771
13	Topsoil Type A- Planting Soil	SY	70	$35	$2,450
14	Woodchip Mulch, Coarse	SY	440	$7	$3,080
15	Mulch, Fine	SY	70	$7	$490
16	Gravel Backfill for Drain	CY	80	$40	$3,200
17	Plants	LS	1	$12,000	$12,000
18	Plant Establishment -Second Year	EST	1	$15,000	$15,000
19	Curb Cuts (in existing curb)	EA	80	$100	$8,000
20	Removing Asphalt Conc. Pavement	SY	25	$11	$275
21	Trench Pavement Patch	SY	25	$25	$627
22	Removing Plastic Crosswalk Line	SF	100	$4	$400
23	Plastic Crosswalk Line	SF	100	$6	$600
24	Impermeable Liner	SF	4250	$4	$17,000
25	Catch Basin Type 2 48 In. Diam. With Flow Contrl	EA	1	$5,000	$5,000
26	Catch Basin Type 1	EA	2	$2,000	$4,000
27	Shoring and Extra Excavation	SF	430	$2	$860
28	Connection to Drainage Structure	EA	5	$1,000	$5,000
29	Seeded Lawn Installation	SY	300	$5	$1,500
30	Weed and Pest Control	EST	1	$500	$500
31	Restoration	LS	1	$3,000	$3,000
	SUBTOTAL				$144,884

*Unit costs include materials, labor, equipment, contractor overhead and profit, bonds, permits and liability insurance.

Sub-Total:			$144,884
WA State Sales Tax	9.5%	$13,764	
Sub-Total:			$158,648
Contingency	40%	$63,459	
Sub-Total:			$222,107
Environmental Permitting	20%		$44,421
Engineering Design and Administration	35%		$77,800
TOTAL			**$345,000**

Mukilteo Stormwater Retrofit Predesign
Site 3 - 55th Pl W and 127th Pl SW

Prepared By: K Wood Date: 12/5/2014
Checked By: C Boyle/J Paulson

Item No	Bid Item	Unit	Quantity	Unit Cost*	Total Cost
1	Mobilization	LS	1	$13,404	$13,404
2	Erosion/Water Pollution Control	LS	1	$5,000	$5,000
3	SPCC Plan	LS	1	$1,000	$1,000
4	Project Temporary Traffic Control	LS	1	$10,000	$10,000
5	Clearing and Grubbing	LS	1	$5,000	$5,000
6	Removal of Structures and Obstructions	LS	1	$1,000	$1,000
7	Solid Wall PVC Storm Sewer Pipe 6 In. Diam. (overflow)	LF	400	$25	$10,000
8	Underdrain Pipe 6" Diam (slotted pvc sch 40)	LF	400	$20	$8,000
9	6" Beehive Grate on Overflow	EA	7	$160	$1,120
10	Quarry Spalls	CY	10	$100	$1,000
11	Bioretention Soil Media	CY	240	$50	$12,000
12	Topsoil Type A- Planting Soil	SY	40	$35	$1,400
13	Woodchip Mulch, Coarse	SY	360	$7	$2,520
14	Mulch, Fine	SY	40	$7	$280
15	Streambed Cobbles	CY	2	$85	$142
16	Gravel Backfill for Drain	CY	90	$40	$3,600
17	Plants	LS	1	$12,000	$12,000
18	Plant Establishment -Second Year	EST	1	$15,000	$15,000
19	Grated Inlet Through Sidewalk	EA	15	$1,868	$28,025
20	Catch Basin Type 1L with Flow Control Structure	EA	2	$4,000	$8,000
21	Shoring and Extra Excavation	SF	1600	$2	$3,200
22	Connection to Drainage Structure	EA	2	$1,000	$2,000
23	Seeded Lawn Installation	SY	50	$5	$250
24	Weed and Pest Control	EST	1	$500	$500
25	Restoration	LS	1	$3,000	$3,000
	SUBTOTAL				$147,440

*Unit costs include materials, labor, equipment, contractor overhead and profit, bonds, permits and liability insurance.

Sub-Total:			$147,440
WA State Sales Tax	9.5%	$14,007	
Sub-Total:			$161,447
Contingency	40%	$64,579	
Sub-Total:			$226,026
Environmental Permitting	20%		$45,205
Engineering Design and Administration	35%		$79,110
TOTAL			**$351,000**

Appendix E: WWHM Storm Simulation Output

WWHM2012
PROJECT REPORT

Project Name: Site1_SSPondRet_SWP Exist
Site Name: Site 1, Staybridge Suites Pond
Site Address:
City : mukilteo
Report Date: 2/6/2015
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2015/02/06

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : BG08 Big Gulch North
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	4.8
C, Forest, Steep	10
Pervious Total	14.8

Impervious Land Use	Acres
Impervious Total	0
Basin Total	14.8

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : BG08 Big Gulch N
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Forest, Steep	**1.63**
C, Pasture, Mod	**5**

Pervious Total **6.63**

Impervious Land Use	**Acres**
ROADS FLAT	**7.8**
POND	**0.37**

Impervious Total **8.17**

Basin Total **14.8**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Trapezoidal Pond 1
Bottom Length: 70.00 ft.
Bottom Width: 73.00 ft.
Depth: 6 ft.
Volume at riser head: 0.8843 acre-ft.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 5.6 ft.
Riser Diameter: 18 in.
Orifice 1 Diameter: 18 in. **Elevation:** 0 ft.

Element Flows To:
Outlet 1 **Outlet 2**

Pond Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.117	0.000	0.000	0.000
0.0667	0.118	0.007	2.197	0.000
0.1333	0.119	0.015	3.107	0.000
0.2000	0.120	0.023	3.805	0.000
0.2667	0.120	0.031	4.394	0.000
0.3333	0.121	0.039	4.913	0.000
0.4000	0.122	0.048	5.381	0.000
0.4667	0.123	0.056	5.813	0.000
0.5333	0.124	0.064	6.214	0.000
0.6000	0.125	0.072	6.591	0.000
0.6667	0.126	0.081	6.948	0.000

0.7333	0.127	0.089	7.287	0.000
0.8000	0.128	0.098	7.611	0.000
0.8667	0.129	0.106	7.921	0.000
0.9333	0.129	0.115	8.221	0.000
1.0000	0.130	0.124	8.509	0.000
1.0667	0.131	0.132	8.788	0.000
1.1333	0.132	0.141	9.059	0.000
1.2000	0.133	0.150	9.321	0.000
1.2667	0.134	0.159	9.577	0.000
1.3333	0.135	0.168	9.825	0.000
1.4000	0.136	0.177	10.06	0.000
1.4667	0.137	0.186	10.30	0.000
1.5333	0.138	0.195	10.53	0.000
1.6000	0.139	0.205	10.76	0.000
1.6667	0.140	0.214	10.98	0.000
1.7333	0.141	0.223	11.20	0.000
1.8000	0.142	0.233	11.41	0.000
1.8667	0.143	0.242	11.62	0.000
1.9333	0.144	0.252	11.83	0.000
2.0000	0.145	0.261	12.03	0.000
2.0667	0.146	0.271	12.23	0.000
2.1333	0.147	0.281	12.42	0.000
2.2000	0.148	0.291	12.62	0.000
2.2667	0.149	0.301	12.81	0.000
2.3333	0.149	0.311	12.99	0.000
2.4000	0.150	0.321	13.18	0.000
2.4667	0.151	0.331	13.36	0.000
2.5333	0.152	0.341	13.54	0.000
2.6000	0.153	0.351	13.72	0.000
2.6667	0.154	0.361	13.89	0.000
2.7333	0.155	0.372	14.06	0.000
2.8000	0.157	0.382	14.23	0.000
2.8667	0.158	0.393	14.40	0.000
2.9333	0.159	0.403	14.57	0.000
3.0000	0.160	0.414	14.73	0.000
3.0667	0.161	0.425	14.90	0.000
3.1333	0.162	0.435	15.06	0.000
3.2000	0.163	0.446	15.22	0.000
3.2667	0.164	0.457	15.38	0.000
3.3333	0.165	0.468	15.53	0.000
3.4000	0.166	0.479	15.69	0.000
3.4667	0.167	0.490	15.84	0.000
3.5333	0.168	0.501	15.99	0.000
3.6000	0.169	0.513	16.14	0.000
3.6667	0.170	0.524	16.29	0.000
3.7333	0.171	0.535	16.44	0.000
3.8000	0.172	0.547	16.58	0.000
3.8667	0.173	0.558	16.73	0.000
3.9333	0.174	0.570	16.87	0.000
4.0000	0.175	0.582	17.01	0.000
4.0667	0.176	0.593	17.16	0.000
4.1333	0.177	0.605	17.30	0.000
4.2000	0.178	0.617	17.43	0.000
4.2667	0.180	0.629	17.57	0.000
4.3333	0.181	0.641	17.71	0.000
4.4000	0.182	0.653	17.85	0.000
4.4667	0.183	0.665	17.98	0.000

4.5333	0.184	0.678	18.11	0.000
4.6000	0.185	0.690	18.25	0.000
4.6667	0.186	0.702	18.38	0.000
4.7333	0.187	0.715	18.51	0.000
4.8000	0.188	0.727	18.64	0.000
4.8667	0.189	0.740	18.77	0.000
4.9333	0.191	0.753	18.90	0.000
5.0000	0.192	0.766	19.02	0.000
5.0667	0.193	0.778	19.15	0.000
5.1333	0.194	0.791	19.28	0.000
5.2000	0.195	0.804	19.40	0.000
5.2667	0.196	0.817	19.52	0.000
5.3333	0.197	0.831	19.65	0.000
5.4000	0.198	0.844	19.77	0.000
5.4667	0.200	0.857	19.89	0.000
5.5333	0.201	0.870	20.01	0.000
5.6000	0.202	0.884	20.13	0.000
5.6667	0.203	0.897	20.50	0.000
5.7333	0.204	0.911	21.08	0.000
5.8000	0.205	0.925	21.80	0.000
5.8667	0.207	0.938	22.62	0.000
5.9333	0.208	0.952	23.53	0.000
6.0000	0.209	0.966	24.54	0.000
6.0667	0.210	0.980	25.61	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:14.8
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:6.63
Total Impervious Area:8.17

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.23584
5 year	0.360834
10 year	0.44196
25 year	0.540901
50 year	0.611627
100 year	0.679714

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	2.539532
5 year	3.374668

10 year	3.964652
25 year	4.75378
50 year	5.374224
100 year	6.023281

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.074	2.210
1950	0.309	3.268
1951	0.209	2.936
1952	0.181	2.147
1953	0.154	2.995
1954	0.429	3.743
1955	0.397	3.169
1956	0.321	1.501
1957	0.366	2.553
1958	0.274	4.715
1959	0.265	2.428
1960	0.241	1.955
1961	0.254	6.598
1962	0.173	2.626
1963	0.234	3.543
1964	0.232	1.842
1965	0.219	1.791
1966	0.125	1.940
1967	0.338	4.950
1968	0.356	2.835
1969	0.172	4.252
1970	0.172	1.875
1971	0.275	2.880
1972	0.267	3.871
1973	0.155	2.834
1974	0.278	3.678
1975	0.184	2.741
1976	0.190	1.917
1977	0.101	1.953
1978	0.183	1.627
1979	0.329	3.545
1980	0.219	1.970
1981	0.187	1.946
1982	0.261	2.041
1983	0.257	2.474
1984	0.222	2.381
1985	0.334	3.678
1986	0.842	3.462
1987	0.288	2.804
1988	0.198	2.566
1989	0.160	2.546
1990	0.236	1.670
1991	0.254	2.428
1992	0.181	2.141
1993	0.131	1.842
1994	0.096	1.647
1995	0.228	1.945
1996	0.526	2.478

1997	0.892	3.388
1998	0.127	3.405
1999	0.230	1.639
2000	0.146	4.772
2001	0.030	1.950
2002	0.222	1.842
2003	0.147	2.485
2004	0.214	3.979
2005	0.196	2.250
2006	0.511	3.028
2007	0.394	2.828
2008	0.578	2.278
2009	0.184	2.249

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8918	6.5983
2	0.8421	4.9499
3	0.5784	4.7720
4	0.5259	4.7151
5	0.5110	4.2524
6	0.4291	3.9790
7	0.3971	3.8711
8	0.3938	3.7430
9	0.3665	3.6782
10	0.3565	3.6777
11	0.3384	3.5452
12	0.3340	3.5431
13	0.3295	3.4621
14	0.3205	3.4048
15	0.3088	3.3882
16	0.2881	3.2678
17	0.2778	3.1693
18	0.2752	3.0282
19	0.2744	2.9946
20	0.2670	2.9357
21	0.2649	2.8800
22	0.2609	2.8347
23	0.2567	2.8343
24	0.2539	2.8285
25	0.2535	2.8038
26	0.2405	2.7410
27	0.2362	2.6262
28	0.2338	2.5660
29	0.2323	2.5526
30	0.2297	2.5456
31	0.2276	2.4847
32	0.2223	2.4785
33	0.2221	2.4744
34	0.2192	2.4279
35	0.2186	2.4279
36	0.2136	2.3815
37	0.2086	2.2783
38	0.1976	2.2505
39	0.1963	2.2490

40	0.1897	2.2095
41	0.1873	2.1469
42	0.1840	2.1407
43	0.1836	2.0411
44	0.1828	1.9700
45	0.1812	1.9549
46	0.1810	1.9534
47	0.1726	1.9495
48	0.1721	1.9463
49	0.1719	1.9448
50	0.1595	1.9397
51	0.1548	1.9170
52	0.1538	1.8751
53	0.1473	1.8421
54	0.1459	1.8417
55	0.1315	1.8415
56	0.1266	1.7910
57	0.1247	1.6696
58	0.1010	1.6469
59	0.0961	1.6394
60	0.0737	1.6266
61	0.0295	1.5008

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	**Predev**	**Mit**	**Percentage**	**Pass/Fail**
0.1179	16153	118815	735	Fail
0.1229	14649	114901	784	Fail
0.1279	13340	111265	834	Fail
0.1329	12207	107693	882	Fail
0.1379	11167	104292	933	Fail
0.1429	10230	100870	986	Fail
0.1478	9362	97683	1043	Fail
0.1528	8570	94645	1104	Fail
0.1578	7826	91801	1173	Fail
0.1628	7178	89170	1242	Fail
0.1678	6581	86646	1316	Fail
0.1728	6032	84336	1398	Fail
0.1778	5505	82133	1491	Fail
0.1828	5043	79994	1586	Fail
0.1877	4650	78005	1677	Fail
0.1927	4269	76144	1783	Fail
0.1977	3914	74262	1897	Fail
0.2027	3583	72444	2021	Fail
0.2077	3311	70754	2136	Fail
0.2127	3074	69086	2247	Fail
0.2177	2823	67482	2390	Fail
0.2226	2614	65878	2520	Fail
0.2276	2432	64423	2648	Fail
0.2326	2276	62840	2760	Fail
0.2376	2141	61429	2869	Fail
0.2426	1995	60060	3010	Fail
0.2476	1845	58755	3184	Fail

0.2526	1714	57450	3351	Fail
0.2576	1581	56188	3553	Fail
0.2625	1484	54991	3705	Fail
0.2675	1393	53793	3861	Fail
0.2725	1314	52616	4004	Fail
0.2775	1234	51440	4168	Fail
0.2825	1166	50306	4314	Fail
0.2875	1116	49237	4411	Fail
0.2925	1075	48168	4480	Fail
0.2974	1028	47098	4581	Fail
0.3024	988	46071	4663	Fail
0.3074	937	45066	4809	Fail
0.3124	890	44125	4957	Fail
0.3174	832	43141	5185	Fail
0.3224	792	42264	5336	Fail
0.3274	748	41409	5535	Fail
0.3324	717	40510	5649	Fail
0.3373	685	39676	5792	Fail
0.3423	659	38863	5897	Fail
0.3473	640	38072	5948	Fail
0.3523	617	37238	6035	Fail
0.3573	598	36489	6101	Fail
0.3623	584	35698	6112	Fail
0.3673	565	34928	6181	Fail
0.3723	551	34243	6214	Fail
0.3772	542	33538	6187	Fail
0.3822	526	32832	6241	Fail
0.3872	513	32147	6266	Fail
0.3922	496	31484	6347	Fail
0.3972	484	30885	6381	Fail
0.4022	471	30287	6430	Fail
0.4072	460	29709	6458	Fail
0.4121	449	29132	6488	Fail
0.4171	436	28533	6544	Fail
0.4221	426	27998	6572	Fail
0.4271	418	27420	6559	Fail
0.4321	407	26864	6600	Fail
0.4371	398	26351	6620	Fail
0.4421	386	25838	6693	Fail
0.4471	375	25324	6753	Fail
0.4520	367	24832	6766	Fail
0.4570	349	24298	6962	Fail
0.4620	333	23827	7155	Fail
0.4670	324	23335	7202	Fail
0.4720	316	22972	7269	Fail
0.4770	302	22501	7450	Fail
0.4820	287	22073	7690	Fail
0.4870	279	21688	7773	Fail
0.4919	270	21275	7879	Fail
0.4969	262	20865	7963	Fail
0.5019	257	20435	7951	Fail
0.5069	250	20069	8027	Fail
0.5119	245	19727	8051	Fail
0.5169	238	19342	8126	Fail
0.5219	234	18950	8098	Fail
0.5268	228	18593	8154	Fail
0.5318	225	18249	8110	Fail

0.5368	220	17926	8148	Fail
0.5418	215	17575	8174	Fail
0.5468	209	17235	8246	Fail
0.5518	206	16886	8197	Fail
0.5568	202	16555	8195	Fail
0.5618	196	16245	8288	Fail
0.5667	190	15926	8382	Fail
0.5717	184	15620	8489	Fail
0.5767	180	15304	8502	Fail
0.5817	174	15053	8651	Fail
0.5867	170	14775	8691	Fail
0.5917	167	14499	8682	Fail
0.5967	166	14249	8583	Fail
0.6017	164	13967	8516	Fail
0.6066	160	13723	8576	Fail
0.6116	156	13473	8636	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:14.8
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:6.63
Total Impervious Area:8.17

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.23584
5 year	0.360834
10 year	0.44196
25 year	0.540901
50 year	0.611627
100 year	0.679714

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	2.539532
5 year	3.374668
10 year	3.964652
25 year	4.75378
50 year	5.374224
100 year	6.023281

LID Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.074	2.210
1950	0.309	3.268
1951	0.209	2.936
1952	0.181	2.147
1953	0.154	2.995
1954	0.429	3.743
1955	0.397	3.169
1956	0.321	1.501
1957	0.366	2.553
1958	0.274	4.715
1959	0.265	2.428
1960	0.241	1.955
1961	0.254	6.598
1962	0.173	2.626
1963	0.234	3.543
1964	0.232	1.842
1965	0.219	1.791
1966	0.125	1.940
1967	0.338	4.950
1968	0.356	2.835
1969	0.172	4.252
1970	0.172	1.875
1971	0.275	2.880
1972	0.267	3.871
1973	0.155	2.834
1974	0.278	3.678
1975	0.184	2.741
1976	0.190	1.917
1977	0.101	1.953
1978	0.183	1.627
1979	0.329	3.545
1980	0.219	1.970
1981	0.187	1.946
1982	0.261	2.041
1983	0.257	2.474
1984	0.222	2.381
1985	0.334	3.678
1986	0.842	3.462
1987	0.288	2.804
1988	0.198	2.566
1989	0.160	2.546
1990	0.236	1.670
1991	0.254	2.428
1992	0.181	2.141
1993	0.131	1.842
1994	0.096	1.647
1995	0.228	1.945
1996	0.526	2.478
1997	0.892	3.388
1998	0.127	3.405
1999	0.230	1.639
2000	0.146	4.772

2001	0.030	1.950
2002	0.222	1.842
2003	0.147	2.485
2004	0.214	3.979
2005	0.196	2.250
2006	0.511	3.028
2007	0.394	2.828
2008	0.578	2.278
2009	0.184	2.249

LID Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.8918	6.5983
2	0.8421	4.9499
3	0.5784	4.7720
4	0.5259	4.7151
5	0.5110	4.2524
6	0.4291	3.9790
7	0.3971	3.8711
8	0.3938	3.7430
9	0.3665	3.6782
10	0.3565	3.6777
11	0.3384	3.5452
12	0.3340	3.5431
13	0.3295	3.4621
14	0.3205	3.4048
15	0.3088	3.3882
16	0.2881	3.2678
17	0.2778	3.1693
18	0.2752	3.0282
19	0.2744	2.9946
20	0.2670	2.9357
21	0.2649	2.8800
22	0.2609	2.8347
23	0.2567	2.8343
24	0.2539	2.8285
25	0.2535	2.8038
26	0.2405	2.7410
27	0.2362	2.6262
28	0.2338	2.5660
29	0.2323	2.5526
30	0.2297	2.5456
31	0.2276	2.4847
32	0.2223	2.4785
33	0.2221	2.4744
34	0.2192	2.4279
35	0.2186	2.4279
36	0.2136	2.3815
37	0.2086	2.2783
38	0.1976	2.2505
39	0.1963	2.2490
40	0.1897	2.2095
41	0.1873	2.1469
42	0.1840	2.1407
43	0.1836	2.0411

44	0.1828	1.9700
45	0.1812	1.9549
46	0.1810	1.9534
47	0.1726	1.9495
48	0.1721	1.9463
49	0.1719	1.9448
50	0.1595	1.9397
51	0.1548	1.9170
52	0.1538	1.8751
53	0.1473	1.8421
54	0.1459	1.8417
55	0.1315	1.8415
56	0.1266	1.7910
57	0.1247	1.6696
58	0.1010	1.6469
59	0.0961	1.6394
60	0.0737	1.6266
61	0.0295	1.5008

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0189	173399	338371	195	Fail
0.0199	166833	330671	198	Fail
0.0209	160715	323399	201	Fail
0.0219	154962	316768	204	Fail
0.0229	149529	310138	207	Fail
0.0239	144374	304149	210	Fail
0.0249	139519	298374	213	Fail
0.0259	134899	292813	217	Fail
0.0269	130536	287679	220	Fail
0.0279	126344	282546	223	Fail
0.0289	122387	277841	227	Fail
0.0299	118558	273135	230	Fail
0.0309	114965	268857	233	Fail
0.0319	111543	264793	237	Fail
0.0329	108270	260729	240	Fail
0.0339	105040	256879	244	Fail
0.0349	102003	253030	248	Fail
0.0359	99073	249607	251	Fail
0.0369	96314	245971	255	Fail
0.0379	93662	242763	259	Fail
0.0389	91116	239555	262	Fail
0.0399	88678	236346	266	Fail
0.0409	86261	233352	270	Fail
0.0419	84037	230571	274	Fail
0.0429	81791	227791	278	Fail
0.0439	79673	225010	282	Fail
0.0449	77684	222230	286	Fail
0.0459	75738	219663	290	Fail
0.0469	73856	217096	293	Fail
0.0479	72016	214530	297	Fail
0.0489	70241	212198	302	Fail

0.0499	68551	209824	306	Fail
0.0509	66904	207493	310	Fail
0.0519	65300	205204	314	Fail
0.0529	63739	202958	318	Fail
0.0539	62199	200712	322	Fail
0.0549	60701	198531	327	Fail
0.0559	59268	196413	331	Fail
0.0569	57899	194296	335	Fail
0.0579	56552	192200	339	Fail
0.0589	55204	190125	344	Fail
0.0599	53943	188029	348	Fail
0.0609	52723	185976	352	Fail
0.0619	51461	183965	357	Fail
0.0629	50264	181955	361	Fail
0.0639	49087	180030	366	Fail
0.0649	47954	178083	371	Fail
0.0659	46820	176201	376	Fail
0.0669	45751	174297	380	Fail
0.0679	44724	172522	385	Fail
0.0689	43740	170704	390	Fail
0.0699	42778	169057	395	Fail
0.0709	41836	167367	400	Fail
0.0719	40917	165763	405	Fail
0.0729	40018	164138	410	Fail
0.0739	39120	162555	415	Fail
0.0749	38265	161079	420	Fail
0.0759	37409	159646	426	Fail
0.0769	36553	158256	432	Fail
0.0779	35762	156844	438	Fail
0.0789	35013	155518	444	Fail
0.0799	34286	154192	449	Fail
0.0809	33559	152887	455	Fail
0.0819	32832	151647	461	Fail
0.0829	32126	150470	468	Fail
0.0839	31506	149315	473	Fail
0.0849	30864	148203	480	Fail
0.0859	30201	147048	486	Fail
0.0869	29581	145893	493	Fail
0.0879	28939	144759	500	Fail
0.0889	28340	143669	506	Fail
0.0899	27741	142663	514	Fail
0.0909	27164	141637	521	Fail
0.0919	26586	140653	529	Fail
0.0929	26052	139647	536	Fail
0.0939	25538	138685	543	Fail
0.0949	25004	137701	550	Fail
0.0959	24469	136760	558	Fail
0.0969	23955	135819	566	Fail
0.0979	23442	134899	575	Fail
0.0989	22950	133979	583	Fail
0.0999	22480	133081	591	Fail
0.1009	22030	132140	599	Fail
0.1019	21603	131242	607	Fail
0.1029	21171	130343	615	Fail
0.1039	20751	129466	623	Fail
0.1049	20330	128611	632	Fail
0.1059	19934	127755	640	Fail

0.1069	19554	126921	649	Fail
0.1079	19188	126044	656	Fail
0.1089	18831	125253	665	Fail
0.1099	18486	124440	673	Fail
0.1109	18133	123649	681	Fail
0.1119	17798	122857	690	Fail
0.1129	17473	122087	698	Fail
0.1139	17130	121317	708	Fail
0.1149	16816	120526	716	Fail
0.1159	16493	119735	725	Fail
0.1169	16185	118900	734	Fail
0.1179	15870	118130	744	Fail

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes
No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Site1_SSPondRet_SWP Ret
Site Name: Site 1, Staybridge Suites Pond
Site Address:
City : Mukilteo
Report Date: 3/31/2015
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2015/03/18

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : BG08 Big Gluch North
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Forest, Mod	4.8
C, Forest, Steep	10
Pervious Total	14.8
Impervious Land Use	**Acres**
Impervious Total	0
Basin Total	14.8

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : BG08 Big Gulch N
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Forest, Steep	**1.63**
C, Pasture, Mod	**5**

Pervious Total **6.63**

Impervious Land Use	**Acres**
ROADS FLAT	**7.8**
POND	**0.37**

Impervious Total **8.17**

Basin Total **14.8**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Trapezoidal Pond 1	Trapezoidal Pond 1	

Name : Trapezoidal Pond 1
Bottom Length: 105.00 ft.
Bottom Width: 105.00 ft.
Depth: 8.5 ft.
Volume at riser head: 2.5155 acre-ft.
Side slope 1: 2 To 1
Side slope 2: 2 To 1
Side slope 3: 2 To 1
Side slope 4: 2 To 1
Discharge Structure
Riser Height: 7.5 ft.
Riser Diameter: 18 in.
Orifice 1 Diameter: 1.32 in. **Elevation:** 0.5 ft.
Orifice 2 Diameter: 2 in. **Elevation:** 6 ft.
Orifice 3 Diameter: 5 in. **Elevation:** 7 ft.

Element Flows To:
Outlet 1 **Outlet 2**

Pond Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.253	0.000	0.000	0.000
0.0944	0.254	0.024	0.000	0.000
0.1889	0.256	0.048	0.000	0.000
0.2833	0.258	0.072	0.000	0.000
0.3778	0.260	0.097	0.000	0.000
0.4722	0.262	0.121	0.000	0.000
0.5667	0.264	0.146	0.011	0.000
0.6611	0.266	0.171	0.018	0.000
0.7556	0.267	0.196	0.023	0.000

0.8500	0.269	0.222	0.027	0.000
0.9444	0.271	0.247	0.030	0.000
1.0389	0.273	0.273	0.033	0.000
1.1333	0.275	0.299	0.036	0.000
1.2278	0.277	0.325	0.039	0.000
1.3222	0.279	0.351	0.041	0.000
1.4167	0.281	0.378	0.043	0.000
1.5111	0.283	0.404	0.046	0.000
1.6056	0.285	0.431	0.048	0.000
1.7000	0.286	0.458	0.050	0.000
1.7944	0.288	0.485	0.052	0.000
1.8889	0.290	0.513	0.053	0.000
1.9833	0.292	0.540	0.055	0.000
2.0778	0.294	0.568	0.057	0.000
2.1722	0.296	0.596	0.059	0.000
2.2667	0.298	0.624	0.060	0.000
2.3611	0.300	0.653	0.062	0.000
2.4556	0.302	0.681	0.064	0.000
2.5500	0.304	0.710	0.065	0.000
2.6444	0.306	0.739	0.067	0.000
2.7389	0.308	0.768	0.068	0.000
2.8333	0.310	0.797	0.069	0.000
2.9278	0.312	0.826	0.071	0.000
3.0222	0.314	0.856	0.072	0.000
3.1167	0.316	0.886	0.074	0.000
3.2111	0.318	0.916	0.075	0.000
3.3056	0.320	0.946	0.076	0.000
3.4000	0.322	0.976	0.077	0.000
3.4944	0.325	1.007	0.079	0.000
3.5889	0.327	1.038	0.080	0.000
3.6833	0.329	1.069	0.081	0.000
3.7778	0.331	1.100	0.082	0.000
3.8722	0.333	1.131	0.084	0.000
3.9667	0.335	1.163	0.085	0.000
4.0611	0.337	1.195	0.086	0.000
4.1556	0.339	1.227	0.087	0.000
4.2500	0.341	1.259	0.088	0.000
4.3444	0.343	1.291	0.089	0.000
4.4389	0.345	1.324	0.090	0.000
4.5333	0.348	1.356	0.091	0.000
4.6278	0.350	1.389	0.093	0.000
4.7222	0.352	1.423	0.094	0.000
4.8167	0.354	1.456	0.095	0.000
4.9111	0.356	1.490	0.096	0.000
5.0056	0.358	1.523	0.097	0.000
5.1000	0.361	1.557	0.098	0.000
5.1944	0.363	1.592	0.099	0.000
5.2889	0.365	1.626	0.100	0.000
5.3833	0.367	1.661	0.101	0.000
5.4778	0.369	1.695	0.102	0.000
5.5722	0.372	1.730	0.103	0.000
5.6667	0.374	1.766	0.104	0.000
5.7611	0.376	1.801	0.105	0.000
5.8556	0.378	1.837	0.105	0.000
5.9500	0.380	1.873	0.106	0.000
6.0444	0.383	1.909	0.129	0.000
6.1389	0.385	1.945	0.147	0.000

6.2333	0.387	1.981	0.160	0.000
6.3278	0.389	2.018	0.170	0.000
6.4222	0.392	2.055	0.179	0.000
6.5167	0.394	2.092	0.187	0.000
6.6111	0.396	2.130	0.195	0.000
6.7056	0.398	2.167	0.202	0.000
6.8000	0.401	2.205	0.208	0.000
6.8944	0.403	2.243	0.215	0.000
6.9889	0.405	2.281	0.221	0.000
7.0833	0.408	2.320	0.416	0.000
7.1778	0.410	2.358	0.509	0.000
7.2722	0.412	2.397	0.580	0.000
7.3667	0.415	2.436	0.640	0.000
7.4611	0.417	2.476	0.693	0.000
7.5556	0.419	2.515	0.933	0.000
7.6500	0.422	2.555	1.635	0.000
7.7444	0.424	2.595	2.594	0.000
7.8389	0.426	2.635	3.749	0.000
7.9333	0.429	2.675	5.072	0.000
8.0278	0.431	2.716	6.542	0.000
8.1222	0.434	2.757	8.145	0.000
8.2167	0.436	2.798	9.870	0.000
8.3111	0.438	2.839	11.71	0.000
8.4056	0.441	2.881	13.65	0.000
8.5000	0.443	2.923	15.70	0.000
8.5944	0.446	2.965	17.85	0.000

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:14.8
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:6.63
Total Impervious Area:8.17

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.256493
5 year	0.388541
10 year	0.473641
25 year	0.576936
50 year	0.650498
100 year	0.721126

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)

2 year	0.131978
5 year	0.271492
10 year	0.421648
25 year	0.70885
50 year	1.019851
100 year	1.44217

Stream Protection Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.091	0.091
1950	0.336	0.157
1951	0.222	0.094
1952	0.201	0.090
1953	0.171	0.081
1954	0.469	0.101
1955	0.427	0.561
1956	0.345	0.549
1957	0.395	0.175
1958	0.301	0.103
1959	0.291	0.104
1960	0.264	0.101
1961	0.273	0.201
1962	0.192	0.084
1963	0.262	0.092
1964	0.255	0.079
1965	0.231	0.106
1966	0.135	0.088
1967	0.367	0.094
1968	0.393	0.114
1969	0.186	0.099
1970	0.185	0.096
1971	0.297	0.447
1972	0.291	0.091
1973	0.171	0.169
1974	0.300	0.104
1975	0.195	0.085
1976	0.206	0.093
1977	0.114	0.087
1978	0.199	0.089
1979	0.352	0.087
1980	0.242	0.088
1981	0.206	0.081
1982	0.282	0.105
1983	0.280	0.100
1984	0.238	0.425
1985	0.357	0.381
1986	0.895	1.748
1987	0.309	0.650
1988	0.214	0.111
1989	0.177	0.080
1990	0.251	0.162
1991	0.270	0.106
1992	0.201	0.148
1993	0.143	0.076
1994	0.106	0.103

1995	0.244	0.203
1996	0.566	0.210
1997	0.952	2.848
1998	0.150	0.096
1999	0.243	0.105
2000	0.159	0.158
2001	0.033	0.065
2002	0.236	0.207
2003	0.158	0.096
2004	0.227	0.163
2005	0.215	0.099
2006	0.544	0.217
2007	0.422	0.211
2008	0.623	1.155
2009	0.197	0.101

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9523	2.8484
2	0.8950	1.7475
3	0.6232	1.1549
4	0.5660	0.6495
5	0.5445	0.5609
6	0.4689	0.5489
7	0.4274	0.4470
8	0.4218	0.4252
9	0.3953	0.3806
10	0.3931	0.2172
11	0.3666	0.2112
12	0.3575	0.2096
13	0.3519	0.2070
14	0.3447	0.2033
15	0.3360	0.2014
16	0.3087	0.1750
17	0.3013	0.1694
18	0.2997	0.1626
19	0.2972	0.1617
20	0.2913	0.1577
21	0.2908	0.1572
22	0.2819	0.1475
23	0.2800	0.1136
24	0.2727	0.1114
25	0.2702	0.1063
26	0.2639	0.1057
27	0.2624	0.1051
28	0.2554	0.1049
29	0.2513	0.1044
30	0.2442	0.1037
31	0.2426	0.1033
32	0.2416	0.1032
33	0.2376	0.1012
34	0.2362	0.1009
35	0.2314	0.1009
36	0.2273	0.1003
37	0.2217	0.0994

38	0.2147	0.0991
39	0.2138	0.0960
40	0.2062	0.0957
41	0.2055	0.0956
42	0.2013	0.0939
43	0.2005	0.0937
44	0.1991	0.0931
45	0.1975	0.0920
46	0.1955	0.0905
47	0.1917	0.0905
48	0.1857	0.0897
49	0.1852	0.0892
50	0.1769	0.0880
51	0.1712	0.0875
52	0.1712	0.0875
53	0.1594	0.0869
54	0.1584	0.0846
55	0.1497	0.0841
56	0.1431	0.0811
57	0.1348	0.0810
58	0.1136	0.0801
59	0.1063	0.0785
60	0.0911	0.0758
61	0.0329	0.0651

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.1282	15064	7732	51	Pass
0.1335	13762	7430	53	Pass
0.1388	12647	7058	55	Pass
0.1441	11434	6663	58	Pass
0.1493	10543	6297	59	Pass
0.1546	9704	5865	60	Pass
0.1599	8926	5478	61	Pass
0.1652	8036	4962	61	Pass
0.1704	7424	4558	61	Pass
0.1757	6834	4160	60	Pass
0.1810	6290	3822	60	Pass
0.1863	5713	3414	59	Pass
0.1915	5251	3076	58	Pass
0.1968	4836	2712	56	Pass
0.2021	4400	2239	50	Pass
0.2074	4060	1838	45	Pass
0.2127	3739	1460	39	Pass
0.2179	3459	1102	31	Pass
0.2232	3172	782	24	Pass
0.2285	2947	766	25	Pass
0.2338	2731	753	27	Pass
0.2390	2490	738	29	Pass
0.2443	2334	730	31	Pass
0.2496	2197	722	32	Pass

0.2549	2055	709	34	Pass
0.2601	1889	702	37	Pass
0.2654	1756	690	39	Pass
0.2707	1639	681	41	Pass
0.2760	1522	670	44	Pass
0.2812	1413	660	46	Pass
0.2865	1336	646	48	Pass
0.2918	1260	636	50	Pass
0.2971	1178	625	53	Pass
0.3023	1119	617	55	Pass
0.3076	1079	613	56	Pass
0.3129	1034	598	57	Pass
0.3182	986	590	59	Pass
0.3234	934	584	62	Pass
0.3287	893	577	64	Pass
0.3340	846	568	67	Pass
0.3393	804	560	69	Pass
0.3445	765	555	72	Pass
0.3498	734	549	74	Pass
0.3551	689	543	78	Pass
0.3604	659	534	81	Pass
0.3656	636	527	82	Pass
0.3709	617	522	84	Pass
0.3762	598	513	85	Pass
0.3815	577	505	87	Pass
0.3867	555	500	90	Pass
0.3920	537	495	92	Pass
0.3973	523	488	93	Pass
0.4026	511	481	94	Pass
0.4078	494	471	95	Pass
0.4131	481	460	95	Pass
0.4184	471	453	96	Pass
0.4237	455	439	96	Pass
0.4289	445	423	95	Pass
0.4342	434	399	91	Pass
0.4395	422	383	90	Pass
0.4448	415	367	88	Pass
0.4500	407	358	87	Pass
0.4553	400	351	87	Pass
0.4606	391	347	88	Pass
0.4659	384	342	89	Pass
0.4711	371	334	90	Pass
0.4764	363	329	90	Pass
0.4817	349	323	92	Pass
0.4870	335	320	95	Pass
0.4922	323	313	96	Pass
0.4975	316	307	97	Pass
0.5028	307	298	97	Pass
0.5081	288	290	100	Pass
0.5133	280	286	102	Pass
0.5186	268	282	105	Pass
0.5239	263	276	104	Pass
0.5292	254	270	106	Pass
0.5344	247	264	106	Pass
0.5397	242	259	107	Pass
0.5450	235	251	106	Pass
0.5503	229	240	104	Pass

0.5555	225	236	104	Pass
0.5608	222	229	103	Pass
0.5661	218	223	102	Pass
0.5714	212	220	103	Pass
0.5766	209	216	103	Pass
0.5819	205	209	101	Pass
0.5872	201	206	102	Pass
0.5925	197	202	102	Pass
0.5977	192	199	103	Pass
0.6030	186	193	103	Pass
0.6083	181	186	102	Pass
0.6136	176	182	103	Pass
0.6188	169	175	103	Pass
0.6241	163	173	106	Pass
0.6294	162	167	103	Pass
0.6347	160	165	103	Pass
0.6399	159	161	101	Pass
0.6452	154	155	100	Pass
0.6505	151	151	100	Pass

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:14.8
Total Impervious Area:0

Mitigated Landuse Totals for POC #1
Total Pervious Area:6.63
Total Impervious Area:8.17

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.256493
5 year	0.388541
10 year	0.473641
25 year	0.576936
50 year	0.650498
100 year	0.721126

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.131978
5 year	0.271492
10 year	0.421648
25 year	0.70885
50 year	1.019851
100 year	1.44217

LID Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Predeveloped	Mitigated
1949	0.091	0.091
1950	0.336	0.157
1951	0.222	0.094
1952	0.201	0.090
1953	0.171	0.081
1954	0.469	0.101
1955	0.427	0.561
1956	0.345	0.549
1957	0.395	0.175
1958	0.301	0.103
1959	0.291	0.104
1960	0.264	0.101
1961	0.273	0.201
1962	0.192	0.084
1963	0.262	0.092
1964	0.255	0.079
1965	0.231	0.106
1966	0.135	0.088
1967	0.367	0.094
1968	0.393	0.114
1969	0.186	0.099
1970	0.185	0.096
1971	0.297	0.447
1972	0.291	0.091
1973	0.171	0.169
1974	0.300	0.104
1975	0.195	0.085
1976	0.206	0.093
1977	0.114	0.087
1978	0.199	0.089
1979	0.352	0.087
1980	0.242	0.088
1981	0.206	0.081
1982	0.282	0.105
1983	0.280	0.100
1984	0.238	0.425
1985	0.357	0.381
1986	0.895	1.748
1987	0.309	0.650
1988	0.214	0.111
1989	0.177	0.080
1990	0.251	0.162
1991	0.270	0.106
1992	0.201	0.148
1993	0.143	0.076
1994	0.106	0.103
1995	0.244	0.203
1996	0.566	0.210
1997	0.952	2.848
1998	0.150	0.096
1999	0.243	0.105
2000	0.159	0.158
2001	0.033	0.065
2002	0.236	0.207

2003	0.158	0.096
2004	0.227	0.163
2005	0.215	0.099
2006	0.544	0.217
2007	0.422	0.211
2008	0.623	1.155
2009	0.197	0.101

LID Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	Predeveloped	Mitigated
1	0.9523	2.8484
2	0.8950	1.7475
3	0.6232	1.1549
4	0.5660	0.6495
5	0.5445	0.5609
6	0.4689	0.5489
7	0.4274	0.4470
8	0.4218	0.4252
9	0.3953	0.3806
10	0.3931	0.2172
11	0.3666	0.2112
12	0.3575	0.2096
13	0.3519	0.2070
14	0.3447	0.2033
15	0.3360	0.2014
16	0.3087	0.1750
17	0.3013	0.1694
18	0.2997	0.1626
19	0.2972	0.1617
20	0.2913	0.1577
21	0.2908	0.1572
22	0.2819	0.1475
23	0.2800	0.1136
24	0.2727	0.1114
25	0.2702	0.1063
26	0.2639	0.1057
27	0.2624	0.1051
28	0.2554	0.1049
29	0.2513	0.1044
30	0.2442	0.1037
31	0.2426	0.1033
32	0.2416	0.1032
33	0.2376	0.1012
34	0.2362	0.1009
35	0.2314	0.1009
36	0.2273	0.1003
37	0.2217	0.0994
38	0.2147	0.0991
39	0.2138	0.0960
40	0.2062	0.0957
41	0.2055	0.0956
42	0.2013	0.0939
43	0.2005	0.0937
44	0.1991	0.0931
45	0.1975	0.0920

46	0.1955	0.0905
47	0.1917	0.0905
48	0.1857	0.0897
49	0.1852	0.0892
50	0.1769	0.0880
51	0.1712	0.0875
52	0.1712	0.0875
53	0.1594	0.0869
54	0.1584	0.0846
55	0.1497	0.0841
56	0.1431	0.0811
57	0.1348	0.0810
58	0.1136	0.0801
59	0.1063	0.0785
60	0.0911	0.0758
61	0.0329	0.0651

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0205	167025	977254	585	Fail
0.0216	160673	956293	595	Fail
0.0227	154684	936188	605	Fail
0.0238	149144	914371	613	Fail
0.0249	143861	891485	619	Fail
0.0260	138920	870096	626	Fail
0.0270	134257	849563	632	Fail
0.0281	129809	826891	637	Fail
0.0292	125638	805502	641	Fail
0.0303	121574	784541	645	Fail
0.0314	117638	762511	648	Fail
0.0325	114024	740908	649	Fail
0.0336	110473	719519	651	Fail
0.0347	107158	697061	650	Fail
0.0358	103950	675886	650	Fail
0.0368	100891	655567	649	Fail
0.0379	97961	635461	648	Fail
0.0390	95116	616211	647	Fail
0.0401	92442	596534	645	Fail
0.0412	89854	577498	642	Fail
0.0423	87373	558248	638	Fail
0.0434	84978	538784	634	Fail
0.0445	82732	520390	629	Fail
0.0455	80529	501567	622	Fail
0.0466	78433	482745	615	Fail
0.0477	76401	464137	607	Fail
0.0488	74476	446170	599	Fail
0.0499	72615	429273	591	Fail
0.0510	70776	413232	583	Fail
0.0521	69064	397404	575	Fail
0.0532	67375	381576	566	Fail
0.0543	65749	366176	556	Fail
0.0553	64145	351204	547	Fail

0.0564	62519	336446	538	Fail
0.0575	60958	322543	529	Fail
0.0586	59418	308854	519	Fail
0.0597	57985	294952	508	Fail
0.0608	56552	281690	498	Fail
0.0619	55247	269071	487	Fail
0.0630	53921	256666	476	Fail
0.0640	52638	244474	464	Fail
0.0651	51397	232282	451	Fail
0.0662	50200	220732	439	Fail
0.0673	49045	209824	427	Fail
0.0684	47847	199258	416	Fail
0.0695	46735	189398	405	Fail
0.0706	45622	179623	393	Fail
0.0717	44596	169763	380	Fail
0.0728	43548	160908	369	Fail
0.0738	42521	152802	359	Fail
0.0749	41580	144353	347	Fail
0.0760	40617	136033	334	Fail
0.0771	39719	128140	322	Fail
0.0782	38842	120783	310	Fail
0.0793	38051	113425	298	Fail
0.0804	37152	106367	286	Fail
0.0815	36318	99479	273	Fail
0.0825	35527	93277	262	Fail
0.0836	34735	87095	250	Fail
0.0847	33965	81042	238	Fail
0.0858	33238	75524	227	Fail
0.0869	32511	70583	217	Fail
0.0880	31805	65728	206	Fail
0.0891	31121	60594	194	Fail
0.0902	30436	55932	183	Fail
0.0912	29816	51675	173	Fail
0.0923	29196	47547	162	Fail
0.0934	28597	43548	152	Fail
0.0945	27977	40018	143	Fail
0.0956	27378	36511	133	Fail
0.0967	26779	33217	124	Fail
0.0978	26201	29944	114	Fail
0.0989	25667	26907	104	Fail
0.1000	25132	23998	95	Pass
0.1010	24619	21284	86	Pass
0.1021	24127	18713	77	Pass
0.1032	23613	16262	68	Pass
0.1043	23143	13680	59	Pass
0.1054	22694	11813	52	Pass
0.1065	22202	9916	44	Pass
0.1076	21752	9041	41	Pass
0.1087	21314	8943	41	Pass
0.1097	20878	8859	42	Pass
0.1108	20461	8759	42	Pass
0.1119	20041	8677	43	Pass
0.1130	19622	8596	43	Pass
0.1141	19209	8521	44	Pass
0.1152	18865	8468	44	Pass
0.1163	18484	8412	45	Pass
0.1174	18133	8352	46	Pass

0.1185	17783	8286	46	Pass
0.1195	17438	8205	47	Pass
0.1206	17122	8132	47	Pass
0.1217	16799	8070	48	Pass
0.1228	16486	8010	48	Pass
0.1239	16204	7957	49	Pass
0.1250	15900	7897	49	Pass
0.1261	15614	7843	50	Pass
0.1272	15308	7786	50	Pass
0.1282	15021	7723	51	Pass

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.1869 **acre-feet**
On-line facility target flow: 0.0946 **cfs.**
Adjusted for 15 min: 0.0946 **cfs.**
Off-line facility target flow: 0.0639 **cfs.**
Adjusted for 15 min: 0.0639 **cfs.**

Wetlands Fluctuation for POC 1
Average Annual Volume (acft)

Month	Predevel	Mitigated	Percent	Pass/Fail
Jan	53.7766	141.0667	262.3	Fail
Feb	40.8050	101.7894	249.5	Fail
Mar	34.6331	96.3252	278.1	Fail
Apr	19.6497	61.5567	313.3	Fail
May	4.0345	40.2256	997.1	Fail
Jun	3.4743	36.9190	1062.6	Fail
Jul	0.5339	18.8711	3534.8	Fail
Aug	0.0274	20.5040	74743.3	Fail
Sep	0.0667	33.7511	50625.4	Fail
Oct	0.6063	64.5020	10639.0	Fail
Nov	14.0278	117.1997	835.5	Fail
Dec	44.5114	154.9285	348.1	Fail

Day	Predevel	Mitigated	Percent	Pass/Fail
Jan1	1.9386	4.9753	256.6	Fail
2	1.6475	4.7071	285.7	Fail
3	1.4512	4.5893	316.2	Fail
4	1.8147	4.5714	251.9	Fail
5	1.8905	4.6886	248.0	Fail
6	1.6139	4.5319	280.8	Fail
7	2.0276	4.6686	230.3	Fail
8	2.1176	4.7119	222.5	Fail
9	1.6769	4.7707	284.5	Fail
10	1.2645	4.6284	366.0	Fail
11	1.3067	4.5076	345.0	Fail
12	1.2769	4.4180	346.0	Fail
13	1.6713	4.5379	271.5	Fail
14	2.1340	4.6140	216.2	Fail

15	1.8311	4.5103	246.3	Fail
16	1.8016	4.5577	253.0	Fail
17	2.2502	5.1213	227.6	Fail
18	2.4855	4.9675	199.9	Fail
19	1.9487	4.6784	240.1	Fail
20	1.4113	4.4312	314.0	Fail
21	1.3505	4.3362	321.1	Fail
22	1.5256	4.4805	293.7	Fail
23	2.0003	4.7686	238.4	Fail
24	1.6404	4.4700	272.5	Fail
25	1.2685	4.1939	330.6	Fail
26	1.0838	3.9346	363.0	Fail
27	1.3740	3.7718	274.5	Fail
28	1.8698	3.9739	212.5	Fail
29	2.0665	4.0544	196.2	Fail
30	1.7024	4.0514	238.0	Fail
31	1.6413	4.0939	249.4	Fail
Feb1	1.4496	4.0099	276.6	Fail
2	1.0869	3.7582	345.8	Fail
3	1.4124	3.7718	267.0	Fail
4	1.4745	3.6374	246.7	Fail
5	1.5725	3.5807	227.7	Fail
6	1.2434	3.5857	288.4	Fail
7	1.8601	3.6565	196.6	Fail
8	1.2935	3.6555	282.6	Fail
9	0.8832	3.4269	388.0	Fail
10	0.9909	3.2949	332.5	Fail
11	1.2803	3.3437	261.2	Fail
12	1.3796	3.4566	250.5	Fail
13	1.2808	3.4599	270.1	Fail
14	1.3313	3.5895	269.6	Fail
15	1.2976	3.6269	279.5	Fail
16	1.5097	3.6868	244.2	Fail
17	1.5139	3.7125	245.2	Fail
18	1.7717	3.7971	214.3	Fail
19	1.3202	3.6905	279.6	Fail
20	1.3972	3.6267	259.6	Fail
21	1.5243	3.5831	235.1	Fail
22	1.3751	3.4697	252.3	Fail
23	2.1257	3.4344	161.6	Fail
24	1.8498	3.5342	191.1	Fail
25	1.7192	3.6109	210.0	Fail
26	1.4358	3.4767	242.1	Fail
27	1.4023	3.4607	246.8	Fail
28	1.4702	2.9072	197.7	Fail
29	1.5417	3.6107	234.2	Fail
Mar1	1.4697	3.6199	246.3	Fail
2	1.5845	3.6260	228.8	Fail
3	1.5598	3.6042	231.1	Fail
4	1.1632	3.5049	301.3	Fail
5	0.9005	3.2197	357.6	Fail
6	0.9000	3.0883	343.2	Fail
7	0.8260	3.0685	371.5	Fail
8	1.3457	3.2766	243.5	Fail
9	1.2521	3.2811	262.0	Fail
10	1.4807	3.3277	224.7	Fail
11	1.3513	3.2737	242.3	Fail

12	1.1923	3.2304	270.9	Fail
13	1.0018	3.1265	312.1	Fail
14	1.1162	3.1148	279.0	Fail
15	1.1418	3.1606	276.8	Fail
16	1.0903	3.0970	284.0	Fail
17	1.2378	3.0109	243.2	Fail
18	1.1388	3.0365	266.6	Fail
19	0.9810	2.9872	304.5	Fail
20	0.7226	2.8158	389.7	Fail
21	0.9665	2.8403	293.9	Fail
22	1.1613	2.9904	257.5	Fail
23	1.1423	3.0104	263.5	Fail
24	1.0633	2.9459	277.1	Fail
25	1.1435	2.9347	256.6	Fail
26	0.9223	2.8607	310.2	Fail
27	0.9112	2.7868	305.9	Fail
28	0.8218	2.7186	330.8	Fail
29	0.6870	2.6488	385.6	Fail
30	0.8188	2.5110	306.7	Fail
31	0.7743	2.5297	326.7	Fail
Apr1	0.6979	2.5403	364.0	Fail
2	0.6826	2.4609	360.5	Fail
3	0.9145	2.4230	264.9	Fail
4	0.9952	2.4082	242.0	Fail
5	0.8639	2.3578	272.9	Fail
6	0.5532	2.2093	399.4	Fail
7	0.7979	2.2312	279.6	Fail
8	0.7339	2.2496	306.5	Fail
9	0.6846	2.1488	313.9	Fail
10	0.7766	2.2795	293.5	Fail
11	0.8411	2.3961	284.9	Fail
12	0.6714	2.3803	354.5	Fail
13	0.4687	2.3248	496.0	Fail
14	0.4561	2.2551	494.4	Fail
15	0.9118	2.2896	251.1	Fail
16	0.6988	2.2187	317.5	Fail
17	0.4675	2.0435	437.1	Fail
18	0.6154	2.1361	347.1	Fail
19	0.9975	2.0854	209.1	Fail
20	0.4341	1.7443	401.9	Fail
21	0.2796	1.4804	529.5	Fail
22	0.8411	1.4944	177.7	Fail
23	0.7335	1.6167	220.4	Fail
24	0.4817	1.5390	319.5	Fail
25	0.3128	1.4357	459.0	Fail
26	0.4666	1.4165	303.6	Fail
27	0.5709	1.5949	279.4	Fail
28	0.3911	1.5933	407.4	Fail
29	0.5373	1.6765	312.0	Fail
30	0.3801	1.5608	410.6	Fail
May1	0.2441	1.4579	597.3	Fail
2	0.2349	1.4466	615.8	Fail
3	0.2589	1.3559	523.6	Fail
4	0.2726	1.4632	536.7	Fail
5	0.2044	1.4304	699.9	Fail
6	0.1371	1.2610	919.8	Fail
7	0.0693	1.1595	1673.0	Fail

8	0.0392	1.1407	2910.3	Fail
9	0.3758	1.2687	337.6	Fail
10	0.3369	1.4628	434.2	Fail
11	0.2274	1.4541	639.4	Fail
12	0.1626	1.4163	870.8	Fail
13	0.1329	1.3908	1046.8	Fail
14	0.1312	1.3688	1043.4	Fail
15	0.0807	1.3515	1675.0	Fail
16	0.0395	1.2491	3161.7	Fail
17	0.0462	1.1642	2518.2	Fail
18	0.0648	1.2066	1862.0	Fail
19	0.0709	1.3120	1849.8	Fail
20	0.0435	1.2706	2918.8	Fail
21	0.0289	1.0948	3790.6	Fail
22	0.0271	0.9924	3662.8	Fail
23	0.0308	1.0709	3472.2	Fail
24	0.0317	1.0882	3429.2	Fail
25	0.0384	1.0380	2702.0	Fail
26	0.0366	1.1530	3151.9	Fail
27	0.0650	1.3074	2011.8	Fail
28	0.0485	1.2973	2672.4	Fail
29	0.0434	1.4439	3330.2	Fail
30	0.1311	1.5519	1183.6	Fail
31	0.1770	1.5998	903.8	Fail
Jun1	0.1704	1.4845	871.1	Fail
2	0.2650	1.4724	555.6	Fail
3	0.1725	1.4565	844.3	Fail
4	0.1128	1.4202	1259.2	Fail
5	0.0907	1.3222	1457.0	Fail
6	0.2476	1.2905	521.2	Fail
7	0.2177	1.1939	548.4	Fail
8	0.0990	1.1632	1174.5	Fail
9	0.1557	1.3439	863.0	Fail
10	0.1514	1.5210	1004.8	Fail
11	0.0614	1.5906	2589.5	Fail
12	0.0303	1.5416	5086.3	Fail
13	0.0127	1.2687	9970.9	Fail
14	0.0085	1.1116	13081.4	Fail
15	0.0562	1.0594	1884.9	Fail
16	0.1355	1.0814	798.3	Fail
17	0.1540	1.0972	712.6	Fail
18	0.1804	1.1122	616.7	Fail
19	0.0801	1.0376	1296.2	Fail
20	0.1201	0.9713	809.1	Fail
21	0.0969	0.9332	963.0	Fail
22	0.1388	1.0356	746.3	Fail
23	0.0884	1.0984	1242.9	Fail
24	0.0613	1.2966	2115.0	Fail
25	0.0447	1.2478	2791.8	Fail
26	0.0738	1.1137	1509.2	Fail
27	0.0512	1.0545	2059.2	Fail
28	0.1485	1.0605	713.9	Fail
29	0.0719	0.9421	1309.9	Fail
30	0.0489	0.9300	1901.5	Fail
Jul1	0.1508	1.1352	752.8	Fail
2	0.0603	1.1291	1873.0	Fail
3	0.0252	1.0308	4096.6	Fail

4	0.0151	0.9968	6601.0	Fail
5	0.0080	0.9135	11424.9	Fail
6	0.0035	0.7353	20969.4	Fail
7	0.0084	0.7866	9315.6	Fail
8	0.0531	0.7636	1436.6	Fail
9	0.0722	0.6988	967.5	Fail
10	0.0271	0.5755	2121.6	Fail
11	0.0133	0.5425	4091.8	Fail
12	0.0117	0.4824	4128.8	Fail
13	0.0074	0.5258	7151.9	Fail
14	0.0032	0.4335	13540.9	Fail
15	0.0061	0.5860	9661.5	Fail
16	0.0051	0.7054	13710.5	Fail
17	0.0029	0.5987	20948.9	Fail
18	0.0015	0.6161	40274.3	Fail
19	0.0029	0.6157	20931.6	Fail
20	0.0020	0.5101	25106.7	Fail
21	0.0014	0.4351	31920.5	Fail
22	0.0005	0.3798	74159.1	Fail
23	0.0002	0.2875	140941.0	Fail
24	0.0001	0.2779	371980.3	Fail
25	0.0008	0.3860	46707.3	Fail
26	0.0006	0.4212	74125.2	Fail
27	0.0006	0.4022	67496.6	Fail
28	0.0006	0.4035	66000.0	Fail
29	0.0003	0.3350	131939.3	Fail
30	0.0001	0.2334	270795.2	Fail
31	0.0000	0.1969	825742.4	Fail
Aug1	0.0001	0.1461	122759.7	Fail
2	0.0002	0.1396	84543.6	Fail
3	0.0002	0.1838	96539.8	Fail
4	0.0005	0.2272	49414.3	Fail
5	0.0009	0.3219	37619.6	Fail
6	0.0014	0.5047	36420.7	Fail
7	0.0011	0.5349	50467.6	Fail
8	0.0006	0.4838	83929.1	Fail
9	0.0002	0.4015	192482.0	Fail
10	0.0001	0.3677	531908.7	Fail
11	0.0000	0.3501	822155.5	Fail
12	0.0000	0.4340	947298.0	Fail
13	0.0000	0.5428	646407.0	Fail
14	0.0004	0.5864	147676.5	Fail
15	0.0007	0.7555	114254.5	Fail
16	0.0011	0.7466	70387.0	Fail
17	0.0006	0.7596	129237.5	Fail
18	0.0012	0.8010	66756.8	Fail
19	0.0011	0.8838	77854.5	Fail
20	0.0004	0.7110	171467.4	Fail
21	0.0004	0.8527	215762.2	Fail
22	0.0020	0.9762	49077.8	Fail
23	0.0030	1.0778	35512.8	Fail
24	0.0020	1.0392	51666.4	Fail
25	0.0035	1.0119	29194.0	Fail
26	0.0029	1.1374	39414.9	Fail
27	0.0013	1.1937	93662.0	Fail
28	0.0007	1.0802	147142.6	Fail
29	0.0005	1.0140	214589.5	Fail

30	0.0005	1.0430	218603.6	Fail
31	0.0008	1.0307	130658.0	Fail
Sep1	0.0009	1.0152	116127.5	Fail
2	0.0008	0.8917	108562.9	Fail
3	0.0008	0.9009	111433.0	Fail
4	0.0008	0.8191	104064.5	Fail
5	0.0009	0.8823	101277.9	Fail
6	0.0006	0.8552	155012.4	Fail
7	0.0006	0.9306	151650.7	Fail
8	0.0014	1.0403	76293.1	Fail
9	0.0014	1.1350	81606.7	Fail
10	0.0037	1.3268	35876.8	Fail
11	0.0020	1.1961	60834.5	Fail
12	0.0010	1.0519	101852.1	Fail
13	0.0017	1.1001	65408.5	Fail
14	0.0021	1.1636	56571.6	Fail
15	0.0011	1.1516	102598.6	Fail
16	0.0032	1.3039	40472.2	Fail
17	0.0021	1.2734	61006.4	Fail
18	0.0009	1.2347	137040.1	Fail
19	0.0011	1.2782	113897.9	Fail
20	0.0024	1.2691	51872.7	Fail
21	0.0063	1.1734	18766.2	Fail
22	0.0125	1.1862	9504.1	Fail
23	0.0073	1.1995	16362.9	Fail
24	0.0026	1.2014	46877.1	Fail
25	0.0012	1.2471	107232.8	Fail
26	0.0006	1.2294	193373.5	Fail
27	0.0006	1.2546	217668.4	Fail
28	0.0031	1.1786	38131.6	Fail
29	0.0024	1.2331	52094.1	Fail
30	0.0054	1.2199	22697.2	Fail
Oct1	0.0050	1.2517	24879.2	Fail
2	0.0021	1.3002	62522.9	Fail
3	0.0032	1.3837	42838.7	Fail
4	0.0038	1.4829	38518.7	Fail
5	0.0191	1.5777	8243.3	Fail
6	0.0240	1.6245	6769.7	Fail
7	0.0179	1.7559	9802.5	Fail
8	0.0269	1.8545	6900.6	Fail
9	0.0129	1.8787	14525.2	Fail
10	0.0080	1.9629	24422.0	Fail
11	0.0036	1.9436	53709.9	Fail
12	0.0024	1.9634	82795.7	Fail
13	0.0043	1.9084	44370.0	Fail
14	0.0035	1.8206	51516.6	Fail
15	0.0037	1.7869	48778.0	Fail
16	0.0088	1.8211	20789.8	Fail
17	0.0115	1.8611	16180.6	Fail
18	0.0143	2.0056	14027.1	Fail
19	0.0218	2.2839	10494.0	Fail
20	0.0168	2.4225	14419.3	Fail
21	0.0139	2.4335	17552.7	Fail
22	0.0162	2.4945	15357.8	Fail
23	0.0166	2.5575	15370.5	Fail
24	0.0162	2.7463	17001.9	Fail
25	0.0277	2.8483	10268.9	Fail

26	0.0875	2.7863	3184.5	Fail
27	0.0787	2.9714	3773.5	Fail
28	0.0402	2.9367	7310.9	Fail
29	0.0535	2.8741	5376.0	Fail
30	0.0367	2.7485	7488.1	Fail
31	0.0341	2.7838	8174.7	Fail
Nov1	0.0407	2.8133	6920.3	Fail
2	0.0408	2.7465	6726.5	Fail
3	0.0801	3.0937	3860.3	Fail
4	0.0463	3.1121	6723.1	Fail
5	0.0681	3.0977	4551.7	Fail
6	0.0955	3.0663	3211.3	Fail
7	0.0856	3.0516	3565.4	Fail
8	0.0716	3.1162	4350.4	Fail
9	0.0710	3.3153	4671.4	Fail
10	0.1404	3.5313	2515.8	Fail
11	0.2507	3.7412	1492.0	Fail
12	0.2593	3.8674	1491.3	Fail
13	0.2779	3.9783	1431.6	Fail
14	0.3554	3.9130	1101.0	Fail
15	0.3419	3.9533	1156.2	Fail
16	0.2815	4.0826	1450.5	Fail
17	0.3102	4.2114	1357.8	Fail
18	0.5558	4.2592	766.3	Fail
19	0.9395	4.6646	496.5	Fail
20	0.9511	4.5499	478.4	Fail
21	0.5747	4.3915	764.1	Fail
22	0.7954	4.2779	537.8	Fail
23	1.5248	4.9899	327.2	Fail
24	1.2414	4.9425	398.1	Fail
25	0.8902	4.7598	534.7	Fail
26	0.8543	4.7505	556.0	Fail
27	0.7336	4.7192	643.3	Fail
28	0.9781	4.6905	479.6	Fail
29	1.1389	4.7310	415.4	Fail
30	1.1876	4.8149	405.4	Fail
Dec1	0.9395	4.9342	525.2	Fail
2	1.6866	5.6017	332.1	Fail
3	1.4768	5.4670	370.2	Fail
4	1.3415	5.3248	396.9	Fail
5	1.4484	5.3429	368.9	Fail
6	1.0390	5.2172	502.1	Fail
7	0.9469	5.0660	535.0	Fail
8	0.8852	4.9164	555.4	Fail
9	1.0905	4.8621	445.9	Fail
10	1.3067	4.8935	374.5	Fail
11	1.7310	4.9316	284.9	Fail
12	1.5599	4.8421	310.4	Fail
13	1.6068	4.7980	298.6	Fail
14	2.3230	5.1975	223.7	Fail
15	1.8021	5.2545	291.6	Fail
16	1.3717	5.2249	380.9	Fail
17	1.1174	4.9740	445.1	Fail
18	1.4314	4.8057	335.7	Fail
19	1.8143	4.9196	271.2	Fail
20	1.6060	5.0206	312.6	Fail
21	1.2068	5.0845	421.3	Fail

22	1.3107	4.9907	380.8	Fail
23	1.5466	4.9303	318.8	Fail
24	1.7738	4.8063	271.0	Fail
25	1.5265	4.7099	308.5	Fail
26	1.6967	4.9226	290.1	Fail
27	1.1631	4.7635	409.6	Fail
28	1.5047	4.5614	303.1	Fail
29	1.5716	4.8515	308.7	Fail
30	1.5024	4.9016	326.3	Fail
31	2.3407	5.8488	249.9	Fail

LID Report

LID Technique Used for Total Volumn Volumn Infiltration Cumulative
Percent Water Quality Percent Comment
Treatment? Needs Through Volumn Volumn
Volumn Water Quality
Treatment Facility (ac-ft) Infiltration
Infiltrated Treated
(ac-ft) (ac-ft) Credit

Trapezoidal Pond 1 POC N 1018.16 N 0.00
Total Volume Infiltrated 1018.16 0.00 0.00 0.00
0.00 0% No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_EB1 PreDev
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Predeveloped Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Flat	.343
SAT, Forest, Flat	.114
Pervious Total	0.457

Impervious Land Use	Acres
Impervious Total	0
Basin Total	0.457

Element Flows To:

Surface	Interflow	Groundwater

POST-RETROFIT LAND USE

Name : East Bioretention 1
Bottom Length: 200.00 ft.
Bottom Width: 2.50 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW

Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 39.14
Total Outflow (ac-ft): 39.14
Percent Through Underdrain: 100
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:
Outlet 1 **Outlet 2**

East Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0597	0.0000	0.0000	0.0000
0.0495	0.0592	0.0002	0.0000	0.0000
0.0989	0.0585	0.0005	0.0000	0.0000
0.1484	0.0578	0.0007	0.0000	0.0000
0.1978	0.0571	0.0010	0.0000	0.0000
0.2473	0.0564	0.0013	0.0000	0.0000
0.2967	0.0558	0.0016	0.0000	0.0000
0.3462	0.0551	0.0019	0.0000	0.0000
0.3956	0.0544	0.0022	0.0000	0.0000
0.4451	0.0537	0.0025	0.0000	0.0000
0.4945	0.0530	0.0029	0.0000	0.0000
0.5440	0.0523	0.0033	0.0000	0.0000
0.5934	0.0517	0.0036	0.0000	0.0000
0.6429	0.0510	0.0040	0.0000	0.0000
0.6923	0.0503	0.0044	0.0000	0.0000
0.7418	0.0496	0.0048	0.0000	0.0000
0.7912	0.0489	0.0053	0.0000	0.0000
0.8407	0.0483	0.0057	0.0000	0.0000
0.8901	0.0476	0.0062	0.0000	0.0000
0.9396	0.0469	0.0066	0.0000	0.0000
0.9890	0.0462	0.0071	0.0000	0.0000
1.0385	0.0455	0.0076	0.0000	0.0000
1.0879	0.0449	0.0081	0.0000	0.0000
1.1374	0.0442	0.0086	0.0000	0.0000
1.1868	0.0435	0.0092	0.0000	0.0000
1.2363	0.0428	0.0097	0.0000	0.0000
1.2857	0.0421	0.0103	0.0000	0.0000
1.3352	0.0414	0.0108	0.0000	0.0000
1.3846	0.0408	0.0114	0.0000	0.0000
1.4341	0.0401	0.0120	0.0000	0.0000
1.4835	0.0394	0.0126	0.0000	0.0000
1.5330	0.0387	0.0130	0.0000	0.0000
1.5824	0.0380	0.0133	0.0000	0.0000

1.6319	0.0374	0.0136	0.0000	0.0000
1.6813	0.0367	0.0140	0.0000	0.0000
1.7308	0.0360	0.0144	0.0000	0.0000
1.7802	0.0353	0.0147	0.0000	0.0000
1.8297	0.0346	0.0151	0.0000	0.0000
1.8791	0.0340	0.0155	0.0000	0.0000
1.9286	0.0333	0.0159	0.0000	0.0000
1.9780	0.0326	0.0163	0.0000	0.0000
2.0275	0.0319	0.0171	0.0000	0.0000
2.0769	0.0312	0.0179	0.0278	0.0000
2.1264	0.0306	0.0187	0.0295	0.0000
2.1758	0.0299	0.0195	0.0330	0.0000
2.2253	0.0292	0.0204	0.0351	0.0000
2.2747	0.0285	0.0213	0.0408	0.0000
2.3242	0.0278	0.0222	0.0429	0.0000
2.3736	0.0271	0.0231	0.0474	0.0000
2.4231	0.0265	0.0240	0.0513	0.0000
2.4725	0.0258	0.0249	0.0570	0.0000
2.5220	0.0251	0.0258	0.0595	0.0000
2.5714	0.0244	0.0268	0.0634	0.0000
2.6209	0.0237	0.0278	0.0694	0.0000
2.6703	0.0231	0.0288	0.0694	0.0000
2.7198	0.0224	0.0297	0.0694	0.0000
2.7692	0.0217	0.0308	0.0694	0.0000
2.8187	0.0210	0.0318	0.0694	0.0000
2.8681	0.0203	0.0328	0.0694	0.0000
2.9176	0.0197	0.0339	0.0694	0.0000
2.9670	0.0190	0.0349	0.0694	0.0000
3.0165	0.0183	0.0360	0.0694	0.0000
3.0659	0.0176	0.0371	0.0694	0.0000
3.1154	0.0169	0.0382	0.0694	0.0000
3.1648	0.0162	0.0394	0.0694	0.0000
3.2143	0.0156	0.0405	0.0694	0.0000
3.2637	0.0149	0.0416	0.0694	0.0000
3.3132	0.0142	0.0428	0.0694	0.0000
3.3626	0.0135	0.0440	0.0694	0.0000
3.4121	0.0128	0.0452	0.0694	0.0000
3.4615	0.0122	0.0464	0.0694	0.0000
3.5000	0.0115	0.0473	0.0694	0.0000

Surface oretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.0597	0.0473	0.0000	0.0717	0.0000
3.5495	0.0604	0.0503	0.0000	0.0717	0.0000
3.5989	0.0611	0.0533	0.0000	0.0740	0.0000
3.6484	0.0617	0.0563	0.0000	0.0763	0.0000
3.6978	0.0624	0.0594	0.0000	0.0786	0.0000
3.7473	0.0631	0.0625	0.0000	0.0809	0.0000
3.7967	0.0638	0.0657	0.0000	0.0832	0.0000
3.8462	0.0645	0.0688	0.0000	0.0855	0.0000
3.8956	0.0651	0.0720	0.0000	0.0878	0.0000
3.9451	0.0658	0.0753	0.0000	0.0900	0.0000
3.9945	0.0665	0.0785	0.0000	0.0923	0.0000
4.0440	0.0672	0.0818	7.4793	0.0946	0.0000
4.0934	0.0679	0.0852	23.169	0.0969	0.0000
4.1429	0.0685	0.0886	43.821	0.0992	0.0000
4.1923	0.0692	0.0920	68.443	0.1015	0.0000

4.2418	0.0699	0.0954	96.473	0.1038	0.0000
4.2912	0.0706	0.0989	127.54	0.1061	0.0000
4.3407	0.0713	0.1024	161.37	0.1084	0.0000
4.3901	0.0719	0.1059	197.75	0.1107	0.0000
4.4396	0.0726	0.1095	236.52	0.1129	0.0000
4.4890	0.0733	0.1131	277.53	0.1152	0.0000
4.5000	0.0735	0.1139	320.68	0.1157	0.0000

Name : Surface oretention 1

Element Flows To:
Outlet 1 **Outlet 2**
East Bioretention 1

Name : East Bioretention 1 Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.14**
Pervious Total	**0.14**

Impervious Land Use	**Acres**
ROADS FLAT	**0.31**
Impervious Total	**0.31**
Basin Total	**0.45**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface oretention 1	Surface oretention 1	

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.457
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1

Total Pervious Area:0.14
Total Impervious Area:0.31

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.004407
5 year	0.007401
10 year	0.009591
25 year	0.012535
50 year	0.014831
100 year	0.0172

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.045174
5 year	0.054349
10 year	0.059988
25 year	0.066751
50 year	0.071582
100 year	0.07627

Stream Protection Duration
Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	Predeveloped	Post-Retrofit
1949	0.001	0.038
1950	0.005	0.055
1951	0.004	0.044
1952	0.003	0.043
1953	0.002	0.047
1954	0.006	0.049
1955	0.010	0.059
1956	0.008	0.035
1957	0.007	0.050
1958	0.005	0.063
1959	0.004	0.044
1960	0.004	0.041
1961	0.005	0.069
1962	0.003	0.042
1963	0.004	0.058
1964	0.004	0.042
1965	0.005	0.029
1966	0.002	0.034
1967	0.006	0.041
1968	0.006	0.050
1969	0.003	0.052
1970	0.003	0.036
1971	0.005	0.055
1972	0.005	0.063
1973	0.003	0.050
1974	0.004	0.049
1975	0.004	0.051
1976	0.004	0.045
1977	0.002	0.037
1978	0.003	0.034
1979	0.007	0.064

1980	0.004	0.036
1981	0.003	0.041
1982	0.007	0.044
1983	0.004	0.047
1984	0.005	0.044
1985	0.007	0.053
1986	0.019	0.063
1987	0.007	0.049
1988	0.004	0.037
1989	0.003	0.044
1990	0.004	0.033
1991	0.005	0.042
1992	0.004	0.036
1993	0.002	0.038
1994	0.002	0.031
1995	0.004	0.043
1996	0.015	0.048
1997	0.028	0.066
1998	0.003	0.056
1999	0.006	0.034
2000	0.004	0.034
2001	0.001	0.041
2002	0.004	0.034
2003	0.003	0.033
2004	0.004	0.064
2005	0.004	0.058
2006	0.012	0.049
2007	0.007	0.048
2008	0.010	0.066
2009	0.005	0.048

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	**Predeveloped**	**Post-Retrofit**
1	0.0278	0.0693
2	0.0185	0.0664
3	0.0147	0.0657
4	0.0123	0.0638
5	0.0105	0.0636
6	0.0097	0.0629
7	0.0078	0.0629
8	0.0071	0.0628
9	0.0069	0.0587
10	0.0066	0.0584
11	0.0066	0.0577
12	0.0065	0.0562
13	0.0065	0.0553
14	0.0060	0.0545
15	0.0060	0.0533
16	0.0059	0.0518
17	0.0057	0.0506
18	0.0054	0.0503
19	0.0052	0.0503
20	0.0050	0.0496
21	0.0049	0.0494
22	0.0048	0.0493

23	0.0047	0.0488
24	0.0047	0.0485
25	0.0046	0.0483
26	0.0045	0.0477
27	0.0045	0.0477
28	0.0045	0.0474
29	0.0044	0.0473
30	0.0044	0.0453
31	0.0044	0.0444
32	0.0043	0.0442
33	0.0042	0.0441
34	0.0041	0.0438
35	0.0040	0.0438
36	0.0038	0.0432
37	0.0038	0.0428
38	0.0037	0.0424
39	0.0037	0.0421
40	0.0036	0.0417
41	0.0036	0.0415
42	0.0036	0.0412
43	0.0036	0.0409
44	0.0036	0.0408
45	0.0034	0.0381
46	0.0034	0.0380
47	0.0033	0.0367
48	0.0032	0.0367
49	0.0032	0.0362
50	0.0030	0.0358
51	0.0028	0.0355
52	0.0028	0.0347
53	0.0027	0.0343
54	0.0026	0.0343
55	0.0024	0.0342
56	0.0023	0.0341
57	0.0023	0.0337
58	0.0018	0.0334
59	0.0016	0.0330
60	0.0006	0.0315
61	0.0005	0.0294

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0022	22351	180586	807	Fail
0.0023	19733	174041	881	Fail
0.0025	17269	167817	971	Fail
0.0026	15169	161806	1066	Fail
0.0027	13458	156331	1161	Fail
0.0028	11926	151582	1271	Fail
0.0030	10609	147326	1388	Fail
0.0031	9488	143412	1511	Fail
0.0032	8476	139926	1650	Fail
0.0034	7595	136439	1796	Fail

0.0035	6791	133252	1962	Fail
0.0036	6012	130258	2166	Fail
0.0037	5358	127392	2377	Fail
0.0039	4810	124697	2592	Fail
0.0040	4331	122044	2817	Fail
0.0041	3903	119435	3060	Fail
0.0042	3501	116911	3339	Fail
0.0044	3195	114537	3584	Fail
0.0045	2924	112099	3833	Fail
0.0046	2674	109682	4101	Fail
0.0048	2470	107329	4345	Fail
0.0049	2276	105083	4617	Fail
0.0050	2104	102795	4885	Fail
0.0051	1957	100656	5143	Fail
0.0053	1805	98388	5450	Fail
0.0054	1668	96185	5766	Fail
0.0055	1535	94068	6128	Fail
0.0056	1438	91908	6391	Fail
0.0058	1355	89940	6637	Fail
0.0059	1279	88058	6884	Fail
0.0060	1216	86282	7095	Fail
0.0062	1157	84657	7316	Fail
0.0063	1105	83074	7518	Fail
0.0064	1059	81534	7699	Fail
0.0065	1010	80122	7932	Fail
0.0067	955	78796	8250	Fail
0.0068	905	77534	8567	Fail
0.0069	867	76208	8789	Fail
0.0071	831	75011	9026	Fail
0.0072	803	73813	9192	Fail
0.0073	776	72679	9365	Fail
0.0074	745	71481	9594	Fail
0.0076	718	70348	9797	Fail
0.0077	685	69257	10110	Fail
0.0078	656	68166	10391	Fail
0.0079	626	67118	10721	Fail
0.0081	604	66091	10942	Fail
0.0082	579	65065	11237	Fail
0.0083	557	64038	11496	Fail
0.0085	536	63011	11755	Fail
0.0086	517	62028	11997	Fail
0.0087	500	61044	12208	Fail
0.0088	483	60038	12430	Fail
0.0090	466	59140	12690	Fail
0.0091	441	58242	13206	Fail
0.0092	413	57386	13894	Fail
0.0093	397	56531	14239	Fail
0.0095	381	55675	14612	Fail
0.0096	367	54819	14937	Fail
0.0097	352	54028	15348	Fail
0.0099	336	53173	15825	Fail
0.0100	325	52381	16117	Fail
0.0101	314	51633	16443	Fail
0.0102	308	50970	16548	Fail
0.0104	302	50221	16629	Fail
0.0105	291	49472	17000	Fail
0.0106	283	48745	17224	Fail

0.0107	275	48082	17484	Fail
0.0109	266	47355	17802	Fail
0.0110	259	46628	18003	Fail
0.0111	251	45922	18295	Fail
0.0113	248	45280	18258	Fail
0.0114	241	44596	18504	Fail
0.0115	237	43911	18527	Fail
0.0116	235	43291	18421	Fail
0.0118	226	42713	18899	Fail
0.0119	219	42072	19210	Fail
0.0120	216	41473	19200	Fail
0.0122	211	40853	19361	Fail
0.0123	205	40318	19667	Fail
0.0124	198	39676	20038	Fail
0.0125	194	39056	20131	Fail
0.0127	190	38478	20251	Fail
0.0128	182	37944	20848	Fail
0.0129	178	37430	21028	Fail
0.0130	175	36938	21107	Fail
0.0132	170	36447	21439	Fail
0.0133	166	35955	21659	Fail
0.0134	161	35484	22039	Fail
0.0136	158	34949	22119	Fail
0.0137	153	34500	22549	Fail
0.0138	149	34008	22824	Fail
0.0139	144	33602	23334	Fail
0.0141	141	33110	23482	Fail
0.0142	139	32639	23481	Fail
0.0143	135	32212	23860	Fail
0.0144	130	31827	24482	Fail
0.0146	127	31420	24740	Fail
0.0147	123	30950	25162	Fail
0.0148	117	30543	26105	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.457
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.14
Total Impervious Area:0.31

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.004407
5 year	0.007401
10 year	0.009591
25 year	0.012535
50 year	0.014831
100 year	0.0172

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.045174
5 year	0.054349
10 year	0.059988
25 year	0.066751
50 year	0.071582
100 year	0.07627

LID Duration

Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	Predeveloped	Post-Retrofit
1949	0.001	0.038
1950	0.005	0.055
1951	0.004	0.044
1952	0.003	0.043
1953	0.002	0.047
1954	0.006	0.049
1955	0.010	0.059
1956	0.008	0.035
1957	0.007	0.050
1958	0.005	0.063
1959	0.004	0.044
1960	0.004	0.041
1961	0.005	0.069
1962	0.003	0.042
1963	0.004	0.058
1964	0.004	0.042
1965	0.005	0.029
1966	0.002	0.034
1967	0.006	0.041
1968	0.006	0.050
1969	0.003	0.052
1970	0.003	0.036
1971	0.005	0.055
1972	0.005	0.063
1973	0.003	0.050
1974	0.004	0.049
1975	0.004	0.051
1976	0.004	0.045
1977	0.002	0.037
1978	0.003	0.034
1979	0.007	0.064
1980	0.004	0.036
1981	0.003	0.041
1982	0.007	0.044
1983	0.004	0.047

1984	0.005	0.044
1985	0.007	0.053
1986	0.019	0.063
1987	0.007	0.049
1988	0.004	0.037
1989	0.003	0.044
1990	0.004	0.033
1991	0.005	0.042
1992	0.004	0.036
1993	0.002	0.038
1994	0.002	0.031
1995	0.004	0.043
1996	0.015	0.048
1997	0.028	0.066
1998	0.003	0.056
1999	0.006	0.034
2000	0.004	0.034
2001	0.001	0.041
2002	0.004	0.034
2003	0.003	0.033
2004	0.004	0.064
2005	0.004	0.058
2006	0.012	0.049
2007	0.007	0.048
2008	0.010	0.066
2009	0.005	0.048

LID Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	Predeveloped	Post-Retrofit
1	0.0278	0.0693
2	0.0185	0.0664
3	0.0147	0.0657
4	0.0123	0.0638
5	0.0105	0.0636
6	0.0097	0.0629
7	0.0078	0.0629
8	0.0071	0.0628
9	0.0069	0.0587
10	0.0066	0.0584
11	0.0066	0.0577
12	0.0065	0.0562
13	0.0065	0.0553
14	0.0060	0.0545
15	0.0060	0.0533
16	0.0059	0.0518
17	0.0057	0.0506
18	0.0054	0.0503
19	0.0052	0.0503
20	0.0050	0.0496
21	0.0049	0.0494
22	0.0048	0.0493
23	0.0047	0.0488
24	0.0047	0.0485
25	0.0046	0.0483
26	0.0045	0.0477

27	0.0045	0.0477
28	0.0045	0.0474
29	0.0044	0.0473
30	0.0044	0.0453
31	0.0044	0.0444
32	0.0043	0.0442
33	0.0042	0.0441
34	0.0041	0.0438
35	0.0040	0.0438
36	0.0038	0.0432
37	0.0038	0.0428
38	0.0037	0.0424
39	0.0037	0.0421
40	0.0036	0.0417
41	0.0036	0.0415
42	0.0036	0.0412
43	0.0036	0.0409
44	0.0036	0.0408
45	0.0034	0.0381
46	0.0034	0.0380
47	0.0033	0.0367
48	0.0032	0.0367
49	0.0032	0.0362
50	0.0030	0.0358
51	0.0028	0.0355
52	0.0028	0.0347
53	0.0027	0.0343
54	0.0026	0.0343
55	0.0024	0.0342
56	0.0023	0.0341
57	0.0023	0.0337
58	0.0018	0.0334
59	0.0016	0.0330
60	0.0006	0.0315
61	0.0005	0.0294

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0004	221802	438257	197	Fail
0.0004	213738	429487	200	Fail
0.0004	206637	421787	204	Fail
0.0004	199451	414087	207	Fail
0.0004	192542	406601	211	Fail
0.0004	186168	399329	214	Fail
0.0005	180286	392912	217	Fail
0.0005	174361	386496	221	Fail
0.0005	168865	380293	225	Fail
0.0005	163902	374518	228	Fail
0.0005	158983	368743	231	Fail
0.0006	154320	363182	235	Fail
0.0006	150042	358262	238	Fail
0.0006	145765	353129	242	Fail

0.0006	141594	347996	245	Fail
0.0006	137616	343290	249	Fail
0.0007	133979	338799	252	Fail
0.0007	130279	334307	256	Fail
0.0007	126750	330029	260	Fail
0.0007	123478	325965	263	Fail
0.0007	120162	321901	267	Fail
0.0007	116911	318051	272	Fail
0.0008	113981	314415	275	Fail
0.0008	111051	310779	279	Fail
0.0008	108142	306929	283	Fail
0.0008	105490	303721	287	Fail
0.0008	102795	300299	292	Fail
0.0009	100185	296877	296	Fail
0.0009	97747	293668	300	Fail
0.0009	95480	290674	304	Fail
0.0009	93212	287679	308	Fail
0.0009	91031	284685	312	Fail
0.0010	89042	282118	316	Fail
0.0010	87031	279338	320	Fail
0.0010	85020	276557	325	Fail
0.0010	83181	273991	329	Fail
0.0010	81277	271424	333	Fail
0.0010	79481	268857	338	Fail
0.0011	77684	266504	343	Fail
0.0011	76037	264152	347	Fail
0.0011	74347	261799	352	Fail
0.0011	72658	259446	357	Fail
0.0011	71096	257521	362	Fail
0.0012	69535	255382	367	Fail
0.0012	68059	253243	372	Fail
0.0012	66690	251318	376	Fail
0.0012	65236	249180	381	Fail
0.0012	63824	247255	387	Fail
0.0012	62541	245543	392	Fail
0.0013	61193	243618	398	Fail
0.0013	59889	241693	403	Fail
0.0013	58627	239982	409	Fail
0.0013	57429	238271	414	Fail
0.0013	56167	236560	421	Fail
0.0014	54948	234635	427	Fail
0.0014	53793	233138	433	Fail
0.0014	52616	231641	440	Fail
0.0014	51504	229930	446	Fail
0.0014	50456	228432	452	Fail
0.0015	49430	226935	459	Fail
0.0015	48424	225438	465	Fail
0.0015	47440	223941	472	Fail
0.0015	46478	222444	478	Fail
0.0015	45515	220946	485	Fail
0.0015	44574	219663	492	Fail
0.0016	43697	218380	499	Fail
0.0016	42820	216882	506	Fail
0.0016	41922	215599	514	Fail
0.0016	41088	214316	521	Fail
0.0016	40232	213011	529	Fail
0.0017	39420	211728	537	Fail

0.0017	38628	210487	544	Fail
0.0017	37922	209332	552	Fail
0.0017	37131	208092	560	Fail
0.0017	36382	206851	568	Fail
0.0018	35677	205717	576	Fail
0.0018	34928	204541	585	Fail
0.0018	34243	203386	593	Fail
0.0018	33623	202252	601	Fail
0.0018	32960	201097	610	Fail
0.0018	32297	199964	619	Fail
0.0019	31698	198937	627	Fail
0.0019	31035	197846	637	Fail
0.0019	30415	196756	646	Fail
0.0019	29795	195686	656	Fail
0.0019	29238	194659	665	Fail
0.0020	28661	193569	675	Fail
0.0020	28105	192542	685	Fail
0.0020	27549	191537	695	Fail
0.0020	26993	190510	705	Fail
0.0020	26458	189483	716	Fail
0.0021	25987	188478	725	Fail
0.0021	25495	187516	735	Fail
0.0021	25004	186510	745	Fail
0.0021	24512	185505	756	Fail
0.0021	24105	184564	765	Fail
0.0021	23635	183580	776	Fail
0.0022	23185	182553	787	Fail
0.0022	22758	181570	797	Fail
0.0022	22351	180586	807	Fail

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_EB1
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PRE-RETROFIT LAND USE

Name : Pre-Retrofit Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	.14
Pervious Total	0.14

Impervious Land Use	Acres
ROADS FLAT	0.31
Impervious Total	0.31
Basin Total	0.45

Element Flows To:

Surface	Interflow	Groundwater

MITIGATED LAND USE

Name : East Bioretention 1
Bottom Length: 200.00 ft.
Bottom Width: 2.50 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW

Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 39.14
Total Outflow (ac-ft): 39.14
Percent Through Underdrain: 100
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:
Outlet 1 **Outlet 2**

East Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0597	0.0000	0.0000	0.0000
0.0495	0.0592	0.0002	0.0000	0.0000
0.0989	0.0585	0.0005	0.0000	0.0000
0.1484	0.0578	0.0007	0.0000	0.0000
0.1978	0.0571	0.0010	0.0000	0.0000
0.2473	0.0564	0.0013	0.0000	0.0000
0.2967	0.0558	0.0016	0.0000	0.0000
0.3462	0.0551	0.0019	0.0000	0.0000
0.3956	0.0544	0.0022	0.0000	0.0000
0.4451	0.0537	0.0025	0.0000	0.0000
0.4945	0.0530	0.0029	0.0000	0.0000
0.5440	0.0523	0.0033	0.0000	0.0000
0.5934	0.0517	0.0036	0.0000	0.0000
0.6429	0.0510	0.0040	0.0000	0.0000
0.6923	0.0503	0.0044	0.0000	0.0000
0.7418	0.0496	0.0048	0.0000	0.0000
0.7912	0.0489	0.0053	0.0000	0.0000
0.8407	0.0483	0.0057	0.0000	0.0000
0.8901	0.0476	0.0062	0.0000	0.0000
0.9396	0.0469	0.0066	0.0000	0.0000
0.9890	0.0462	0.0071	0.0000	0.0000
1.0385	0.0455	0.0076	0.0000	0.0000
1.0879	0.0449	0.0081	0.0000	0.0000
1.1374	0.0442	0.0086	0.0000	0.0000
1.1868	0.0435	0.0092	0.0000	0.0000
1.2363	0.0428	0.0097	0.0000	0.0000
1.2857	0.0421	0.0103	0.0000	0.0000
1.3352	0.0414	0.0108	0.0000	0.0000
1.3846	0.0408	0.0114	0.0000	0.0000
1.4341	0.0401	0.0120	0.0000	0.0000
1.4835	0.0394	0.0126	0.0000	0.0000
1.5330	0.0387	0.0130	0.0000	0.0000
1.5824	0.0380	0.0133	0.0000	0.0000

1.6319	0.0374	0.0136	0.0000	0.0000
1.6813	0.0367	0.0140	0.0000	0.0000
1.7308	0.0360	0.0144	0.0000	0.0000
1.7802	0.0353	0.0147	0.0000	0.0000
1.8297	0.0346	0.0151	0.0000	0.0000
1.8791	0.0340	0.0155	0.0000	0.0000
1.9286	0.0333	0.0159	0.0000	0.0000
1.9780	0.0326	0.0163	0.0000	0.0000
2.0275	0.0319	0.0171	0.0000	0.0000
2.0769	0.0312	0.0179	0.0278	0.0000
2.1264	0.0306	0.0187	0.0295	0.0000
2.1758	0.0299	0.0195	0.0330	0.0000
2.2253	0.0292	0.0204	0.0351	0.0000
2.2747	0.0285	0.0213	0.0408	0.0000
2.3242	0.0278	0.0222	0.0429	0.0000
2.3736	0.0271	0.0231	0.0474	0.0000
2.4231	0.0265	0.0240	0.0513	0.0000
2.4725	0.0258	0.0249	0.0570	0.0000
2.5220	0.0251	0.0258	0.0595	0.0000
2.5714	0.0244	0.0268	0.0634	0.0000
2.6209	0.0237	0.0278	0.0694	0.0000
2.6703	0.0231	0.0288	0.0694	0.0000
2.7198	0.0224	0.0297	0.0694	0.0000
2.7692	0.0217	0.0308	0.0694	0.0000
2.8187	0.0210	0.0318	0.0694	0.0000
2.8681	0.0203	0.0328	0.0694	0.0000
2.9176	0.0197	0.0339	0.0694	0.0000
2.9670	0.0190	0.0349	0.0694	0.0000
3.0165	0.0183	0.0360	0.0694	0.0000
3.0659	0.0176	0.0371	0.0694	0.0000
3.1154	0.0169	0.0382	0.0694	0.0000
3.1648	0.0162	0.0394	0.0694	0.0000
3.2143	0.0156	0.0405	0.0694	0.0000
3.2637	0.0149	0.0416	0.0694	0.0000
3.3132	0.0142	0.0428	0.0694	0.0000
3.3626	0.0135	0.0440	0.0694	0.0000
3.4121	0.0128	0.0452	0.0694	0.0000
3.4615	0.0122	0.0464	0.0694	0.0000
3.5000	0.0115	0.0473	0.0694	0.0000

Surface Bioretention Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.0597	0.0473	0.0000	0.0717	0.0000
3.5495	0.0604	0.0503	0.0000	0.0717	0.0000
3.5989	0.0611	0.0533	0.0000	0.0740	0.0000
3.6484	0.0617	0.0563	0.0000	0.0763	0.0000
3.6978	0.0624	0.0594	0.0000	0.0786	0.0000
3.7473	0.0631	0.0625	0.0000	0.0809	0.0000
3.7967	0.0638	0.0657	0.0000	0.0832	0.0000
3.8462	0.0645	0.0688	0.0000	0.0855	0.0000
3.8956	0.0651	0.0720	0.0000	0.0878	0.0000
3.9451	0.0658	0.0753	0.0000	0.0900	0.0000
3.9945	0.0665	0.0785	0.0000	0.0923	0.0000
4.0440	0.0672	0.0818	7.4793	0.0946	0.0000
4.0934	0.0679	0.0852	23.169	0.0969	0.0000
4.1429	0.0685	0.0886	43.821	0.0992	0.0000
4.1923	0.0692	0.0920	68.443	0.1015	0.0000

4.2418	0.0699	0.0954	96.473	0.1038	0.0000
4.2912	0.0706	0.0989	127.54	0.1061	0.0000
4.3407	0.0713	0.1024	161.37	0.1084	0.0000
4.3901	0.0719	0.1059	197.75	0.1107	0.0000
4.4396	0.0726	0.1095	236.52	0.1129	0.0000
4.4890	0.0733	0.1131	277.53	0.1152	0.0000
4.5000	0.0735	0.1139	320.68	0.1157	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1	**Outlet 2**
East Bioretention 1	

Name : East Bioretention 1 Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.14**

Pervious Total **0.14**

Impervious Land Use	**Acres**
ROADS FLAT	**0.31**

Impervious Total **0.31**

Basin Total **0.45**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface Bioretention	Surface Bioretention	

ANALYSIS RESULTS

Stream Protection Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.14
Total Impervious Area:0.31

Mitigated Landuse Totals for POC #1

Total Pervious Area:0.14
Total Impervious Area:0.31

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.102942
5 year	0.142523
10 year	0.171986
25 year	0.213092
50 year	0.246647
100 year	0.282815

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.045174
5 year	0.054349
10 year	0.059988
25 year	0.066751
50 year	0.071582
100 year	0.07627

Stream Protection Duration
Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Year	Pre-Retrofit	Mitigated
1949	0.099	0.038
1950	0.132	0.055
1951	0.106	0.044
1952	0.092	0.043
1953	0.125	0.047
1954	0.174	0.049
1955	0.125	0.059
1956	0.056	0.035
1957	0.103	0.050
1958	0.237	0.063
1959	0.096	0.044
1960	0.087	0.041
1961	0.339	0.069
1962	0.112	0.042
1963	0.147	0.058
1964	0.075	0.042
1965	0.071	0.029
1966	0.073	0.034
1967	0.207	0.041
1968	0.114	0.050
1969	0.229	0.052
1970	0.080	0.036
1971	0.120	0.055
1972	0.154	0.063
1973	0.122	0.050
1974	0.151	0.049
1975	0.119	0.051
1976	0.081	0.045
1977	0.079	0.037
1978	0.063	0.034
1979	0.147	0.064

1980	0.071	0.036
1981	0.080	0.041
1982	0.081	0.044
1983	0.110	0.047
1984	0.094	0.044
1985	0.147	0.053
1986	0.142	0.063
1987	0.121	0.049
1988	0.092	0.037
1989	0.105	0.044
1990	0.069	0.033
1991	0.093	0.042
1992	0.094	0.036
1993	0.072	0.038
1994	0.069	0.031
1995	0.077	0.043
1996	0.096	0.048
1997	0.137	0.066
1998	0.135	0.056
1999	0.064	0.034
2000	0.187	0.034
2001	0.075	0.041
2002	0.069	0.034
2003	0.094	0.033
2004	0.182	0.064
2005	0.086	0.058
2006	0.115	0.049
2007	0.108	0.048
2008	0.087	0.066
2009	0.090	0.048

Stream Protection Duration
Ranked Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Rank	Pre-Retrofit	Mitigated
1	0.3388	0.0693
2	0.2368	0.0664
3	0.2286	0.0657
4	0.2071	0.0638
5	0.1872	0.0636
6	0.1822	0.0629
7	0.1739	0.0629
8	0.1544	0.0628
9	0.1512	0.0587
10	0.1472	0.0584
11	0.1471	0.0577
12	0.1466	0.0562
13	0.1420	0.0553
14	0.1368	0.0545
15	0.1348	0.0533
16	0.1322	0.0518
17	0.1254	0.0506
18	0.1247	0.0503
19	0.1224	0.0503
20	0.1206	0.0496
21	0.1205	0.0494
22	0.1192	0.0493

23	0.1152	0.0488
24	0.1140	0.0485
25	0.1122	0.0483
26	0.1097	0.0477
27	0.1081	0.0477
28	0.1060	0.0474
29	0.1047	0.0473
30	0.1030	0.0453
31	0.0988	0.0444
32	0.0964	0.0442
33	0.0958	0.0441
34	0.0943	0.0438
35	0.0942	0.0438
36	0.0942	0.0432
37	0.0932	0.0428
38	0.0916	0.0424
39	0.0916	0.0421
40	0.0900	0.0417
41	0.0869	0.0415
42	0.0869	0.0412
43	0.0857	0.0409
44	0.0813	0.0408
45	0.0807	0.0381
46	0.0805	0.0380
47	0.0803	0.0367
48	0.0793	0.0367
49	0.0769	0.0362
50	0.0746	0.0358
51	0.0745	0.0355
52	0.0728	0.0347
53	0.0722	0.0343
54	0.0712	0.0343
55	0.0709	0.0342
56	0.0695	0.0341
57	0.0688	0.0337
58	0.0687	0.0334
59	0.0636	0.0330
60	0.0627	0.0315
61	0.0561	0.0294

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0515	221802	4907	2	Pass
0.0534	213845	4363	2	Pass
0.0554	206466	3955	1	Pass
0.0574	199344	3613	1	Pass
0.0594	192606	3268	1	Pass
0.0613	186296	2979	1	Pass
0.0633	180158	2704	1	Pass
0.0653	174383	2415	1	Pass
0.0672	168929	2150	1	Pass

0.0692	163795	1959	1	Pass
0.0712	158962	1787	1	Pass
0.0732	154320	1639	1	Pass
0.0751	149935	1507	1	Pass
0.0771	145701	1401	0	Pass
0.0791	141572	1301	0	Pass
0.0810	137701	1227	0	Pass
0.0830	133894	1157	0	Pass
0.0850	130194	1083	0	Pass
0.0870	126793	1012	0	Pass
0.0889	123349	949	0	Pass
0.0909	120120	868	0	Pass
0.0929	116890	796	0	Pass
0.0948	113853	740	0	Pass
0.0968	111008	685	0	Pass
0.0988	108099	632	0	Pass
0.1008	105361	592	0	Pass
0.1027	102730	562	0	Pass
0.1047	100142	536	0	Pass
0.1067	97747	513	0	Pass
0.1086	95394	491	0	Pass
0.1106	93148	450	0	Pass
0.1126	91009	424	0	Pass
0.1146	88935	402	0	Pass
0.1165	86945	375	0	Pass
0.1185	85020	348	0	Pass
0.1205	83074	323	0	Pass
0.1224	81213	306	0	Pass
0.1244	79438	291	0	Pass
0.1264	77663	275	0	Pass
0.1284	75973	260	0	Pass
0.1303	74305	248	0	Pass
0.1323	72636	237	0	Pass
0.1343	71011	226	0	Pass
0.1362	69471	218	0	Pass
0.1382	68016	212	0	Pass
0.1402	66605	208	0	Pass
0.1422	65150	203	0	Pass
0.1441	63760	195	0	Pass
0.1461	62434	188	0	Pass
0.1481	61108	182	0	Pass
0.1500	59846	162	0	Pass
0.1520	58584	141	0	Pass
0.1540	57343	130	0	Pass
0.1560	56103	123	0	Pass
0.1579	54884	109	0	Pass
0.1599	53686	91	0	Pass
0.1619	52552	86	0	Pass
0.1638	51461	83	0	Pass
0.1658	50371	78	0	Pass
0.1678	49344	71	0	Pass
0.1698	48339	62	0	Pass
0.1717	47398	50	0	Pass
0.1737	46414	47	0	Pass
0.1757	45430	45	0	Pass
0.1776	44531	42	0	Pass
0.1796	43655	38	0	Pass

0.1816	42756	36	0	Pass
0.1836	41879	34	0	Pass
0.1855	41002	33	0	Pass
0.1875	40168	31	0	Pass
0.1895	39377	29	0	Pass
0.1914	38607	27	0	Pass
0.1934	37837	13	0	Pass
0.1954	37088	9	0	Pass
0.1974	36340	9	0	Pass
0.1993	35612	8	0	Pass
0.2013	34864	8	0	Pass
0.2033	34201	8	0	Pass
0.2052	33559	7	0	Pass
0.2072	32896	7	0	Pass
0.2092	32276	7	0	Pass
0.2112	31613	7	0	Pass
0.2131	30971	5	0	Pass
0.2151	30372	4	0	Pass
0.2171	29752	4	0	Pass
0.2190	29174	3	0	Pass
0.2210	28618	3	0	Pass
0.2230	28041	3	0	Pass
0.2250	27485	2	0	Pass
0.2269	26928	2	0	Pass
0.2289	26415	2	0	Pass
0.2309	25923	2	0	Pass
0.2328	25431	1	0	Pass
0.2348	24939	1	0	Pass
0.2368	24490	1	0	Pass
0.2388	24041	1	0	Pass
0.2407	23592	1	0	Pass
0.2427	23164	1	0	Pass
0.2447	22715	1	0	Pass
0.2466	22287	1	0	Pass

LID Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.14
Total Impervious Area:0.31

Mitigated Landuse Totals for POC #1
Total Pervious Area:0.14
Total Impervious Area:0.31

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.102942
5 year	0.142523

10 year	0.171986
25 year	0.213092
50 year	0.246647
100 year	0.282815

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**
2 year	0.045174
5 year	0.054349
10 year	0.059988
25 year	0.066751
50 year	0.071582
100 year	0.07627

LID Duration

Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Year	**Pre-Retrofit**	**Mitigated**
1949	0.099	0.038
1950	0.132	0.055
1951	0.106	0.044
1952	0.092	0.043
1953	0.125	0.047
1954	0.174	0.049
1955	0.125	0.059
1956	0.056	0.035
1957	0.103	0.050
1958	0.237	0.063
1959	0.096	0.044
1960	0.087	0.041
1961	0.339	0.069
1962	0.112	0.042
1963	0.147	0.058
1964	0.075	0.042
1965	0.071	0.029
1966	0.073	0.034
1967	0.207	0.041
1968	0.114	0.050
1969	0.229	0.052
1970	0.080	0.036
1971	0.120	0.055
1972	0.154	0.063
1973	0.122	0.050
1974	0.151	0.049
1975	0.119	0.051
1976	0.081	0.045
1977	0.079	0.037
1978	0.063	0.034
1979	0.147	0.064
1980	0.071	0.036
1981	0.080	0.041
1982	0.081	0.044
1983	0.110	0.047
1984	0.094	0.044
1985	0.147	0.053
1986	0.142	0.063
1987	0.121	0.049

1988	0.092	0.037
1989	0.105	0.044
1990	0.069	0.033
1991	0.093	0.042
1992	0.094	0.036
1993	0.072	0.038
1994	0.069	0.031
1995	0.077	0.043
1996	0.096	0.048
1997	0.137	0.066
1998	0.135	0.056
1999	0.064	0.034
2000	0.187	0.034
2001	0.075	0.041
2002	0.069	0.034
2003	0.094	0.033
2004	0.182	0.064
2005	0.086	0.058
2006	0.115	0.049
2007	0.108	0.048
2008	0.087	0.066
2009	0.090	0.048

LID Duration
Ranked Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Rank	**Pre-Retrofit**	**Mitigated**
1	0.3388	0.0693
2	0.2368	0.0664
3	0.2286	0.0657
4	0.2071	0.0638
5	0.1872	0.0636
6	0.1822	0.0629
7	0.1739	0.0629
8	0.1544	0.0628
9	0.1512	0.0587
10	0.1472	0.0584
11	0.1471	0.0577
12	0.1466	0.0562
13	0.1420	0.0553
14	0.1368	0.0545
15	0.1348	0.0533
16	0.1322	0.0518
17	0.1254	0.0506
18	0.1247	0.0503
19	0.1224	0.0503
20	0.1206	0.0496
21	0.1205	0.0494
22	0.1192	0.0493
23	0.1152	0.0488
24	0.1140	0.0485
25	0.1122	0.0483
26	0.1097	0.0477
27	0.1081	0.0477
28	0.1060	0.0474
29	0.1047	0.0473
30	0.1030	0.0453

31	0.0988	0.0444
32	0.0964	0.0442
33	0.0958	0.0441
34	0.0943	0.0438
35	0.0942	0.0438
36	0.0942	0.0432
37	0.0932	0.0428
38	0.0916	0.0424
39	0.0916	0.0421
40	0.0900	0.0417
41	0.0869	0.0415
42	0.0869	0.0412
43	0.0857	0.0409
44	0.0813	0.0408
45	0.0807	0.0381
46	0.0805	0.0380
47	0.0803	0.0367
48	0.0793	0.0367
49	0.0769	0.0362
50	0.0746	0.0358
51	0.0745	0.0355
52	0.0728	0.0347
53	0.0722	0.0343
54	0.0712	0.0343
55	0.0709	0.0342
56	0.0695	0.0341
57	0.0688	0.0337
58	0.0687	0.0334
59	0.0636	0.0330
60	0.0627	0.0315
61	0.0561	0.0294

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0082	67909	64787	95	Pass
0.0087	64316	61322	95	Pass
0.0091	61044	58113	95	Pass
0.0095	57942	55183	95	Pass
0.0100	54969	52403	95	Pass
0.0104	52317	49921	95	Pass
0.0109	49750	47462	95	Pass
0.0113	47291	45066	95	Pass
0.0117	45002	42885	95	Pass
0.0122	42820	40810	95	Pass
0.0126	40703	38735	95	Pass
0.0130	38757	36981	95	Pass
0.0135	37003	35270	95	Pass
0.0139	35227	33666	95	Pass
0.0143	33687	32126	95	Pass
0.0148	32062	30693	95	Pass
0.0152	30500	29324	96	Pass
0.0157	29174	28105	96	Pass

0.0161	27870	26886	96	Pass
0.0165	26629	25731	96	Pass
0.0170	25410	24661	97	Pass
0.0174	24298	23613	97	Pass
0.0178	23143	22694	98	Pass
0.0183	22137	21752	98	Pass
0.0187	21196	20899	98	Pass
0.0192	20345	20050	98	Pass
0.0196	19436	19293	99	Pass
0.0200	18604	18608	100	Pass
0.0205	17821	17896	100	Pass
0.0209	17070	17280	101	Fail
0.0213	16335	16655	101	Fail
0.0218	15610	16078	102	Fail
0.0222	14893	15464	103	Fail
0.0226	14258	14964	104	Fail
0.0231	13646	14431	105	Fail
0.0235	13062	13956	106	Fail
0.0240	12515	13513	107	Fail
0.0244	11999	13086	109	Fail
0.0248	11460	12647	110	Fail
0.0253	10998	12217	111	Fail
0.0257	10493	11764	112	Fail
0.0261	10072	11323	112	Fail
0.0266	9691	10940	112	Fail
0.0270	9276	10555	113	Fail
0.0275	8864	10170	114	Fail
0.0279	8496	9751	114	Fail
0.0283	8166	8160	99	Pass
0.0288	7843	6810	86	Pass
0.0292	7537	5807	77	Pass
0.0296	7240	5135	70	Pass
0.0301	6943	4673	67	Pass
0.0305	6669	4333	64	Pass
0.0309	6372	3989	62	Pass
0.0314	6113	3722	60	Pass
0.0318	5878	3420	58	Pass
0.0323	5638	3148	55	Pass
0.0327	5424	2909	53	Pass
0.0331	5212	2639	50	Pass
0.0336	5011	2396	47	Pass
0.0340	4821	2156	44	Pass
0.0344	4639	1961	42	Pass
0.0349	4440	1781	40	Pass
0.0353	4250	1680	39	Pass
0.0357	4096	1595	38	Pass
0.0362	3936	1519	38	Pass
0.0366	3792	1452	38	Pass
0.0371	3679	1397	37	Pass
0.0375	3544	1335	37	Pass
0.0379	3435	1275	37	Pass
0.0384	3317	1216	36	Pass
0.0388	3217	1160	36	Pass
0.0392	3084	1093	35	Pass
0.0397	2988	1053	35	Pass
0.0401	2902	990	34	Pass
0.0406	2793	957	34	Pass

0.0410	2689	904	33	Pass
0.0414	2601	843	32	Pass
0.0419	2513	771	30	Pass
0.0423	2436	702	28	Pass
0.0427	2357	651	27	Pass
0.0432	2282	604	26	Pass
0.0436	2218	573	25	Pass
0.0440	2147	535	24	Pass
0.0445	2081	510	24	Pass
0.0449	2028	486	23	Pass
0.0454	1967	467	23	Pass
0.0458	1886	443	23	Pass
0.0462	1828	415	22	Pass
0.0467	1765	403	22	Pass
0.0471	1716	378	22	Pass
0.0475	1669	361	21	Pass
0.0480	1625	341	20	Pass
0.0484	1561	325	20	Pass
0.0489	1524	301	19	Pass
0.0493	1473	291	19	Pass
0.0497	1427	269	18	Pass
0.0502	1396	258	18	Pass
0.0506	1361	245	18	Pass
0.0510	1314	233	17	Pass
0.0515	1284	221	17	Pass

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique Used for Total Volumn Volumn Infiltration Cumulative
Percent Water Quality Percent Comment
Treatment? Needs Through Volumn Volumn
Volumn Water Quality
Treatment Facility (ac-ft) Infiltration
Infiltrated Treated
(ac-ft) (ac-ft) Credit

Bioretention POC N 35.62 N
0.00
Total Volume Infiltrated 35.62 0.00 0.00 0.00
0.00 0% No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Failed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_EB2 PreDev
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Predeveloped Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Forest, Flat	**.14**
SAT, Forest, Flat	**.05**
Pervious Total	**0.19**

Impervious Land Use	**Acres**
Impervious Total	**0**
Basin Total	**0.19**

Element Flows To:

Surface	**Interflow**	**Groundwater**

POST-RETROFIT LAND USE

Name : East Bioretention 2
Bottom Length: 27.00 ft.
Bottom Width: 2.50 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW

Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 16.9
Total Outflow (ac-ft): 16.937
Percent Through Underdrain: 99.78
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:
Outlet 1 **Outlet 2**

East Bioretention 2 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0143	0.0000	0.0000	0.0000
0.0495	0.0141	0.0001	0.0000	0.0000
0.0989	0.0139	0.0001	0.0000	0.0000
0.1484	0.0136	0.0002	0.0000	0.0000
0.1978	0.0134	0.0003	0.0000	0.0000
0.2473	0.0131	0.0004	0.0000	0.0000
0.2967	0.0129	0.0004	0.0000	0.0000
0.3462	0.0127	0.0005	0.0000	0.0000
0.3956	0.0124	0.0006	0.0000	0.0000
0.4451	0.0122	0.0007	0.0000	0.0000
0.4945	0.0120	0.0008	0.0000	0.0000
0.5440	0.0117	0.0009	0.0000	0.0000
0.5934	0.0115	0.0010	0.0000	0.0000
0.6429	0.0113	0.0012	0.0000	0.0000
0.6923	0.0110	0.0013	0.0000	0.0000
0.7418	0.0108	0.0014	0.0000	0.0000
0.7912	0.0106	0.0016	0.0000	0.0000
0.8407	0.0104	0.0017	0.0000	0.0000
0.8901	0.0102	0.0018	0.0000	0.0000
0.9396	0.0099	0.0020	0.0000	0.0000
0.9890	0.0097	0.0022	0.0000	0.0000
1.0385	0.0095	0.0023	0.0000	0.0000
1.0879	0.0093	0.0025	0.0000	0.0000
1.1374	0.0091	0.0027	0.0000	0.0000
1.1868	0.0089	0.0028	0.0000	0.0000
1.2363	0.0087	0.0030	0.0000	0.0000
1.2857	0.0085	0.0032	0.0000	0.0000
1.3352	0.0083	0.0034	0.0000	0.0000
1.3846	0.0081	0.0036	0.0000	0.0000
1.4341	0.0079	0.0038	0.0000	0.0000
1.4835	0.0077	0.0041	0.0000	0.0000
1.5330	0.0075	0.0042	0.0000	0.0000
1.5824	0.0073	0.0043	0.0000	0.0000

1.6319	0.0072	0.0044	0.0000	0.0000
1.6813	0.0070	0.0046	0.0000	0.0000
1.7308	0.0068	0.0047	0.0000	0.0000
1.7802	0.0066	0.0048	0.0000	0.0000
1.8297	0.0064	0.0050	0.0000	0.0000
1.8791	0.0062	0.0051	0.0000	0.0000
1.9286	0.0061	0.0053	0.0000	0.0000
1.9780	0.0059	0.0054	0.0000	0.0000
2.0275	0.0057	0.0056	0.0000	0.0000
2.0769	0.0056	0.0057	0.0038	0.0000
2.1264	0.0054	0.0059	0.0040	0.0000
2.1758	0.0052	0.0061	0.0045	0.0000
2.2253	0.0051	0.0062	0.0050	0.0000
2.2747	0.0049	0.0064	0.0055	0.0000
2.3242	0.0047	0.0066	0.0061	0.0000
2.3736	0.0046	0.0068	0.0067	0.0000
2.4231	0.0044	0.0070	0.0074	0.0000
2.4725	0.0043	0.0072	0.0080	0.0000
2.5220	0.0041	0.0074	0.0088	0.0000
2.5714	0.0040	0.0076	0.0094	0.0000
2.6209	0.0038	0.0078	0.0094	0.0000
2.6703	0.0037	0.0080	0.0094	0.0000
2.7198	0.0036	0.0082	0.0094	0.0000
2.7692	0.0034	0.0084	0.0094	0.0000
2.8187	0.0033	0.0086	0.0094	0.0000
2.8681	0.0031	0.0089	0.0094	0.0000
2.9176	0.0030	0.0091	0.0094	0.0000
2.9670	0.0029	0.0093	0.0094	0.0000
3.0165	0.0027	0.0096	0.0094	0.0000
3.0659	0.0026	0.0098	0.0094	0.0000
3.1154	0.0025	0.0101	0.0094	0.0000
3.1648	0.0024	0.0103	0.0094	0.0000
3.2143	0.0022	0.0106	0.0094	0.0000
3.2637	0.0021	0.0109	0.0094	0.0000
3.3132	0.0020	0.0111	0.0094	0.0000
3.3626	0.0019	0.0114	0.0094	0.0000
3.4121	0.0018	0.0117	0.0094	0.0000
3.4615	0.0017	0.0120	0.0094	0.0000
3.5000	0.0015	0.0122	0.0094	0.0000

Surface oretention 2 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.0143	0.0122	0.0000	0.0097	0.0000
3.5495	0.0146	0.0129	0.0000	0.0097	0.0000
3.5989	0.0148	0.0137	0.0000	0.0100	0.0000
3.6484	0.0151	0.0144	0.0000	0.0103	0.0000
3.6978	0.0153	0.0152	0.0000	0.0106	0.0000
3.7473	0.0156	0.0159	0.0000	0.0109	0.0000
3.7967	0.0159	0.0167	0.0000	0.0112	0.0000
3.8462	0.0161	0.0175	0.0000	0.0115	0.0000
3.8956	0.0164	0.0183	0.0000	0.0118	0.0000
3.9451	0.0167	0.0191	0.0000	0.0122	0.0000
3.9945	0.0169	0.0199	0.0000	0.0125	0.0000
4.0440	0.0172	0.0208	7.4793	0.0128	0.0000
4.0934	0.0175	0.0216	23.169	0.0131	0.0000
4.1429	0.0178	0.0225	43.821	0.0134	0.0000
4.1923	0.0181	0.0234	68.443	0.0137	0.0000

4.2418	0.0183	0.0243	96.473	0.0140	0.0000
4.2912	0.0186	0.0252	127.54	0.0143	0.0000
4.3407	0.0189	0.0261	161.37	0.0146	0.0000
4.3901	0.0192	0.0271	197.75	0.0149	0.0000
4.4396	0.0195	0.0280	236.52	0.0152	0.0000
4.4890	0.0198	0.0290	277.53	0.0156	0.0000
4.5000	0.0198	0.0292	320.68	0.0156	0.0000

Name : Surface oretention 2

Element Flows To:

Outlet 1	**Outlet 2**
East Bioretention 2	

Name : East Bioretention 2 Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.05**
C, Lawn, Mod	**.02**

Pervious Total 0.07

Impervious Land Use	**Acres**
ROADS FLAT	**0.12**

Impervious Total 0.12

Basin Total 0.19

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface oretention 2	Surface oretention 2	

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.19
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	**Flow(cfs)**
2 year	0.001812
5 year	0.003054
10 year	0.003965
25 year	0.005191
50 year	0.006149
100 year	0.007139

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	**Flow(cfs)**
2 year	0.009913
5 year	0.013879
10 year	0.016981
25 year	0.021488
50 year	0.025305
100 year	0.029544

Stream Protection Duration
Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	**Predeveloped**	**Post-Retrofit**
1949	0.000	0.009
1950	0.002	0.009
1951	0.002	0.009
1952	0.001	0.009
1953	0.001	0.009
1954	0.002	0.009
1955	0.004	0.009
1956	0.003	0.009
1957	0.003	0.009
1958	0.002	0.017
1959	0.002	0.009
1960	0.002	0.009
1961	0.002	0.035
1962	0.001	0.009
1963	0.001	0.009
1964	0.002	0.009
1965	0.002	0.009
1966	0.001	0.009
1967	0.002	0.009
1968	0.002	0.009
1969	0.001	0.009
1970	0.001	0.009
1971	0.002	0.009
1972	0.002	0.009
1973	0.001	0.009
1974	0.002	0.009
1975	0.002	0.009
1976	0.002	0.009
1977	0.001	0.009
1978	0.001	0.009

1979	0.003	0.009
1980	0.001	0.009
1981	0.001	0.009
1982	0.003	0.009
1983	0.002	0.009
1984	0.002	0.009
1985	0.003	0.009
1986	0.008	0.042
1987	0.003	0.009
1988	0.001	0.009
1989	0.001	0.009
1990	0.002	0.009
1991	0.002	0.009
1992	0.001	0.009
1993	0.001	0.009
1994	0.001	0.009
1995	0.002	0.009
1996	0.006	0.009
1997	0.012	0.059
1998	0.001	0.009
1999	0.003	0.009
2000	0.002	0.009
2001	0.000	0.009
2002	0.002	0.009
2003	0.001	0.009
2004	0.002	0.009
2005	0.001	0.009
2006	0.005	0.009
2007	0.003	0.009
2008	0.004	0.028
2009	0.002	0.009

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	**Predeveloped**	**Post-Retrofit**
1	0.0117	0.0593
2	0.0077	0.0417
3	0.0062	0.0349
4	0.0051	0.0276
5	0.0044	0.0168
6	0.0040	0.0094
7	0.0033	0.0094
8	0.0029	0.0094
9	0.0028	0.0094
10	0.0027	0.0094
11	0.0027	0.0094
12	0.0027	0.0094
13	0.0027	0.0094
14	0.0025	0.0094
15	0.0025	0.0094
16	0.0024	0.0094
17	0.0023	0.0094
18	0.0022	0.0094
19	0.0021	0.0094
20	0.0020	0.0094
21	0.0020	0.0094

22	0.0020	0.0094
23	0.0020	0.0094
24	0.0019	0.0094
25	0.0019	0.0094
26	0.0019	0.0094
27	0.0018	0.0094
28	0.0018	0.0094
29	0.0018	0.0094
30	0.0018	0.0094
31	0.0018	0.0094
32	0.0018	0.0094
33	0.0017	0.0094
34	0.0017	0.0094
35	0.0016	0.0094
36	0.0016	0.0094
37	0.0015	0.0094
38	0.0015	0.0094
39	0.0015	0.0094
40	0.0015	0.0094
41	0.0015	0.0094
42	0.0015	0.0094
43	0.0015	0.0094
44	0.0015	0.0094
45	0.0014	0.0094
46	0.0014	0.0094
47	0.0013	0.0094
48	0.0013	0.0094
49	0.0013	0.0094
50	0.0012	0.0094
51	0.0011	0.0094
52	0.0011	0.0094
53	0.0011	0.0093
54	0.0010	0.0093
55	0.0010	0.0092
56	0.0009	0.0092
57	0.0009	0.0091
58	0.0007	0.0091
59	0.0007	0.0090
60	0.0003	0.0089
61	0.0002	0.0088

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0009	22244	201033	903	Fail
0.0010	19626	194253	989	Fail
0.0010	17152	187665	1094	Fail
0.0011	15049	181783	1207	Fail
0.0011	13321	176714	1326	Fail
0.0012	11796	172351	1461	Fail
0.0012	10478	168458	1607	Fail
0.0013	9366	164822	1759	Fail
0.0013	8350	161400	1932	Fail

0.0014	7458	158299	2122	Fail
0.0014	6654	155347	2334	Fail
0.0015	5888	152524	2590	Fail
0.0015	5251	149850	2853	Fail
0.0016	4699	147347	3135	Fail
0.0016	4229	144888	3426	Fail
0.0017	3790	142514	3760	Fail
0.0018	3426	140161	4091	Fail
0.0018	3127	137894	4409	Fail
0.0019	2868	135691	4731	Fail
0.0019	2616	133466	5101	Fail
0.0020	2417	131242	5429	Fail
0.0020	2227	129081	5796	Fail
0.0021	2059	126921	6164	Fail
0.0021	1908	124761	6538	Fail
0.0022	1757	122729	6985	Fail
0.0022	1621	120783	7451	Fail
0.0023	1507	118879	7888	Fail
0.0023	1412	117146	8296	Fail
0.0024	1332	115542	8674	Fail
0.0024	1265	113960	9008	Fail
0.0025	1198	112591	9398	Fail
0.0025	1141	111243	9749	Fail
0.0026	1096	109981	10034	Fail
0.0027	1049	108783	10370	Fail
0.0027	993	107650	10840	Fail
0.0028	932	106538	11431	Fail
0.0028	887	105447	11888	Fail
0.0029	854	104377	12222	Fail
0.0029	822	103351	12573	Fail
0.0030	795	102281	12865	Fail
0.0030	764	101319	13261	Fail
0.0031	732	100271	13698	Fail
0.0031	705	99330	14089	Fail
0.0032	674	98367	14594	Fail
0.0032	646	97383	15074	Fail
0.0033	617	96399	15623	Fail
0.0033	593	95373	16083	Fail
0.0034	570	94432	16567	Fail
0.0034	551	93341	16940	Fail
0.0035	527	92400	17533	Fail
0.0036	505	91459	18110	Fail
0.0036	489	90432	18493	Fail
0.0037	473	89427	18906	Fail
0.0037	455	88400	19428	Fail
0.0038	428	87138	20359	Fail
0.0038	407	82197	20195	Fail
0.0039	391	76743	19627	Fail
0.0039	378	72037	19057	Fail
0.0040	359	68359	19041	Fail
0.0040	343	65813	19187	Fail
0.0041	331	63568	19204	Fail
0.0041	319	61685	19336	Fail
0.0042	311	59910	19263	Fail
0.0042	306	58178	19012	Fail
0.0043	297	56531	19034	Fail
0.0043	286	54991	19227	Fail

0.0044	277	53493	19311	Fail
0.0045	268	52060	19425	Fail
0.0045	261	50563	19372	Fail
0.0046	253	49216	19452	Fail
0.0046	249	47932	19249	Fail
0.0047	241	46649	19356	Fail
0.0047	238	45430	19088	Fail
0.0048	235	44211	18813	Fail
0.0048	228	43077	18893	Fail
0.0049	220	41901	19045	Fail
0.0049	216	40831	18903	Fail
0.0050	212	39805	18775	Fail
0.0050	206	38821	18845	Fail
0.0051	200	37858	18929	Fail
0.0051	195	36896	18921	Fail
0.0052	189	36019	19057	Fail
0.0052	182	35185	19332	Fail
0.0053	178	34350	19297	Fail
0.0054	174	33538	19274	Fail
0.0054	170	32682	19224	Fail
0.0055	165	31848	19301	Fail
0.0055	160	31121	19450	Fail
0.0056	159	30372	19101	Fail
0.0056	153	29602	19347	Fail
0.0057	147	28875	19642	Fail
0.0057	144	28126	19531	Fail
0.0058	142	27485	19355	Fail
0.0058	138	26843	19451	Fail
0.0059	136	26223	19281	Fail
0.0059	132	25602	19395	Fail
0.0060	129	25004	19382	Fail
0.0060	124	24447	19715	Fail
0.0061	119	23891	20076	Fail
0.0061	114	23357	20488	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.19
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.001812
5 year	0.003054
10 year	0.003965
25 year	0.005191
50 year	0.006149
100 year	0.007139

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.009913
5 year	0.013879
10 year	0.016981
25 year	0.021488
50 year	0.025305
100 year	0.029544

LID Duration
Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	Predeveloped	Post-Retrofit
1949	0.000	0.009
1950	0.002	0.009
1951	0.002	0.009
1952	0.001	0.009
1953	0.001	0.009
1954	0.002	0.009
1955	0.004	0.009
1956	0.003	0.009
1957	0.003	0.009
1958	0.002	0.017
1959	0.002	0.009
1960	0.002	0.009
1961	0.002	0.035
1962	0.001	0.009
1963	0.001	0.009
1964	0.002	0.009
1965	0.002	0.009
1966	0.001	0.009
1967	0.002	0.009
1968	0.002	0.009
1969	0.001	0.009
1970	0.001	0.009
1971	0.002	0.009
1972	0.002	0.009
1973	0.001	0.009
1974	0.002	0.009
1975	0.002	0.009
1976	0.002	0.009
1977	0.001	0.009
1978	0.001	0.009
1979	0.003	0.009
1980	0.001	0.009
1981	0.001	0.009
1982	0.003	0.009

1983	0.002	0.009
1984	0.002	0.009
1985	0.003	0.009
1986	0.008	0.042
1987	0.003	0.009
1988	0.001	0.009
1989	0.001	0.009
1990	0.002	0.009
1991	0.002	0.009
1992	0.001	0.009
1993	0.001	0.009
1994	0.001	0.009
1995	0.002	0.009
1996	0.006	0.009
1997	0.012	0.059
1998	0.001	0.009
1999	0.003	0.009
2000	0.002	0.009
2001	0.000	0.009
2002	0.002	0.009
2003	0.001	0.009
2004	0.002	0.009
2005	0.001	0.009
2006	0.005	0.009
2007	0.003	0.009
2008	0.004	0.028
2009	0.002	0.009

LID Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	Predeveloped	Post-Retrofit
1	0.0117	0.0593
2	0.0077	0.0417
3	0.0062	0.0349
4	0.0051	0.0276
5	0.0044	0.0168
6	0.0040	0.0094
7	0.0033	0.0094
8	0.0029	0.0094
9	0.0028	0.0094
10	0.0027	0.0094
11	0.0027	0.0094
12	0.0027	0.0094
13	0.0027	0.0094
14	0.0025	0.0094
15	0.0025	0.0094
16	0.0024	0.0094
17	0.0023	0.0094
18	0.0022	0.0094
19	0.0021	0.0094
20	0.0020	0.0094
21	0.0020	0.0094
22	0.0020	0.0094
23	0.0020	0.0094
24	0.0019	0.0094
25	0.0019	0.0094

26	0.0019	0.0094
27	0.0018	0.0094
28	0.0018	0.0094
29	0.0018	0.0094
30	0.0018	0.0094
31	0.0018	0.0094
32	0.0018	0.0094
33	0.0017	0.0094
34	0.0017	0.0094
35	0.0016	0.0094
36	0.0016	0.0094
37	0.0015	0.0094
38	0.0015	0.0094
39	0.0015	0.0094
40	0.0015	0.0094
41	0.0015	0.0094
42	0.0015	0.0094
43	0.0015	0.0094
44	0.0015	0.0094
45	0.0014	0.0094
46	0.0014	0.0094
47	0.0013	0.0094
48	0.0013	0.0094
49	0.0013	0.0094
50	0.0012	0.0094
51	0.0011	0.0094
52	0.0011	0.0094
53	0.0011	0.0093
54	0.0010	0.0093
55	0.0010	0.0092
56	0.0009	0.0092
57	0.0009	0.0091
58	0.0007	0.0091
59	0.0007	0.0090
60	0.0003	0.0089
61	0.0002	0.0088

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0001	222871	490659	220	Fail
0.0002	214530	480820	224	Fail
0.0002	206937	471195	227	Fail
0.0002	199558	462212	231	Fail
0.0002	193398	454726	235	Fail
0.0002	186767	446598	239	Fail
0.0002	180393	438684	243	Fail
0.0002	175046	432054	246	Fail
0.0002	169314	424782	250	Fail
0.0002	163924	417937	254	Fail
0.0002	159518	411948	258	Fail
0.0002	154727	405532	262	Fail
0.0002	150085	399543	266	Fail

0.0002	146214	394196	269	Fail
0.0003	141936	388634	273	Fail
0.0003	137808	383073	277	Fail
0.0003	134386	378368	281	Fail
0.0003	130514	373235	285	Fail
0.0003	126900	368315	290	Fail
0.0003	123371	363396	294	Fail
0.0003	120355	359332	298	Fail
0.0003	117040	354840	303	Fail
0.0003	113874	350349	307	Fail
0.0003	111243	346712	311	Fail
0.0003	108291	342435	316	Fail
0.0003	105404	338585	321	Fail
0.0003	102966	335162	325	Fail
0.0004	100292	331313	330	Fail
0.0004	97747	327463	335	Fail
0.0004	95608	324468	339	Fail
0.0004	93277	320832	343	Fail
0.0004	91031	317410	348	Fail
0.0004	89127	314415	352	Fail
0.0004	87052	311207	357	Fail
0.0004	85020	307999	362	Fail
0.0004	83031	305004	367	Fail
0.0004	81320	302224	371	Fail
0.0004	79438	299229	376	Fail
0.0004	77599	296449	382	Fail
0.0004	76059	294096	386	Fail
0.0005	74305	291315	392	Fail
0.0005	72572	288535	397	Fail
0.0005	71118	286182	402	Fail
0.0005	69514	283829	408	Fail
0.0005	67974	281263	413	Fail
0.0005	66648	279124	418	Fail
0.0005	65193	276771	424	Fail
0.0005	63760	274632	430	Fail
0.0005	62519	272493	435	Fail
0.0005	61129	270354	442	Fail
0.0005	59803	268216	448	Fail
0.0005	58498	266077	454	Fail
0.0005	57365	264152	460	Fail
0.0006	56060	262227	467	Fail
0.0006	54777	260302	475	Fail
0.0006	53707	258591	481	Fail
0.0006	52531	256666	488	Fail
0.0006	51376	254954	496	Fail
0.0006	50392	253243	502	Fail
0.0006	49301	251532	510	Fail
0.0006	48275	249821	517	Fail
0.0006	47376	248324	524	Fail
0.0006	46371	246613	531	Fail
0.0006	45366	244902	539	Fail
0.0006	44531	243618	547	Fail
0.0006	43612	242121	555	Fail
0.0007	42713	240410	562	Fail
0.0007	41751	238913	572	Fail
0.0007	40981	237630	579	Fail
0.0007	40104	236132	588	Fail

0.0007	39270	234635	597	Fail
0.0007	38585	233352	604	Fail
0.0007	37773	232068	614	Fail
0.0007	36981	230571	623	Fail
0.0007	36318	229502	631	Fail
0.0007	35570	228005	641	Fail
0.0007	34778	226721	651	Fail
0.0007	34179	225652	660	Fail
0.0007	33495	224369	669	Fail
0.0008	32832	223085	679	Fail
0.0008	32233	221802	688	Fail
0.0008	31591	220732	698	Fail
0.0008	30907	219449	710	Fail
0.0008	30265	218166	720	Fail
0.0008	29730	217096	730	Fail
0.0008	29110	216027	742	Fail
0.0008	28511	214744	753	Fail
0.0008	27998	213760	763	Fail
0.0008	27442	212626	774	Fail
0.0008	26843	211535	788	Fail
0.0008	26394	210573	797	Fail
0.0008	25880	209525	809	Fail
0.0009	25367	208412	821	Fail
0.0009	24918	207450	832	Fail
0.0009	24447	206338	844	Fail
0.0009	23977	205268	856	Fail
0.0009	23549	204327	867	Fail
0.0009	23100	203258	879	Fail
0.0009	22651	202124	892	Fail
0.0009	22244	201033	903	Fail

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_EB2
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PRE-RETROFIT LAND USE

Name : Pre-Retrofit Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	.05
C, Lawn, Mod	.02
Pervious Total	0.07

Impervious Land Use	Acres
ROADS FLAT	0.12
Impervious Total	0.12
Basin Total	0.19

Element Flows To:

Surface	Interflow	Groundwater

POST-RETROFIT LAND USE

Name : East Bioretention 2
Bottom Length: 27.00 ft.
Bottom Width: 2.50 ft.
Material thickness of first layer: 1.5

Material type for first layer: SMMWW
Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 16.9
Total Outflow (ac-ft): 16.937
Percent Through Underdrain: 99.78
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:
Outlet 1 **Outlet 2**

East Bioretention 2 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0143	0.0000	0.0000	0.0000
0.0495	0.0141	0.0001	0.0000	0.0000
0.0989	0.0139	0.0001	0.0000	0.0000
0.1484	0.0136	0.0002	0.0000	0.0000
0.1978	0.0134	0.0003	0.0000	0.0000
0.2473	0.0131	0.0004	0.0000	0.0000
0.2967	0.0129	0.0004	0.0000	0.0000
0.3462	0.0127	0.0005	0.0000	0.0000
0.3956	0.0124	0.0006	0.0000	0.0000
0.4451	0.0122	0.0007	0.0000	0.0000
0.4945	0.0120	0.0008	0.0000	0.0000
0.5440	0.0117	0.0009	0.0000	0.0000
0.5934	0.0115	0.0010	0.0000	0.0000
0.6429	0.0113	0.0012	0.0000	0.0000
0.6923	0.0110	0.0013	0.0000	0.0000
0.7418	0.0108	0.0014	0.0000	0.0000
0.7912	0.0106	0.0016	0.0000	0.0000
0.8407	0.0104	0.0017	0.0000	0.0000
0.8901	0.0102	0.0018	0.0000	0.0000
0.9396	0.0099	0.0020	0.0000	0.0000
0.9890	0.0097	0.0022	0.0000	0.0000
1.0385	0.0095	0.0023	0.0000	0.0000
1.0879	0.0093	0.0025	0.0000	0.0000
1.1374	0.0091	0.0027	0.0000	0.0000
1.1868	0.0089	0.0028	0.0000	0.0000
1.2363	0.0087	0.0030	0.0000	0.0000
1.2857	0.0085	0.0032	0.0000	0.0000
1.3352	0.0083	0.0034	0.0000	0.0000
1.3846	0.0081	0.0036	0.0000	0.0000
1.4341	0.0079	0.0038	0.0000	0.0000
1.4835	0.0077	0.0041	0.0000	0.0000
1.5330	0.0075	0.0042	0.0000	0.0000

1.5824	0.0073	0.0043	0.0000	0.0000
1.6319	0.0072	0.0044	0.0000	0.0000
1.6813	0.0070	0.0046	0.0000	0.0000
1.7308	0.0068	0.0047	0.0000	0.0000
1.7802	0.0066	0.0048	0.0000	0.0000
1.8297	0.0064	0.0050	0.0000	0.0000
1.8791	0.0062	0.0051	0.0000	0.0000
1.9286	0.0061	0.0053	0.0000	0.0000
1.9780	0.0059	0.0054	0.0000	0.0000
2.0275	0.0057	0.0056	0.0000	0.0000
2.0769	0.0056	0.0057	0.0038	0.0000
2.1264	0.0054	0.0059	0.0040	0.0000
2.1758	0.0052	0.0061	0.0045	0.0000
2.2253	0.0051	0.0062	0.0050	0.0000
2.2747	0.0049	0.0064	0.0055	0.0000
2.3242	0.0047	0.0066	0.0061	0.0000
2.3736	0.0046	0.0068	0.0067	0.0000
2.4231	0.0044	0.0070	0.0074	0.0000
2.4725	0.0043	0.0072	0.0080	0.0000
2.5220	0.0041	0.0074	0.0088	0.0000
2.5714	0.0040	0.0076	0.0094	0.0000
2.6209	0.0038	0.0078	0.0094	0.0000
2.6703	0.0037	0.0080	0.0094	0.0000
2.7198	0.0036	0.0082	0.0094	0.0000
2.7692	0.0034	0.0084	0.0094	0.0000
2.8187	0.0033	0.0086	0.0094	0.0000
2.8681	0.0031	0.0089	0.0094	0.0000
2.9176	0.0030	0.0091	0.0094	0.0000
2.9670	0.0029	0.0093	0.0094	0.0000
3.0165	0.0027	0.0096	0.0094	0.0000
3.0659	0.0026	0.0098	0.0094	0.0000
3.1154	0.0025	0.0101	0.0094	0.0000
3.1648	0.0024	0.0103	0.0094	0.0000
3.2143	0.0022	0.0106	0.0094	0.0000
3.2637	0.0021	0.0109	0.0094	0.0000
3.3132	0.0020	0.0111	0.0094	0.0000
3.3626	0.0019	0.0114	0.0094	0.0000
3.4121	0.0018	0.0117	0.0094	0.0000
3.4615	0.0017	0.0120	0.0094	0.0000
3.5000	0.0015	0.0122	0.0094	0.0000

Surface Bioretention Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.0143	0.0122	0.0000	0.0097	0.0000
3.5495	0.0146	0.0129	0.0000	0.0097	0.0000
3.5989	0.0148	0.0137	0.0000	0.0100	0.0000
3.6484	0.0151	0.0144	0.0000	0.0103	0.0000
3.6978	0.0153	0.0152	0.0000	0.0106	0.0000
3.7473	0.0156	0.0159	0.0000	0.0109	0.0000
3.7967	0.0159	0.0167	0.0000	0.0112	0.0000
3.8462	0.0161	0.0175	0.0000	0.0115	0.0000
3.8956	0.0164	0.0183	0.0000	0.0118	0.0000
3.9451	0.0167	0.0191	0.0000	0.0122	0.0000
3.9945	0.0169	0.0199	0.0000	0.0125	0.0000
4.0440	0.0172	0.0208	7.4793	0.0128	0.0000
4.0934	0.0175	0.0216	23.169	0.0131	0.0000
4.1429	0.0178	0.0225	43.821	0.0134	0.0000

4.1923	0.0181	0.0234	68.443	0.0137	0.0000
4.2418	0.0183	0.0243	96.473	0.0140	0.0000
4.2912	0.0186	0.0252	127.54	0.0143	0.0000
4.3407	0.0189	0.0261	161.37	0.0146	0.0000
4.3901	0.0192	0.0271	197.75	0.0149	0.0000
4.4396	0.0195	0.0280	236.52	0.0152	0.0000
4.4890	0.0198	0.0290	277.53	0.0156	0.0000
4.5000	0.0198	0.0292	320.68	0.0156	0.0000

Name : Surface Bioretention

Element Flows To:

Outlet 1	**Outlet 2**
Small East Bioretentio	

Name : East Bioretention 2 Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.05**
C, Lawn, Mod	**.02**

Pervious Total **0.07**

Impervious Land Use	**Acres**
ROADS FLAT	**0.12**

Impervious Total **0.12**

Basin Total **0.19**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface Bioretention	Surface Bioretention	

ANALYSIS RESULTS

Stream Protection Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.040375
5 year	0.056221
10 year	0.068069
25 year	0.084658
50 year	0.098242
100 year	0.112921

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.009913
5 year	0.013879
10 year	0.016981
25 year	0.021488
50 year	0.025305
100 year	0.029544

Stream Protection Duration
Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Year	Pre-Retrofit	Post-Retrofit
1949	0.039	0.009
1950	0.052	0.009
1951	0.041	0.009
1952	0.036	0.009
1953	0.049	0.009
1954	0.070	0.009
1955	0.050	0.009
1956	0.022	0.009
1957	0.041	0.009
1958	0.094	0.017
1959	0.037	0.009
1960	0.034	0.009
1961	0.136	0.035
1962	0.043	0.009
1963	0.059	0.009
1964	0.029	0.009
1965	0.028	0.009
1966	0.028	0.009
1967	0.080	0.009
1968	0.045	0.009
1969	0.093	0.009
1970	0.031	0.009
1971	0.047	0.009
1972	0.061	0.009
1973	0.048	0.009
1974	0.059	0.009
1975	0.047	0.009
1976	0.032	0.009
1977	0.031	0.009

1978	0.025	0.009
1979	0.058	0.009
1980	0.027	0.009
1981	0.031	0.009
1982	0.031	0.009
1983	0.043	0.009
1984	0.037	0.009
1985	0.057	0.009
1986	0.057	0.042
1987	0.047	0.009
1988	0.036	0.009
1989	0.041	0.009
1990	0.027	0.009
1991	0.036	0.009
1992	0.037	0.009
1993	0.028	0.009
1994	0.027	0.009
1995	0.030	0.009
1996	0.039	0.009
1997	0.055	0.059
1998	0.053	0.009
1999	0.025	0.009
2000	0.073	0.009
2001	0.029	0.009
2002	0.027	0.009
2003	0.036	0.009
2004	0.071	0.009
2005	0.033	0.009
2006	0.046	0.009
2007	0.043	0.009
2008	0.034	0.028
2009	0.035	0.009

Stream Protection Duration
Ranked Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Rank	Pre-Retrofit	Post-Retrofit
1	0.1361	0.0593
2	0.0937	0.0417
3	0.0931	0.0349
4	0.0802	0.0276
5	0.0726	0.0168
6	0.0712	0.0094
7	0.0705	0.0094
8	0.0607	0.0094
9	0.0588	0.0094
10	0.0588	0.0094
11	0.0579	0.0094
12	0.0570	0.0094
13	0.0568	0.0094
14	0.0555	0.0094
15	0.0526	0.0094
16	0.0523	0.0094
17	0.0495	0.0094
18	0.0487	0.0094
19	0.0480	0.0094
20	0.0474	0.0094

21	0.0472	0.0094
22	0.0472	0.0094
23	0.0462	0.0094
24	0.0446	0.0094
25	0.0434	0.0094
26	0.0433	0.0094
27	0.0432	0.0094
28	0.0414	0.0094
29	0.0412	0.0094
30	0.0410	0.0094
31	0.0392	0.0094
32	0.0385	0.0094
33	0.0371	0.0094
34	0.0371	0.0094
35	0.0366	0.0094
36	0.0365	0.0094
37	0.0361	0.0094
38	0.0356	0.0094
39	0.0356	0.0094
40	0.0351	0.0094
41	0.0343	0.0094
42	0.0343	0.0094
43	0.0333	0.0094
44	0.0319	0.0094
45	0.0314	0.0094
46	0.0314	0.0094
47	0.0313	0.0094
48	0.0308	0.0094
49	0.0298	0.0094
50	0.0293	0.0094
51	0.0289	0.0094
52	0.0282	0.0094
53	0.0282	0.0093
54	0.0276	0.0093
55	0.0275	0.0092
56	0.0269	0.0092
57	0.0268	0.0091
58	0.0266	0.0091
59	0.0249	0.0090
60	0.0246	0.0089
61	0.0219	0.0088

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0202	68594	97490	142	Fail
0.0210	64958	94303	145	Fail
0.0218	61578	91095	147	Fail
0.0226	58413	87737	150	Fail
0.0233	55483	72743	131	Fail
0.0241	52702	63439	120	Fail
0.0249	50114	57686	115	Fail
0.0257	47633	52766	110	Fail

0.0265	45301	48210	106	Fail
0.0273	43120	44232	102	Fail
0.0281	40938	40553	99	Pass
0.0289	38992	37409	95	Pass
0.0296	37195	34586	92	Pass
0.0304	35420	31912	90	Pass
0.0312	33773	29474	87	Pass
0.0320	32212	27249	84	Pass
0.0328	30650	25239	82	Pass
0.0336	29260	23421	80	Pass
0.0344	27912	21731	77	Pass
0.0352	26650	20076	75	Pass
0.0360	25431	18672	73	Pass
0.0367	24298	17340	71	Pass
0.0375	23185	16093	69	Pass
0.0383	22159	14968	67	Pass
0.0391	21216	13907	65	Pass
0.0399	20351	12895	63	Pass
0.0407	19410	12018	61	Pass
0.0415	18578	11150	60	Pass
0.0423	17785	10307	57	Pass
0.0431	17049	9529	55	Pass
0.0438	16313	8763	53	Pass
0.0446	15577	8006	51	Pass
0.0454	14861	7313	49	Pass
0.0462	14170	6594	46	Pass
0.0470	13599	5852	43	Pass
0.0478	13024	5088	39	Pass
0.0486	12468	145	1	Pass
0.0494	11944	145	1	Pass
0.0501	11439	145	1	Pass
0.0509	10940	145	1	Pass
0.0517	10455	145	1	Pass
0.0525	10066	145	1	Pass
0.0533	9657	143	1	Pass
0.0541	9242	141	1	Pass
0.0549	8834	140	1	Pass
0.0557	8455	140	1	Pass
0.0565	8132	139	1	Pass
0.0572	7790	137	1	Pass
0.0580	7492	137	1	Pass
0.0588	7159	137	1	Pass
0.0596	6885	137	1	Pass
0.0604	6592	135	2	Pass
0.0612	6340	133	2	Pass
0.0620	6098	133	2	Pass
0.0628	5852	133	2	Pass
0.0636	5604	132	2	Pass
0.0643	5371	132	2	Pass
0.0651	5180	131	2	Pass
0.0659	4994	130	2	Pass
0.0667	4787	130	2	Pass
0.0675	4599	130	2	Pass
0.0683	4408	126	2	Pass
0.0691	4222	126	2	Pass
0.0699	4051	123	3	Pass
0.0706	3903	123	3	Pass

0.0714	3769	123	3	Pass
0.0722	3647	120	3	Pass
0.0730	3518	119	3	Pass
0.0738	3401	117	3	Pass
0.0746	3287	116	3	Pass
0.0754	3172	116	3	Pass
0.0762	3061	116	3	Pass
0.0770	2954	115	3	Pass
0.0777	2860	114	3	Pass
0.0785	2763	113	4	Pass
0.0793	2650	112	4	Pass
0.0801	2571	109	4	Pass
0.0809	2494	108	4	Pass
0.0817	2404	108	4	Pass
0.0825	2325	107	4	Pass
0.0833	2254	105	4	Pass
0.0841	2199	105	4	Pass
0.0848	2128	102	4	Pass
0.0856	2069	100	4	Pass
0.0864	2021	98	4	Pass
0.0872	1940	98	5	Pass
0.0880	1864	96	5	Pass
0.0888	1803	96	5	Pass
0.0896	1749	94	5	Pass
0.0904	1706	94	5	Pass
0.0911	1644	94	5	Pass
0.0919	1599	90	5	Pass
0.0927	1550	89	5	Pass
0.0935	1507	88	5	Pass
0.0943	1454	86	5	Pass
0.0951	1414	86	6	Pass
0.0959	1383	84	6	Pass
0.0967	1333	83	6	Pass
0.0975	1297	83	6	Pass
0.0982	1268	83	6	Pass

The development has an increase in flow durations from 1/2 Pre-Retrofit 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

LID Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.07
Total Impervious Area:0.12

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.040375
5 year	0.056221
10 year	0.068069
25 year	0.084658
50 year	0.098242
100 year	0.112921

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.009913
5 year	0.013879
10 year	0.016981
25 year	0.021488
50 year	0.025305
100 year	0.029544

LID Duration

Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Year	Pre-Retrofit	Post-Retrofit
1949	0.039	0.009
1950	0.052	0.009
1951	0.041	0.009
1952	0.036	0.009
1953	0.049	0.009
1954	0.070	0.009
1955	0.050	0.009
1956	0.022	0.009
1957	0.041	0.009
1958	0.094	0.017
1959	0.037	0.009
1960	0.034	0.009
1961	0.136	0.035
1962	0.043	0.009
1963	0.059	0.009
1964	0.029	0.009
1965	0.028	0.009
1966	0.028	0.009
1967	0.080	0.009
1968	0.045	0.009
1969	0.093	0.009
1970	0.031	0.009
1971	0.047	0.009
1972	0.061	0.009
1973	0.048	0.009
1974	0.059	0.009
1975	0.047	0.009
1976	0.032	0.009
1977	0.031	0.009
1978	0.025	0.009
1979	0.058	0.009
1980	0.027	0.009
1981	0.031	0.009
1982	0.031	0.009
1983	0.043	0.009

1984	0.037	0.009
1985	0.057	0.009
1986	0.057	0.042
1987	0.047	0.009
1988	0.036	0.009
1989	0.041	0.009
1990	0.027	0.009
1991	0.036	0.009
1992	0.037	0.009
1993	0.028	0.009
1994	0.027	0.009
1995	0.030	0.009
1996	0.039	0.009
1997	0.055	0.059
1998	0.053	0.009
1999	0.025	0.009
2000	0.073	0.009
2001	0.029	0.009
2002	0.027	0.009
2003	0.036	0.009
2004	0.071	0.009
2005	0.033	0.009
2006	0.046	0.009
2007	0.043	0.009
2008	0.034	0.028
2009	0.035	0.009

LID Duration
Ranked Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Rank	Pre-Retrofit	Post-Retrofit
1	0.1361	0.0593
2	0.0937	0.0417
3	0.0931	0.0349
4	0.0802	0.0276
5	0.0726	0.0168
6	0.0712	0.0094
7	0.0705	0.0094
8	0.0607	0.0094
9	0.0588	0.0094
10	0.0588	0.0094
11	0.0579	0.0094
12	0.0570	0.0094
13	0.0568	0.0094
14	0.0555	0.0094
15	0.0526	0.0094
16	0.0523	0.0094
17	0.0495	0.0094
18	0.0487	0.0094
19	0.0480	0.0094
20	0.0474	0.0094
21	0.0472	0.0094
22	0.0472	0.0094
23	0.0462	0.0094
24	0.0446	0.0094
25	0.0434	0.0094
26	0.0433	0.0094

27	0.0432	0.0094
28	0.0414	0.0094
29	0.0412	0.0094
30	0.0410	0.0094
31	0.0392	0.0094
32	0.0385	0.0094
33	0.0371	0.0094
34	0.0371	0.0094
35	0.0366	0.0094
36	0.0365	0.0094
37	0.0361	0.0094
38	0.0356	0.0094
39	0.0356	0.0094
40	0.0351	0.0094
41	0.0343	0.0094
42	0.0343	0.0094
43	0.0333	0.0094
44	0.0319	0.0094
45	0.0314	0.0094
46	0.0314	0.0094
47	0.0313	0.0094
48	0.0308	0.0094
49	0.0298	0.0094
50	0.0293	0.0094
51	0.0289	0.0094
52	0.0282	0.0094
53	0.0282	0.0093
54	0.0276	0.0093
55	0.0275	0.0092
56	0.0269	0.0092
57	0.0268	0.0091
58	0.0266	0.0091
59	0.0249	0.0090
60	0.0246	0.0089
61	0.0219	0.0088

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0032	68594	97490	142	Fail
0.0034	64958	94303	145	Fail
0.0036	61578	91095	147	Fail
0.0037	58413	87737	150	Fail
0.0039	55483	72743	131	Fail
0.0041	52702	63439	120	Fail
0.0043	50114	57686	115	Fail
0.0044	47633	52766	110	Fail
0.0046	45301	48210	106	Fail
0.0048	43120	44232	102	Fail
0.0049	40938	40553	99	Pass
0.0051	38992	37409	95	Pass
0.0053	37195	34586	92	Pass
0.0055	35420	31912	90	Pass

0.0056	33773	29474	87	Pass
0.0058	32212	27249	84	Pass
0.0060	30650	25239	82	Pass
0.0061	29260	23421	80	Pass
0.0063	27912	21731	77	Pass
0.0065	26650	20076	75	Pass
0.0067	25431	18672	73	Pass
0.0068	24298	17340	71	Pass
0.0070	23185	16093	69	Pass
0.0072	22159	14968	67	Pass
0.0073	21216	13907	65	Pass
0.0075	20351	12895	63	Pass
0.0077	19410	12018	61	Pass
0.0079	18578	11150	60	Pass
0.0080	17785	10307	57	Pass
0.0082	17049	9529	55	Pass
0.0084	16313	8763	53	Pass
0.0085	15577	8006	51	Pass
0.0087	14861	7313	49	Pass
0.0089	14170	6594	46	Pass
0.0091	13599	5852	43	Pass
0.0092	13024	5088	39	Pass
0.0094	12468	145	1	Pass
0.0096	11944	145	1	Pass
0.0097	11439	145	1	Pass
0.0099	10940	145	1	Pass
0.0101	10455	145	1	Pass
0.0103	10066	145	1	Pass
0.0104	9657	143	1	Pass
0.0106	9242	141	1	Pass
0.0108	8834	140	1	Pass
0.0109	8455	140	1	Pass
0.0111	8132	139	1	Pass
0.0113	7790	137	1	Pass
0.0115	7492	137	1	Pass
0.0116	7159	137	1	Pass
0.0118	6885	137	1	Pass
0.0120	6592	135	2	Pass
0.0121	6340	133	2	Pass
0.0123	6098	133	2	Pass
0.0125	5852	133	2	Pass
0.0127	5604	132	2	Pass
0.0128	5371	132	2	Pass
0.0130	5180	131	2	Pass
0.0132	4994	130	2	Pass
0.0133	4787	130	2	Pass
0.0135	4599	130	2	Pass
0.0137	4408	126	2	Pass
0.0138	4222	126	2	Pass
0.0140	4051	123	3	Pass
0.0142	3903	123	3	Pass
0.0144	3769	123	3	Pass
0.0145	3647	120	3	Pass
0.0147	3518	119	3	Pass
0.0149	3401	117	3	Pass
0.0150	3287	116	3	Pass
0.0152	3172	116	3	Pass

0.0154	3061	116	3	Pass
0.0156	2954	115	3	Pass
0.0157	2860	114	3	Pass
0.0159	2763	113	4	Pass
0.0161	2650	112	4	Pass
0.0162	2571	109	4	Pass
0.0164	2494	108	4	Pass
0.0166	2404	108	4	Pass
0.0168	2325	107	4	Pass
0.0169	2254	105	4	Pass
0.0171	2199	105	4	Pass
0.0173	2128	102	4	Pass
0.0174	2069	100	4	Pass
0.0176	2021	98	4	Pass
0.0178	1940	98	5	Pass
0.0180	1864	96	5	Pass
0.0181	1803	96	5	Pass
0.0183	1749	94	5	Pass
0.0185	1706	94	5	Pass
0.0186	1644	94	5	Pass
0.0188	1599	90	5	Pass
0.0190	1550	89	5	Pass
0.0192	1507	88	5	Pass
0.0193	1454	86	5	Pass
0.0195	1414	86	6	Pass
0.0197	1383	84	6	Pass
0.0198	1333	83	6	Pass
0.0200	1297	83	6	Pass
0.0202	1268	83	6	Pass

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_WB1 PreDev
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Predeveloped Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Flat	.414
SAT, Forest, Flat	.138

Pervious Total 0.552

Impervious Land Use	Acres

Impervious Total 0

Basin Total 0.552

Element Flows To:

Surface	Interflow	Groundwater

POST-RETROFIT LAND USE

Name : West Bioretention 1 Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	.1
Pervious Total	**0.1**

Impervious Land Use	Acres
ROADS FLAT	0.45
Impervious Total	**0.45**
Basin Total	**0.55**

Element Flows To:

Surface	Interflow	Groundwater
Surface oretention 1	Surface oretention 1	

Name : West Bioretention 1
Bottom Length: 331.00 ft.
Bottom Width: 1.50 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 48.908
Total Outflow (ac-ft): 48.908
Percent Through Underdrain: 100
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:

Outlet 1	Outlet 2

West Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.1710	0.0000	0.0000	0.0000
0.0495	0.1692	0.0002	0.0000	0.0000
0.0989	0.1670	0.0005	0.0000	0.0000
0.1484	0.1647	0.0009	0.0000	0.0000
0.1978	0.1625	0.0012	0.0000	0.0000
0.2473	0.1602	0.0017	0.0000	0.0000
0.2967	0.1579	0.0021	0.0000	0.0000

0.3462	0.1557	0.0026	0.0000	0.0000
0.3956	0.1534	0.0032	0.0000	0.0000
0.4451	0.1512	0.0038	0.0000	0.0000
0.4945	0.1489	0.0044	0.0000	0.0000
0.5440	0.1467	0.0051	0.0000	0.0000
0.5934	0.1444	0.0058	0.0000	0.0000
0.6429	0.1422	0.0066	0.0000	0.0000
0.6923	0.1399	0.0074	0.0000	0.0000
0.7418	0.1377	0.0082	0.0000	0.0000
0.7912	0.1354	0.0091	0.0000	0.0000
0.8407	0.1331	0.0101	0.0000	0.0000
0.8901	0.1309	0.0111	0.0000	0.0000
0.9396	0.1286	0.0121	0.0000	0.0000
0.9890	0.1264	0.0132	0.0000	0.0000
1.0385	0.1241	0.0143	0.0000	0.0000
1.0879	0.1219	0.0155	0.0000	0.0000
1.1374	0.1196	0.0167	0.0000	0.0000
1.1868	0.1174	0.0179	0.0000	0.0000
1.2363	0.1151	0.0192	0.0000	0.0000
1.2857	0.1129	0.0205	0.0000	0.0000
1.3352	0.1106	0.0219	0.0000	0.0000
1.3846	0.1083	0.0233	0.0000	0.0000
1.4341	0.1061	0.0248	0.0000	0.0000
1.4835	0.1038	0.0263	0.0000	0.0000
1.5330	0.1016	0.0272	0.0000	0.0000
1.5824	0.0993	0.0280	0.0000	0.0000
1.6319	0.0971	0.0289	0.0000	0.0000
1.6813	0.0948	0.0298	0.0000	0.0000
1.7308	0.0926	0.0307	0.0000	0.0000
1.7802	0.0903	0.0316	0.0000	0.0000
1.8297	0.0881	0.0326	0.0000	0.0000
1.8791	0.0858	0.0336	0.0000	0.0000
1.9286	0.0835	0.0346	0.0000	0.0000
1.9780	0.0813	0.0356	0.0000	0.0000
2.0275	0.0790	0.0366	0.0000	0.0000
2.0769	0.0768	0.0377	0.0276	0.0000
2.1264	0.0745	0.0388	0.0293	0.0000
2.1758	0.0723	0.0399	0.0328	0.0000
2.2253	0.0700	0.0411	0.0351	0.0000
2.2747	0.0678	0.0423	0.0406	0.0000
2.3242	0.0655	0.0435	0.0426	0.0000
2.3736	0.0633	0.0447	0.0470	0.0000
2.4231	0.0610	0.0459	0.0513	0.0000
2.4725	0.0587	0.0472	0.0566	0.0000
2.5220	0.0565	0.0485	0.0591	0.0000
2.5714	0.0542	0.0498	0.0634	0.0000
2.6209	0.0520	0.0511	0.0690	0.0000
2.6703	0.0497	0.0525	0.0690	0.0000
2.7198	0.0475	0.0538	0.0690	0.0000
2.7692	0.0452	0.0552	0.0690	0.0000
2.8187	0.0430	0.0567	0.0690	0.0000
2.8681	0.0407	0.0581	0.0690	0.0000
2.9176	0.0385	0.0596	0.0690	0.0000
2.9670	0.0362	0.0611	0.0690	0.0000
3.0165	0.0339	0.0626	0.0690	0.0000
3.0659	0.0317	0.0641	0.0690	0.0000
3.1154	0.0294	0.0657	0.0690	0.0000

3.1648	0.0272	0.0673	0.0690	0.0000
3.2143	0.0249	0.0689	0.0690	0.0000
3.2637	0.0227	0.0705	0.0690	0.0000
3.3132	0.0204	0.0738	0.0690	0.0000
3.3626	0.0182	0.0772	0.0690	0.0000
3.4121	0.0159	0.0806	0.0690	0.0000
3.4615	0.0137	0.0840	0.0690	0.0000
3.5000	0.0114	0.0868	0.0690	0.0000

Surface oretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.1710	0.0868	0.0000	0.0712	0.0000
3.5495	0.1732	0.0953	0.0000	0.0712	0.0000
3.5989	0.1755	0.1039	0.0000	0.0735	0.0000
3.6484	0.1777	0.1126	0.0000	0.0758	0.0000
3.6978	0.1800	0.1215	0.0000	0.0781	0.0000
3.7473	0.1822	0.1304	0.0000	0.0803	0.0000
3.7967	0.1845	0.1395	0.0000	0.0826	0.0000
3.8462	0.1868	0.1487	0.0000	0.0849	0.0000
3.8956	0.1890	0.1580	0.0000	0.0871	0.0000
3.9451	0.1913	0.1674	0.0000	0.0894	0.0000
3.9945	0.1935	0.1769	0.0000	0.0917	0.0000
4.0440	0.1958	0.1865	7.4793	0.0940	0.0000
4.0934	0.1980	0.1962	23.169	0.0962	0.0000
4.1429	0.2003	0.2061	43.821	0.0985	0.0000
4.1923	0.2025	0.2160	68.443	0.1008	0.0000
4.2418	0.2048	0.2261	96.473	0.1031	0.0000
4.2912	0.2070	0.2363	127.54	0.1053	0.0000
4.3407	0.2093	0.2466	161.37	0.1076	0.0000
4.3901	0.2116	0.2570	197.75	0.1099	0.0000
4.4396	0.2138	0.2675	236.52	0.1122	0.0000
4.4890	0.2161	0.2781	277.53	0.1144	0.0000
4.5000	0.2166	0.2805	320.68	0.1149	0.0000

Name : Surface oretention 1

Element Flows To:
Outlet 1 **Outlet 2**
West Bioretention 1

ANALYSIS RESULTS

Stream Protection Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.552
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1

Total Pervious Area:0.1
Total Impervious Area:0.45

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.005321
5 year	0.008937
10 year	0.011582
25 year	0.015138
50 year	0.017912
100 year	0.020774

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.053894
5 year	0.061997
10 year	0.066495
25 year	0.071483
50 year	0.074807
100 year	0.077862

Stream Protection Duration
Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	Predeveloped	Post-Retrofit
1949	0.001	0.050
1950	0.007	0.058
1951	0.005	0.060
1952	0.004	0.049
1953	0.003	0.057
1954	0.007	0.055
1955	0.013	0.068
1956	0.009	0.043
1957	0.009	0.058
1958	0.006	0.058
1959	0.005	0.057
1960	0.005	0.058
1961	0.006	0.069
1962	0.003	0.050
1963	0.004	0.065
1964	0.005	0.055
1965	0.006	0.038
1966	0.003	0.039
1967	0.007	0.051
1968	0.007	0.064
1969	0.004	0.055
1970	0.004	0.043
1971	0.006	0.059
1972	0.006	0.065
1973	0.003	0.056
1974	0.005	0.054
1975	0.005	0.056
1976	0.005	0.058
1977	0.002	0.041
1978	0.004	0.042
1979	0.008	0.067

1980	0.004	0.048
1981	0.004	0.050
1982	0.008	0.062
1983	0.005	0.054
1984	0.005	0.050
1985	0.008	0.067
1986	0.022	0.069
1987	0.008	0.057
1988	0.004	0.047
1989	0.003	0.050
1990	0.005	0.041
1991	0.006	0.057
1992	0.004	0.044
1993	0.003	0.046
1994	0.002	0.041
1995	0.005	0.055
1996	0.018	0.061
1997	0.034	0.069
1998	0.004	0.054
1999	0.007	0.045
2000	0.004	0.043
2001	0.001	0.042
2002	0.005	0.043
2003	0.003	0.039
2004	0.005	0.069
2005	0.004	0.068
2006	0.015	0.058
2007	0.008	0.057
2008	0.012	0.069
2009	0.006	0.062

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	**Predeveloped**	**Post-Retrofit**
1	0.0336	0.0690
2	0.0224	0.0690
3	0.0177	0.0690
4	0.0149	0.0690
5	0.0126	0.0690
6	0.0117	0.0678
7	0.0094	0.0676
8	0.0086	0.0673
9	0.0083	0.0666
10	0.0080	0.0647
11	0.0080	0.0645
12	0.0079	0.0642
13	0.0079	0.0618
14	0.0073	0.0617
15	0.0073	0.0614
16	0.0071	0.0596
17	0.0069	0.0594
18	0.0065	0.0580
19	0.0062	0.0580
20	0.0060	0.0579
21	0.0059	0.0579
22	0.0058	0.0579

23	0.0057	0.0577
24	0.0056	0.0574
25	0.0056	0.0572
26	0.0055	0.0571
27	0.0054	0.0571
28	0.0054	0.0568
29	0.0053	0.0564
30	0.0053	0.0558
31	0.0053	0.0554
32	0.0052	0.0553
33	0.0051	0.0552
34	0.0049	0.0546
35	0.0049	0.0545
36	0.0046	0.0537
37	0.0045	0.0536
38	0.0045	0.0515
39	0.0044	0.0504
40	0.0044	0.0503
41	0.0044	0.0498
42	0.0043	0.0495
43	0.0043	0.0495
44	0.0043	0.0493
45	0.0041	0.0483
46	0.0041	0.0472
47	0.0039	0.0464
48	0.0038	0.0449
49	0.0038	0.0443
50	0.0036	0.0431
51	0.0034	0.0430
52	0.0034	0.0428
53	0.0032	0.0426
54	0.0031	0.0418
55	0.0029	0.0417
56	0.0028	0.0414
57	0.0028	0.0413
58	0.0021	0.0406
59	0.0019	0.0393
60	0.0008	0.0392
61	0.0007	0.0383

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0027	22330	174169	779	Fail
0.0028	19735	169763	860	Fail
0.0030	17263	165293	957	Fail
0.0031	15169	160908	1060	Fail
0.0033	13449	156395	1162	Fail
0.0034	11926	152010	1274	Fail
0.0036	10602	147775	1393	Fail
0.0037	9486	143711	1514	Fail
0.0039	8472	140054	1653	Fail
0.0040	7591	136760	1801	Fail

0.0042	6785	133808	1972	Fail
0.0044	6000	131113	2185	Fail
0.0045	5347	128632	2405	Fail
0.0047	4804	126279	2628	Fail
0.0048	4327	124012	2866	Fail
0.0050	3897	121852	3126	Fail
0.0051	3497	119820	3426	Fail
0.0053	3189	117745	3692	Fail
0.0054	2920	115820	3966	Fail
0.0056	2669	113853	4265	Fail
0.0057	2470	112056	4536	Fail
0.0059	2274	110174	4844	Fail
0.0060	2104	108377	5150	Fail
0.0062	1954	106516	5451	Fail
0.0064	1802	104805	5816	Fail
0.0065	1667	103115	6185	Fail
0.0067	1534	101447	6613	Fail
0.0068	1438	99715	6934	Fail
0.0070	1353	97982	7241	Fail
0.0071	1279	96271	7527	Fail
0.0073	1216	94603	7779	Fail
0.0074	1157	92870	8026	Fail
0.0076	1104	91159	8257	Fail
0.0077	1059	89384	8440	Fail
0.0079	1008	87673	8697	Fail
0.0081	954	86069	9021	Fail
0.0082	904	84507	9348	Fail
0.0084	866	83074	9592	Fail
0.0085	831	81748	9837	Fail
0.0087	803	80529	10028	Fail
0.0088	775	79331	10236	Fail
0.0090	745	78304	10510	Fail
0.0091	718	77235	10756	Fail
0.0093	684	76166	11135	Fail
0.0094	655	75224	11484	Fail
0.0096	625	74283	11885	Fail
0.0097	604	73321	12139	Fail
0.0099	578	72380	12522	Fail
0.0101	557	71503	12837	Fail
0.0102	539	70604	13099	Fail
0.0104	517	69685	13478	Fail
0.0105	500	68829	13765	Fail
0.0107	482	67952	14097	Fail
0.0108	468	67161	14350	Fail
0.0110	441	66369	15049	Fail
0.0111	413	65514	15862	Fail
0.0113	397	64701	16297	Fail
0.0114	381	63888	16768	Fail
0.0116	367	63097	17192	Fail
0.0117	354	62327	17606	Fail
0.0119	336	61536	18314	Fail
0.0121	327	60851	18608	Fail
0.0122	314	60017	19113	Fail
0.0124	308	59268	19242	Fail
0.0125	301	58541	19448	Fail
0.0127	291	57857	19882	Fail
0.0128	283	57215	20217	Fail

0.0130	275	56466	20533	Fail
0.0131	266	55803	20978	Fail
0.0133	258	55140	21372	Fail
0.0134	251	54520	21721	Fail
0.0136	248	53900	21733	Fail
0.0138	241	53237	22090	Fail
0.0139	237	52659	22218	Fail
0.0141	235	52039	22144	Fail
0.0142	226	51504	22789	Fail
0.0144	219	50905	23244	Fail
0.0145	216	50285	23280	Fail
0.0147	211	49772	23588	Fail
0.0148	205	49173	23986	Fail
0.0150	198	48638	24564	Fail
0.0151	194	48061	24773	Fail
0.0153	190	47505	25002	Fail
0.0154	182	46970	25807	Fail
0.0156	178	46456	26098	Fail
0.0158	175	45965	26265	Fail
0.0159	170	45430	26723	Fail
0.0161	166	44916	27057	Fail
0.0162	161	44446	27606	Fail
0.0164	158	43911	27791	Fail
0.0165	152	43419	28565	Fail
0.0167	149	42991	28853	Fail
0.0168	144	42478	29498	Fail
0.0170	141	42050	29822	Fail
0.0171	139	41601	29928	Fail
0.0173	135	41195	30514	Fail
0.0174	130	40788	31375	Fail
0.0176	126	40361	32032	Fail
0.0178	123	39954	32482	Fail
0.0179	117	39569	33819	Fail

The development has an increase in flow durations from 1/2 Predeveloped 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0.552
Total Impervious Area:0

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.1
Total Impervious Area:0.45

Flow Frequency Return Periods for Predeveloped. POC #1

Return Period	Flow(cfs)
2 year	0.005321
5 year	0.008937
10 year	0.011582
25 year	0.015138
50 year	0.017912
100 year	0.020774

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.053894
5 year	0.061997
10 year	0.066495
25 year	0.071483
50 year	0.074807
100 year	0.077862

LID Duration

Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Year	Predeveloped	Post-Retrofit
1949	0.001	0.050
1950	0.007	0.058
1951	0.005	0.060
1952	0.004	0.049
1953	0.003	0.057
1954	0.007	0.055
1955	0.013	0.068
1956	0.009	0.043
1957	0.009	0.058
1958	0.006	0.058
1959	0.005	0.057
1960	0.005	0.058
1961	0.006	0.069
1962	0.003	0.050
1963	0.004	0.065
1964	0.005	0.055
1965	0.006	0.038
1966	0.003	0.039
1967	0.007	0.051
1968	0.007	0.064
1969	0.004	0.055
1970	0.004	0.043
1971	0.006	0.059
1972	0.006	0.065
1973	0.003	0.056
1974	0.005	0.054
1975	0.005	0.056
1976	0.005	0.058
1977	0.002	0.041
1978	0.004	0.042
1979	0.008	0.067
1980	0.004	0.048
1981	0.004	0.050
1982	0.008	0.062
1983	0.005	0.054

1984	0.005	0.050
1985	0.008	0.067
1986	0.022	0.069
1987	0.008	0.057
1988	0.004	0.047
1989	0.003	0.050
1990	0.005	0.041
1991	0.006	0.057
1992	0.004	0.044
1993	0.003	0.046
1994	0.002	0.041
1995	0.005	0.055
1996	0.018	0.061
1997	0.034	0.069
1998	0.004	0.054
1999	0.007	0.045
2000	0.004	0.043
2001	0.001	0.042
2002	0.005	0.043
2003	0.003	0.039
2004	0.005	0.069
2005	0.004	0.068
2006	0.015	0.058
2007	0.008	0.057
2008	0.012	0.069
2009	0.006	0.062

LID Duration
Ranked Annual Peaks for Predeveloped and Post-Retrofit. POC #1

Rank	Predeveloped	Post-Retrofit
1	0.0336	0.0690
2	0.0224	0.0690
3	0.0177	0.0690
4	0.0149	0.0690
5	0.0126	0.0690
6	0.0117	0.0678
7	0.0094	0.0676
8	0.0086	0.0673
9	0.0083	0.0666
10	0.0080	0.0647
11	0.0080	0.0645
12	0.0079	0.0642
13	0.0079	0.0618
14	0.0073	0.0617
15	0.0073	0.0614
16	0.0071	0.0596
17	0.0069	0.0594
18	0.0065	0.0580
19	0.0062	0.0580
20	0.0060	0.0579
21	0.0059	0.0579
22	0.0058	0.0579
23	0.0057	0.0577
24	0.0056	0.0574
25	0.0056	0.0572
26	0.0055	0.0571

27	0.0054	0.0571
28	0.0054	0.0568
29	0.0053	0.0564
30	0.0053	0.0558
31	0.0053	0.0554
32	0.0052	0.0553
33	0.0051	0.0552
34	0.0049	0.0546
35	0.0049	0.0545
36	0.0046	0.0537
37	0.0045	0.0536
38	0.0045	0.0515
39	0.0044	0.0504
40	0.0044	0.0503
41	0.0044	0.0498
42	0.0043	0.0495
43	0.0043	0.0495
44	0.0043	0.0493
45	0.0041	0.0483
46	0.0041	0.0472
47	0.0039	0.0464
48	0.0038	0.0449
49	0.0038	0.0443
50	0.0036	0.0431
51	0.0034	0.0430
52	0.0034	0.0428
53	0.0032	0.0426
54	0.0031	0.0418
55	0.0029	0.0417
56	0.0028	0.0414
57	0.0028	0.0413
58	0.0021	0.0406
59	0.0019	0.0393
60	0.0008	0.0392
61	0.0007	0.0383

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0004	221802	356765	160	Fail
0.0004	213717	350349	163	Fail
0.0005	206552	344360	166	Fail
0.0005	199365	338585	169	Fail
0.0005	192734	333451	173	Fail
0.0005	186318	328318	176	Fail
0.0006	180094	323399	179	Fail
0.0006	174404	318693	182	Fail
0.0006	168886	314201	186	Fail
0.0006	163860	310138	189	Fail
0.0007	158940	305860	192	Fail
0.0007	154470	302010	195	Fail
0.0007	149935	298160	198	Fail
0.0007	145636	294524	202	Fail

0.0007	141658	291102	205	Fail
0.0008	137680	287893	209	Fail
0.0008	133979	284685	212	Fail
0.0008	130258	281690	216	Fail
0.0008	126729	278696	219	Fail
0.0009	123413	275916	223	Fail
0.0009	120077	272921	227	Fail
0.0009	116975	270354	231	Fail
0.0009	113874	267574	234	Fail
0.0009	111093	265221	238	Fail
0.0010	108142	262868	243	Fail
0.0010	105361	260516	247	Fail
0.0010	102773	258163	251	Fail
0.0010	100164	256024	255	Fail
0.0011	97790	253885	259	Fail
0.0011	95437	251746	263	Fail
0.0011	93234	249607	267	Fail
0.0011	91052	247682	272	Fail
0.0011	88956	245757	276	Fail
0.0012	87010	243832	280	Fail
0.0012	84999	242121	284	Fail
0.0012	83138	240410	289	Fail
0.0012	81256	238485	293	Fail
0.0013	79524	236988	298	Fail
0.0013	77706	235277	302	Fail
0.0013	75952	233566	307	Fail
0.0013	74347	232068	312	Fail
0.0014	72658	230357	317	Fail
0.0014	71075	229074	322	Fail
0.0014	69514	227577	327	Fail
0.0014	68102	226080	331	Fail
0.0014	66626	224582	337	Fail
0.0015	65172	223299	342	Fail
0.0015	63846	222016	347	Fail
0.0015	62455	220732	353	Fail
0.0015	61193	219449	358	Fail
0.0016	59889	217952	363	Fail
0.0016	58648	216882	369	Fail
0.0016	57386	215599	375	Fail
0.0016	56124	214316	381	Fail
0.0016	54948	213204	388	Fail
0.0017	53750	212027	394	Fail
0.0017	52616	210915	400	Fail
0.0017	51504	209781	407	Fail
0.0017	50435	208691	413	Fail
0.0018	49408	207557	420	Fail
0.0018	48381	206487	426	Fail
0.0018	47440	205461	433	Fail
0.0018	46456	204434	440	Fail
0.0018	45515	203407	446	Fail
0.0019	44574	202359	453	Fail
0.0019	43697	201376	460	Fail
0.0019	42820	200413	468	Fail
0.0019	41901	199472	476	Fail
0.0020	41066	198574	483	Fail
0.0020	40211	197611	491	Fail
0.0020	39441	196670	498	Fail

0.0020	38650	195750	506	Fail
0.0021	37880	194831	514	Fail
0.0021	37131	193954	522	Fail
0.0021	36382	193077	530	Fail
0.0021	35655	192200	539	Fail
0.0021	34928	191366	547	Fail
0.0022	34265	190553	556	Fail
0.0022	33602	189719	564	Fail
0.0022	32939	188863	573	Fail
0.0022	32297	188050	582	Fail
0.0023	31655	187238	591	Fail
0.0023	31035	186468	600	Fail
0.0023	30393	185698	610	Fail
0.0023	29816	184970	620	Fail
0.0023	29217	184179	630	Fail
0.0024	28640	183473	640	Fail
0.0024	28105	182703	650	Fail
0.0024	27527	181955	661	Fail
0.0024	26993	181227	671	Fail
0.0025	26458	180479	682	Fail
0.0025	25966	179751	692	Fail
0.0025	25474	179024	702	Fail
0.0025	24982	178276	713	Fail
0.0025	24512	177591	724	Fail
0.0026	24062	176885	735	Fail
0.0026	23635	176265	745	Fail
0.0026	23185	175581	757	Fail
0.0026	22736	174896	769	Fail
0.0027	22330	174169	779	Fail

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: Harbour Pointe MS_WB1
Site Name: Harbour Pointe Middle School
Site Address:
City :
Report Date: 12/9/2014
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PRE-RETROFIT LAND USE

Name : Pre-Retrofit Basin
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Lawn, Flat	.1
Pervious Total	0.1

Impervious Land Use	Acres
ROADS FLAT	0.45
Impervious Total	0.45
Basin Total	0.55

Element Flows To:

Surface	Interflow	Groundwater

POST-RETROFIT LAND USE

Name : West Bioretention 1 Basin
Bypass: No

GroundWater: No

Pervious Land Use	**Acres**
C, Lawn, Flat	**.1**

Pervious Total **0.1**

Impervious Land Use	**Acres**
ROADS FLAT	**0.45**

Impervious Total **0.45**

Basin Total **0.55**

Element Flows To:

Surface	**Interflow**	**Groundwater**
Surface Bioretention	Surface Bioretention	

Name : West Bioretention 1
Bottom Length: 331.00 ft.
Bottom Width: 1.50 ft.
Material thickness of first layer: 1.5
Material type for first layer: SMMWW
Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 3
Offset (in): 12
Flow Through Underdrain (ac-ft): 48.908
Total Outflow (ac-ft): 48.908
Percent Through Underdrain: 100
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 1000 in.

Element Flows To:
Outlet 1 **Outlet 2**

West Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.1710	0.0000	0.0000	0.0000
0.0495	0.1692	0.0002	0.0000	0.0000
0.0989	0.1670	0.0005	0.0000	0.0000
0.1484	0.1647	0.0009	0.0000	0.0000
0.1978	0.1625	0.0012	0.0000	0.0000
0.2473	0.1602	0.0017	0.0000	0.0000
0.2967	0.1579	0.0021	0.0000	0.0000

0.3462	0.1557	0.0026	0.0000	0.0000
0.3956	0.1534	0.0032	0.0000	0.0000
0.4451	0.1512	0.0038	0.0000	0.0000
0.4945	0.1489	0.0044	0.0000	0.0000
0.5440	0.1467	0.0051	0.0000	0.0000
0.5934	0.1444	0.0058	0.0000	0.0000
0.6429	0.1422	0.0066	0.0000	0.0000
0.6923	0.1399	0.0074	0.0000	0.0000
0.7418	0.1377	0.0082	0.0000	0.0000
0.7912	0.1354	0.0091	0.0000	0.0000
0.8407	0.1331	0.0101	0.0000	0.0000
0.8901	0.1309	0.0111	0.0000	0.0000
0.9396	0.1286	0.0121	0.0000	0.0000
0.9890	0.1264	0.0132	0.0000	0.0000
1.0385	0.1241	0.0143	0.0000	0.0000
1.0879	0.1219	0.0155	0.0000	0.0000
1.1374	0.1196	0.0167	0.0000	0.0000
1.1868	0.1174	0.0179	0.0000	0.0000
1.2363	0.1151	0.0192	0.0000	0.0000
1.2857	0.1129	0.0205	0.0000	0.0000
1.3352	0.1106	0.0219	0.0000	0.0000
1.3846	0.1083	0.0233	0.0000	0.0000
1.4341	0.1061	0.0248	0.0000	0.0000
1.4835	0.1038	0.0263	0.0000	0.0000
1.5330	0.1016	0.0272	0.0000	0.0000
1.5824	0.0993	0.0280	0.0000	0.0000
1.6319	0.0971	0.0289	0.0000	0.0000
1.6813	0.0948	0.0298	0.0000	0.0000
1.7308	0.0926	0.0307	0.0000	0.0000
1.7802	0.0903	0.0316	0.0000	0.0000
1.8297	0.0881	0.0326	0.0000	0.0000
1.8791	0.0858	0.0336	0.0000	0.0000
1.9286	0.0835	0.0346	0.0000	0.0000
1.9780	0.0813	0.0356	0.0000	0.0000
2.0275	0.0790	0.0366	0.0000	0.0000
2.0769	0.0768	0.0377	0.0276	0.0000
2.1264	0.0745	0.0388	0.0293	0.0000
2.1758	0.0723	0.0399	0.0328	0.0000
2.2253	0.0700	0.0411	0.0351	0.0000
2.2747	0.0678	0.0423	0.0406	0.0000
2.3242	0.0655	0.0435	0.0426	0.0000
2.3736	0.0633	0.0447	0.0470	0.0000
2.4231	0.0610	0.0459	0.0513	0.0000
2.4725	0.0587	0.0472	0.0566	0.0000
2.5220	0.0565	0.0485	0.0591	0.0000
2.5714	0.0542	0.0498	0.0634	0.0000
2.6209	0.0520	0.0511	0.0690	0.0000
2.6703	0.0497	0.0525	0.0690	0.0000
2.7198	0.0475	0.0538	0.0690	0.0000
2.7692	0.0452	0.0552	0.0690	0.0000
2.8187	0.0430	0.0567	0.0690	0.0000
2.8681	0.0407	0.0581	0.0690	0.0000
2.9176	0.0385	0.0596	0.0690	0.0000
2.9670	0.0362	0.0611	0.0690	0.0000
3.0165	0.0339	0.0626	0.0690	0.0000
3.0659	0.0317	0.0641	0.0690	0.0000
3.1154	0.0294	0.0657	0.0690	0.0000

3.1648	0.0272	0.0673	0.0690	0.0000
3.2143	0.0249	0.0689	0.0690	0.0000
3.2637	0.0227	0.0705	0.0690	0.0000
3.3132	0.0204	0.0738	0.0690	0.0000
3.3626	0.0182	0.0772	0.0690	0.0000
3.4121	0.0159	0.0806	0.0690	0.0000
3.4615	0.0137	0.0840	0.0690	0.0000
3.5000	0.0114	0.0868	0.0690	0.0000

Surface Bioretention Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
3.5000	0.1710	0.0868	0.0000	0.0712	0.0000
3.5495	0.1732	0.0953	0.0000	0.0712	0.0000
3.5989	0.1755	0.1039	0.0000	0.0735	0.0000
3.6484	0.1777	0.1126	0.0000	0.0758	0.0000
3.6978	0.1800	0.1215	0.0000	0.0781	0.0000
3.7473	0.1822	0.1304	0.0000	0.0803	0.0000
3.7967	0.1845	0.1395	0.0000	0.0826	0.0000
3.8462	0.1868	0.1487	0.0000	0.0849	0.0000
3.8956	0.1890	0.1580	0.0000	0.0871	0.0000
3.9451	0.1913	0.1674	0.0000	0.0894	0.0000
3.9945	0.1935	0.1769	0.0000	0.0917	0.0000
4.0440	0.1958	0.1865	7.4793	0.0940	0.0000
4.0934	0.1980	0.1962	23.169	0.0962	0.0000
4.1429	0.2003	0.2061	43.821	0.0985	0.0000
4.1923	0.2025	0.2160	68.443	0.1008	0.0000
4.2418	0.2048	0.2261	96.473	0.1031	0.0000
4.2912	0.2070	0.2363	127.54	0.1053	0.0000
4.3407	0.2093	0.2466	161.37	0.1076	0.0000
4.3901	0.2116	0.2570	197.75	0.1099	0.0000
4.4396	0.2138	0.2675	236.52	0.1122	0.0000
4.4890	0.2161	0.2781	277.53	0.1144	0.0000
4.5000	0.2166	0.2805	320.68	0.1149	0.0000

Name : Surface Bioretention

Element Flows To:
Outlet 1 **Outlet 2**
West Bioretention 1

ANALYSIS RESULTS

Stream Protection Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.1
Total Impervious Area:0.45

Post-Retrofit Landuse Totals for POC #1

Total Pervious Area:0.1
Total Impervious Area:0.45

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.146777
5 year	0.201636
10 year	0.242226
25 year	0.298584
50 year	0.344392
100 year	0.393602

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.053894
5 year	0.061997
10 year	0.066495
25 year	0.071483
50 year	0.074807
100 year	0.077862

Stream Protection Duration
Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Year	Pre-Retrofit	Post-Retrofit
1949	0.139	0.050
1950	0.186	0.058
1951	0.154	0.060
1952	0.132	0.049
1953	0.181	0.057
1954	0.238	0.055
1955	0.174	0.068
1956	0.080	0.043
1957	0.142	0.058
1958	0.335	0.058
1959	0.139	0.057
1960	0.123	0.058
1961	0.464	0.069
1962	0.163	0.050
1963	0.204	0.065
1964	0.106	0.055
1965	0.103	0.038
1966	0.106	0.039
1967	0.300	0.051
1968	0.163	0.064
1969	0.309	0.055
1970	0.116	0.043
1971	0.171	0.059
1972	0.219	0.065
1973	0.174	0.056
1974	0.218	0.054
1975	0.168	0.056
1976	0.116	0.058
1977	0.115	0.041
1978	0.090	0.042
1979	0.206	0.067

1980	0.103	0.048
1981	0.115	0.050
1982	0.116	0.062
1983	0.155	0.054
1984	0.136	0.050
1985	0.214	0.067
1986	0.197	0.069
1987	0.172	0.057
1988	0.132	0.047
1989	0.148	0.050
1990	0.099	0.041
1991	0.135	0.057
1992	0.134	0.044
1993	0.104	0.046
1994	0.100	0.041
1995	0.112	0.055
1996	0.139	0.061
1997	0.185	0.069
1998	0.194	0.054
1999	0.091	0.045
2000	0.271	0.043
2001	0.108	0.042
2002	0.101	0.043
2003	0.137	0.039
2004	0.262	0.069
2005	0.124	0.068
2006	0.159	0.058
2007	0.150	0.057
2008	0.122	0.069
2009	0.129	0.062

Stream Protection Duration
Ranked Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Rank	**Pre-Retrofit**	**Post-Retrofit**
1	0.4641	0.0690
2	0.3346	0.0690
3	0.3089	0.0690
4	0.3004	0.0690
5	0.2712	0.0690
6	0.2615	0.0678
7	0.2377	0.0676
8	0.2189	0.0673
9	0.2181	0.0666
10	0.2136	0.0647
11	0.2064	0.0645
12	0.2042	0.0642
13	0.1974	0.0618
14	0.1940	0.0617
15	0.1862	0.0614
16	0.1846	0.0596
17	0.1810	0.0594
18	0.1744	0.0580
19	0.1740	0.0580
20	0.1722	0.0579
21	0.1709	0.0579
22	0.1684	0.0579

23	0.1633	0.0577
24	0.1628	0.0574
25	0.1585	0.0572
26	0.1552	0.0571
27	0.1538	0.0571
28	0.1503	0.0568
29	0.1477	0.0564
30	0.1421	0.0558
31	0.1389	0.0554
32	0.1389	0.0553
33	0.1386	0.0552
34	0.1367	0.0546
35	0.1365	0.0545
36	0.1352	0.0537
37	0.1335	0.0536
38	0.1325	0.0515
39	0.1323	0.0504
40	0.1289	0.0503
41	0.1237	0.0498
42	0.1232	0.0495
43	0.1223	0.0495
44	0.1162	0.0493
45	0.1159	0.0483
46	0.1155	0.0472
47	0.1153	0.0464
48	0.1148	0.0449
49	0.1116	0.0443
50	0.1083	0.0431
51	0.1057	0.0430
52	0.1056	0.0428
53	0.1036	0.0426
54	0.1033	0.0418
55	0.1028	0.0417
56	0.1008	0.0414
57	0.0998	0.0413
58	0.0989	0.0406
59	0.0906	0.0393
60	0.0896	0.0392
61	0.0804	0.0383

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0734	22907	171346	748	Fail
0.0761	19149	166041	867	Fail
0.0789	15836	160694	1014	Fail
0.0816	13302	155411	1168	Fail
0.0843	11218	150021	1337	Fail
0.0871	9548	144759	1516	Fail
0.0898	8130	139754	1718	Fail
0.0926	6941	135370	1950	Fail
0.0953	5848	131734	2252	Fail
0.0980	4960	128525	2591	Fail

0.1008	4286	125659	2931	Fail
0.1035	3681	122921	3339	Fail
0.1062	3202	120333	3758	Fail
0.1090	2821	117767	4174	Fail
0.1117	2502	115243	4606	Fail
0.1144	2229	112847	5062	Fail
0.1172	2006	110516	5509	Fail
0.1199	1786	108185	6057	Fail
0.1227	1586	105939	6679	Fail
0.1254	1440	103714	7202	Fail
0.1281	1323	101468	7669	Fail
0.1309	1228	99223	8080	Fail
0.1336	1147	97020	8458	Fail
0.1363	1076	94817	8811	Fail
0.1391	1001	92592	9249	Fail
0.1418	921	90410	9816	Fail
0.1446	867	88293	10183	Fail
0.1473	822	86325	10501	Fail
0.1500	782	84635	10822	Fail
0.1528	736	83074	11287	Fail
0.1555	691	81641	11814	Fail
0.1582	655	80272	12255	Fail
0.1610	613	78967	12882	Fail
0.1637	578	77706	13443	Fail
0.1665	548	76486	13957	Fail
0.1692	521	75353	14463	Fail
0.1719	495	74198	14989	Fail
0.1747	472	73064	15479	Fail
0.1774	436	71973	16507	Fail
0.1801	403	70861	17583	Fail
0.1829	381	69856	18334	Fail
0.1856	359	68829	19172	Fail
0.1884	337	67824	20125	Fail
0.1911	321	66840	20822	Fail
0.1938	310	65856	21243	Fail
0.1966	299	64894	21703	Fail
0.1993	286	63931	22353	Fail
0.2020	275	62990	22905	Fail
0.2048	263	62156	23633	Fail
0.2075	251	61300	24422	Fail
0.2103	245	60466	24680	Fail
0.2130	239	59696	24977	Fail
0.2157	233	58926	25290	Fail
0.2185	223	58199	26098	Fail
0.2212	216	57493	26617	Fail
0.2239	208	56766	27291	Fail
0.2267	198	56017	28291	Fail
0.2294	194	55333	28522	Fail
0.2322	183	54627	29850	Fail
0.2349	177	53878	30439	Fail
0.2376	171	53237	31132	Fail
0.2404	166	52616	31696	Fail
0.2431	159	51953	32674	Fail
0.2458	153	51248	33495	Fail
0.2486	147	50649	34455	Fail
0.2513	141	50007	35465	Fail
0.2541	137	49451	36095	Fail

0.2568	133	48831	36715	Fail
0.2595	126	48210	38261	Fail
0.2623	122	47676	39078	Fail
0.2650	113	47162	41736	Fail
0.2677	107	46649	43597	Fail
0.2705	103	46136	44792	Fail
0.2732	96	45622	47522	Fail
0.2760	86	45066	52402	Fail
0.2787	79	44596	56450	Fail
0.2814	76	44168	58115	Fail
0.2842	72	43655	60631	Fail
0.2869	69	43205	62615	Fail
0.2896	60	42778	71296	Fail
0.2924	58	42350	73017	Fail
0.2951	52	41879	80536	Fail
0.2979	49	41409	84508	Fail
0.3006	47	40960	87148	Fail
0.3033	45	40468	89928	Fail
0.3061	42	40018	95280	Fail
0.3088	39	39548	101405	Fail
0.3115	36	39099	108608	Fail
0.3143	34	38692	113800	Fail
0.3170	29	38200	131724	Fail
0.3198	26	37751	145196	Fail
0.3225	25	37345	149380	Fail
0.3252	24	36896	153733	Fail
0.3280	24	36447	151862	Fail
0.3307	24	35655	148562	Fail
0.3334	21	34094	162352	Fail
0.3362	19	32297	169984	Fail
0.3389	18	30565	169805	Fail
0.3417	16	29025	181406	Fail
0.3444	15	27763	185086	Fail

The development has an increase in flow durations from 1/2 Pre-Retrofit 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.
The development has an increase in flow durations for more than 50% of the flows for the range of the duration analysis.

LID Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.1
Total Impervious Area:0.45

Post-Retrofit Landuse Totals for POC #1
Total Pervious Area:0.1
Total Impervious Area:0.45

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.146777
5 year	0.201636
10 year	0.242226
25 year	0.298584
50 year	0.344392
100 year	0.393602

Flow Frequency Return Periods for Post-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.053894
5 year	0.061997
10 year	0.066495
25 year	0.071483
50 year	0.074807
100 year	0.077862

LID Duration

Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Year	Pre-Retrofit	Post-Retrofit
1949	0.139	0.050
1950	0.186	0.058
1951	0.154	0.060
1952	0.132	0.049
1953	0.181	0.057
1954	0.238	0.055
1955	0.174	0.068
1956	0.080	0.043
1957	0.142	0.058
1958	0.335	0.058
1959	0.139	0.057
1960	0.123	0.058
1961	0.464	0.069
1962	0.163	0.050
1963	0.204	0.065
1964	0.106	0.055
1965	0.103	0.038
1966	0.106	0.039
1967	0.300	0.051
1968	0.163	0.064
1969	0.309	0.055
1970	0.116	0.043
1971	0.171	0.059
1972	0.219	0.065
1973	0.174	0.056
1974	0.218	0.054
1975	0.168	0.056
1976	0.116	0.058
1977	0.115	0.041
1978	0.090	0.042
1979	0.206	0.067
1980	0.103	0.048
1981	0.115	0.050
1982	0.116	0.062
1983	0.155	0.054

1984	0.136	0.050
1985	0.214	0.067
1986	0.197	0.069
1987	0.172	0.057
1988	0.132	0.047
1989	0.148	0.050
1990	0.099	0.041
1991	0.135	0.057
1992	0.134	0.044
1993	0.104	0.046
1994	0.100	0.041
1995	0.112	0.055
1996	0.139	0.061
1997	0.185	0.069
1998	0.194	0.054
1999	0.091	0.045
2000	0.271	0.043
2001	0.108	0.042
2002	0.101	0.043
2003	0.137	0.039
2004	0.262	0.069
2005	0.124	0.068
2006	0.159	0.058
2007	0.150	0.057
2008	0.122	0.069
2009	0.129	0.062

LID Duration

Ranked Annual Peaks for Pre-Retrofit and Post-Retrofit. POC #1

Rank	Pre-Retrofit	Post-Retrofit
1	0.4641	0.0690
2	0.3346	0.0690
3	0.3089	0.0690
4	0.3004	0.0690
5	0.2712	0.0690
6	0.2615	0.0678
7	0.2377	0.0676
8	0.2189	0.0673
9	0.2181	0.0666
10	0.2136	0.0647
11	0.2064	0.0645
12	0.2042	0.0642
13	0.1974	0.0618
14	0.1940	0.0617
15	0.1862	0.0614
16	0.1846	0.0596
17	0.1810	0.0594
18	0.1744	0.0580
19	0.1740	0.0580
20	0.1722	0.0579
21	0.1709	0.0579
22	0.1684	0.0579
23	0.1633	0.0577
24	0.1628	0.0574
25	0.1585	0.0572
26	0.1552	0.0571

27	0.1538	0.0571
28	0.1503	0.0568
29	0.1477	0.0564
30	0.1421	0.0558
31	0.1389	0.0554
32	0.1389	0.0553
33	0.1386	0.0552
34	0.1367	0.0546
35	0.1365	0.0545
36	0.1352	0.0537
37	0.1335	0.0536
38	0.1325	0.0515
39	0.1323	0.0504
40	0.1289	0.0503
41	0.1237	0.0498
42	0.1232	0.0495
43	0.1223	0.0495
44	0.1162	0.0493
45	0.1159	0.0483
46	0.1155	0.0472
47	0.1153	0.0464
48	0.1148	0.0449
49	0.1116	0.0443
50	0.1083	0.0431
51	0.1057	0.0430
52	0.1056	0.0428
53	0.1036	0.0426
54	0.1033	0.0418
55	0.1028	0.0417
56	0.1008	0.0414
57	0.0998	0.0413
58	0.0989	0.0406
59	0.0906	0.0393
60	0.0896	0.0392
61	0.0804	0.0383

LID Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0117	66455	62327	93	Pass
0.0124	62990	59268	94	Pass
0.0130	59739	56466	94	Pass
0.0136	56766	53814	94	Pass
0.0142	53921	51419	95	Pass
0.0149	51290	49087	95	Pass
0.0155	48873	46863	95	Pass
0.0161	46414	44788	96	Pass
0.0167	44125	42820	97	Pass
0.0173	42072	41045	97	Pass
0.0180	40018	39462	98	Pass
0.0186	38115	37987	99	Pass
0.0192	36382	36532	100	Pass
0.0198	34714	35163	101	Fail

0.0205	33153	33858	102	Fail
0.0211	31591	32703	103	Fail
0.0217	30137	31527	104	Fail
0.0223	28768	30458	105	Fail
0.0230	27570	29452	106	Fail
0.0236	26351	28511	108	Fail
0.0242	25175	27527	109	Fail
0.0248	24020	26629	110	Fail
0.0254	22972	25667	111	Fail
0.0261	21902	24747	112	Fail
0.0267	20991	23891	113	Fail
0.0273	20165	22972	113	Fail
0.0279	19306	20730	107	Fail
0.0286	18463	16675	90	Pass
0.0292	17684	13845	78	Pass
0.0298	16916	12241	72	Pass
0.0304	16219	11144	68	Pass
0.0310	15522	10284	66	Pass
0.0317	14825	9484	63	Pass
0.0323	14159	8731	61	Pass
0.0329	13567	7959	58	Pass
0.0335	13002	7152	55	Pass
0.0342	12425	6436	51	Pass
0.0348	11920	5818	48	Pass
0.0354	11413	5401	47	Pass
0.0360	10919	5082	46	Pass
0.0366	10468	4789	45	Pass
0.0373	10025	4519	45	Pass
0.0379	9651	4308	44	Pass
0.0385	9257	4111	44	Pass
0.0391	8859	3918	44	Pass
0.0398	8481	3705	43	Pass
0.0404	8156	3491	42	Pass
0.0410	7818	3193	40	Pass
0.0416	7529	2845	37	Pass
0.0423	7219	2541	35	Pass
0.0429	6928	2325	33	Pass
0.0435	6658	2165	32	Pass
0.0441	6389	2043	31	Pass
0.0447	6130	1937	31	Pass
0.0454	5863	1821	31	Pass
0.0460	5627	1732	30	Pass
0.0466	5399	1652	30	Pass
0.0472	5212	1551	29	Pass
0.0479	5009	1460	29	Pass
0.0485	4806	1376	28	Pass
0.0491	4631	1298	28	Pass
0.0497	4453	1227	27	Pass
0.0503	4284	1157	27	Pass
0.0510	4109	1094	26	Pass
0.0516	3968	1042	26	Pass
0.0522	3829	994	25	Pass
0.0528	3698	954	25	Pass
0.0535	3570	900	25	Pass
0.0541	3456	852	24	Pass
0.0547	3352	808	24	Pass
0.0553	3238	762	23	Pass

0.0560	3121	724	23	Pass
0.0566	3016	676	22	Pass
0.0572	2902	611	21	Pass
0.0578	2817	550	19	Pass
0.0584	2723	506	18	Pass
0.0591	2624	471	17	Pass
0.0597	2520	447	17	Pass
0.0603	2449	423	17	Pass
0.0609	2361	405	17	Pass
0.0616	2304	381	16	Pass
0.0622	2229	364	16	Pass
0.0628	2165	344	15	Pass
0.0634	2100	327	15	Pass
0.0640	2049	312	15	Pass
0.0647	1970	296	15	Pass
0.0653	1910	283	14	Pass
0.0659	1840	276	15	Pass
0.0665	1777	262	14	Pass
0.0672	1721	247	14	Pass
0.0678	1670	233	13	Pass
0.0684	1628	222	13	Pass
0.0690	1580	0	0	Pass
0.0697	1526	0	0	Pass
0.0703	1487	0	0	Pass
0.0709	1444	0	0	Pass
0.0715	1405	0	0	Pass
0.0721	1369	0	0	Pass
0.0728	1326	0	0	Pass
0.0734	1292	0	0	Pass

The development has an increase in flow durations from 8% of the 2 year flow to the 50 year flow

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0 **acre-feet**
On-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**
Off-line facility target flow: 0 **cfs.**
Adjusted for 15 min: 0 **cfs.**

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: 55th and 127th EB1
Site Name: Site 3
Site Address:
City :
Report Date: 2/4/2015
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Predeveloped Catchment
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	5.436
SAT, Forest, Flat	.023
Pervious Total	5.459

Impervious Land Use	Acres
Impervious Total	0
Basin Total	5.459

Element Flows To:

Surface	Interflow	Groundwater

Name : Pre-Retrofit Contributing
Bypass: No

GroundWater: No

Pervious Land Use	Acres

Pervious Total **0**

Impervious Land Use	**Acres**
ROADS MOD	**1.313**

Impervious Total **1.313**

Basin Total **1.313**

Element Flows To:

Surface	**Interflow**	**Groundwater**

MITIGATED LAND USE

Name : Pre-Retrofit Contributing
Bypass: No

Impervious Land Use	**Acres**
ROADS FLAT LAT	**1.313**

Element Flows To:

Outlet 1	**Outlet 2**
Surface retention 1	

Name : East Bioretention 1
Bottom Length: 125.00 ft.
Bottom Width: 3.00 ft.
Material thickness of first layer: 2
Material type for first layer: SMMWW
Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 6
Offset (in): 12
Flow Through Underdrain (ac-ft): 151.145
Total Outflow (ac-ft): 153.528
Percent Through Underdrain: 98.45
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.
Notch Type: Rectangular
Notch Width: 0.000 ft.
Notch Height: 0.000 ft.

Element Flows To:

Outlet 1 **Outlet 2**

East Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.0924	0.0000	0.0000	0.0000
0.0549	0.0913	0.0004	0.0000	0.0000
0.1099	0.0900	0.0008	0.0000	0.0000
0.1648	0.0886	0.0013	0.0000	0.0000
0.2198	0.0873	0.0018	0.0000	0.0000
0.2747	0.0860	0.0024	0.0000	0.0000
0.3297	0.0847	0.0030	0.0000	0.0000
0.3846	0.0834	0.0036	0.0000	0.0000
0.4396	0.0821	0.0043	0.0000	0.0000
0.4945	0.0808	0.0051	0.0000	0.0000
0.5495	0.0795	0.0058	0.0000	0.0000
0.6044	0.0783	0.0067	0.0000	0.0000
0.6593	0.0770	0.0075	0.0000	0.0000
0.7143	0.0757	0.0084	0.0000	0.0000
0.7692	0.0744	0.0094	0.0000	0.0000
0.8242	0.0732	0.0104	0.0000	0.0000
0.8791	0.0719	0.0114	0.0000	0.0000
0.9341	0.0707	0.0125	0.0000	0.0000
0.9890	0.0694	0.0137	0.0000	0.0000
1.0440	0.0682	0.0148	0.0000	0.0000
1.0989	0.0670	0.0161	0.0000	0.0000
1.1538	0.0657	0.0173	0.0000	0.0000
1.2088	0.0645	0.0187	0.0000	0.0000
1.2637	0.0633	0.0200	0.0000	0.0000
1.3187	0.0621	0.0214	0.0000	0.0000
1.3736	0.0609	0.0229	0.0000	0.0000
1.4286	0.0597	0.0244	0.0000	0.0000
1.4835	0.0584	0.0260	0.0000	0.0000
1.5385	0.0573	0.0276	0.0000	0.0000
1.5934	0.0561	0.0292	0.0000	0.0000
1.6484	0.0549	0.0309	0.0000	0.0000
1.7033	0.0537	0.0327	0.0000	0.0000
1.7582	0.0525	0.0345	0.0000	0.0000
1.8132	0.0513	0.0363	0.0000	0.0000
1.8681	0.0502	0.0382	0.0000	0.0000
1.9231	0.0490	0.0401	0.0000	0.0000
1.9780	0.0479	0.0421	0.0000	0.0000
2.0330	0.0467	0.0432	0.0096	0.0000
2.0879	0.0456	0.0443	0.0103	0.0000
2.1429	0.0444	0.0454	0.0117	0.0000
2.1978	0.0433	0.0466	0.0132	0.0000
2.2527	0.0422	0.0478	0.0149	0.0000
2.3077	0.0410	0.0490	0.0166	0.0000
2.3626	0.0399	0.0502	0.0185	0.0000
2.4176	0.0388	0.0515	0.0204	0.0000
2.4725	0.0377	0.0528	0.0225	0.0000
2.5275	0.0366	0.0541	0.0247	0.0000
2.5824	0.0355	0.0554	0.0271	0.0000
2.6374	0.0344	0.0568	0.0296	0.0000

2.6923	0.0333	0.0582	0.0322	0.0000
2.7473	0.0322	0.0596	0.0349	0.0000
2.8022	0.0311	0.0611	0.0378	0.0000
2.8571	0.0301	0.0626	0.0408	0.0000
2.9121	0.0290	0.0641	0.0440	0.0000
2.9670	0.0279	0.0656	0.0473	0.0000
3.0220	0.0269	0.0672	0.0492	0.0000
3.0769	0.0258	0.0688	0.0521	0.0000
3.1319	0.0247	0.0704	0.0521	0.0000
3.1868	0.0237	0.0721	0.0521	0.0000
3.2418	0.0227	0.0738	0.0521	0.0000
3.2967	0.0216	0.0755	0.0521	0.0000
3.3516	0.0206	0.0772	0.0521	0.0000
3.4066	0.0196	0.0790	0.0521	0.0000
3.4615	0.0185	0.0808	0.0521	0.0000
3.5165	0.0175	0.0826	0.0521	0.0000
3.5714	0.0165	0.0845	0.0521	0.0000
3.6264	0.0155	0.0864	0.0521	0.0000
3.6813	0.0145	0.0883	0.0521	0.0000
3.7363	0.0135	0.0902	0.0521	0.0000
3.7912	0.0125	0.0922	0.0521	0.0000
3.8462	0.0115	0.0942	0.0521	0.0000
3.9011	0.0106	0.0963	0.0521	0.0000
3.9560	0.0096	0.0983	0.0521	0.0000
4.0000	0.0086	0.1000	0.0521	0.0000

Surface retention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
4.0000	0.0924	0.1000	0.0000	0.0535	0.0000
4.0549	0.0937	0.1051	0.0000	0.0535	0.0000
4.1099	0.0950	0.1103	0.0000	0.0549	0.0000
4.1648	0.0964	0.1155	0.0000	0.0564	0.0000
4.2198	0.0977	0.1209	0.0000	0.0578	0.0000
4.2747	0.0991	0.1263	0.0000	0.0592	0.0000
4.3297	0.1004	0.1318	0.0000	0.0607	0.0000
4.3846	0.1018	0.1373	0.0000	0.0621	0.0000
4.4396	0.1032	0.1430	0.0000	0.0635	0.0000
4.4945	0.1045	0.1487	0.0000	0.0650	0.0000
4.5495	0.1059	0.1544	0.0535	0.0664	0.0000
4.6044	0.1073	0.1603	0.1643	0.0678	0.0000
4.6593	0.1087	0.1662	0.3097	0.0693	0.0000
4.7143	0.1101	0.1722	0.4830	0.0707	0.0000
4.7692	0.1115	0.1783	0.6803	0.0721	0.0000
4.8242	0.1129	0.1845	0.8988	0.0735	0.0000
4.8791	0.1143	0.1907	1.1367	0.0750	0.0000
4.9341	0.1157	0.1971	1.3926	0.0764	0.0000
4.9890	0.1171	0.2035	1.6652	0.0778	0.0000
5.0000	0.1174	0.2047	1.9536	0.0781	0.0000

Name : Surface retention 1

Element Flows To:

Outlet 1	**Outlet 2**
East Bioretention 1	

Name : Pre-Retrofit Catchment
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	2.186
SAT, Forest, Flat	.023
Pervious Total	2.209

Impervious Land Use	Acres
ROADS MOD	3.25
Impervious Total	3.25
Basin Total	5.459

Element Flows To:

Surface	Interflow	Groundwater

ANALYSIS RESULTS

Stream Protection Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.313

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.313

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.521732
5 year	0.702381
10 year	0.833974
25 year	1.014404
50 year	1.159443
100 year	1.31389

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)

2 year	0.116649
5 year	0.205096
10 year	0.27893
25 year	0.390893
50 year	0.488701
100 year	0.599561

Stream Protection Duration
Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Year	Pre-Retrofit	Mitigated
1949	0.524	0.065
1950	0.544	0.139
1951	0.679	0.144
1952	0.510	0.052
1953	0.594	0.052
1954	0.808	0.079
1955	0.656	0.264
1956	0.286	0.101
1957	0.438	0.117
1958	1.158	0.369
1959	0.484	0.095
1960	0.488	0.163
1961	1.492	0.333
1962	0.599	0.218
1963	0.583	0.152
1964	0.337	0.119
1965	0.460	0.052
1966	0.458	0.052
1967	0.953	0.258
1968	0.488	0.216
1969	1.007	0.154
1970	0.420	0.052
1971	0.520	0.103
1972	0.701	0.300
1973	0.568	0.052
1974	0.691	0.128
1975	0.558	0.054
1976	0.407	0.140
1977	0.410	0.123
1978	0.310	0.051
1979	0.633	0.378
1980	0.536	0.102
1981	0.412	0.052
1982	0.453	0.206
1983	0.552	0.145
1984	0.506	0.088
1985	0.688	0.228
1986	0.670	0.298
1987	0.608	0.234
1988	0.530	0.095
1989	0.461	0.050
1990	0.413	0.052
1991	0.541	0.165
1992	0.507	0.052
1993	0.406	0.089
1994	0.438	0.064

1995	0.394	0.095
1996	0.661	0.276
1997	0.565	0.427
1998	0.671	0.109
1999	0.271	0.052
2000	1.173	0.078
2001	0.331	0.052
2002	0.359	0.079
2003	0.496	0.052
2004	0.925	0.289
2005	0.399	0.129
2006	0.578	0.207
2007	0.537	0.174
2008	0.477	0.340
2009	0.400	0.122

Stream Protection Duration
Ranked Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Rank	**Pre-Retrofit**	**Mitigated**
1	1.4919	0.4269
2	1.1734	0.3779
3	1.1577	0.3690
4	1.0066	0.3401
5	0.9531	0.3335
6	0.9252	0.3002
7	0.8078	0.2978
8	0.7015	0.2891
9	0.6906	0.2757
10	0.6884	0.2641
11	0.6792	0.2584
12	0.6706	0.2341
13	0.6703	0.2282
14	0.6611	0.2179
15	0.6564	0.2158
16	0.6325	0.2067
17	0.6079	0.2058
18	0.5992	0.1736
19	0.5944	0.1646
20	0.5828	0.1632
21	0.5784	0.1539
22	0.5681	0.1516
23	0.5655	0.1448
24	0.5575	0.1439
25	0.5520	0.1396
26	0.5435	0.1387
27	0.5414	0.1286
28	0.5367	0.1277
29	0.5358	0.1229
30	0.5298	0.1217
31	0.5241	0.1189
32	0.5199	0.1171
33	0.5102	0.1093
34	0.5069	0.1026
35	0.5064	0.1018
36	0.4959	0.1013
37	0.4882	0.0950

38	0.4878	0.0945
39	0.4842	0.0945
40	0.4768	0.0891
41	0.4613	0.0883
42	0.4601	0.0793
43	0.4581	0.0785
44	0.4530	0.0776
45	0.4376	0.0654
46	0.4375	0.0641
47	0.4201	0.0543
48	0.4125	0.0521
49	0.4120	0.0521
50	0.4097	0.0521
51	0.4071	0.0521
52	0.4058	0.0521
53	0.4000	0.0521
54	0.3987	0.0521
55	0.3940	0.0521
56	0.3586	0.0521
57	0.3374	0.0521
58	0.3308	0.0521
59	0.3105	0.0521
60	0.2859	0.0511
61	0.2707	0.0498

Stream Protection Duration
POC #1

Facility FAILED duration standard for 1+ flows.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.2609	4671	13	0	Pass
0.2699	4381	13	0	Pass
0.2790	4084	13	0	Pass
0.2881	3831	13	0	Pass
0.2972	3610	13	0	Pass
0.3062	3388	13	0	Pass
0.3153	3194	13	0	Pass
0.3244	3005	13	0	Pass
0.3335	2807	13	0	Pass
0.3426	2624	13	0	Pass
0.3516	2452	13	0	Pass
0.3607	2280	13	0	Pass
0.3698	2093	13	0	Pass
0.3789	1935	13	0	Pass
0.3879	1767	13	0	Pass
0.3970	1617	13	0	Pass
0.4061	1451	13	0	Pass
0.4152	1325	13	0	Pass
0.4242	1200	13	1	Pass
0.4333	1089	13	1	Pass
0.4424	983	13	1	Pass
0.4515	875	13	1	Pass
0.4605	772	13	1	Pass
0.4696	681	13	1	Pass
0.4787	608	13	2	Pass

0.4878	541	13	2	Pass
0.4969	486	13	2	Pass
0.5059	438	13	2	Pass
0.5150	401	13	3	Pass
0.5241	369	13	3	Pass
0.5332	328	13	3	Pass
0.5422	278	13	4	Pass
0.5513	240	13	5	Pass
0.5604	202	13	6	Pass
0.5695	162	13	8	Pass
0.5785	136	13	9	Pass
0.5876	114	13	11	Pass
0.5967	104	13	12	Pass
0.6058	92	13	14	Pass
0.6149	82	13	15	Pass
0.6239	68	13	19	Pass
0.6330	59	13	22	Pass
0.6421	51	13	25	Pass
0.6512	47	12	25	Pass
0.6602	42	12	28	Pass
0.6693	37	12	32	Pass
0.6784	32	12	37	Pass
0.6875	26	12	46	Pass
0.6965	19	12	63	Pass
0.7056	15	12	80	Pass
0.7147	13	12	92	Pass
0.7238	9	12	133	Fail
0.7328	7	12	171	Fail
0.7419	6	12	200	Fail
0.7510	3	12	400	Fail
0.7601	3	11	366	Fail
0.7692	2	11	550	Fail
0.7782	1	11	1100	Fail
0.7873	0	11	n/a	Fail
0.7964	0	11	n/a	Fail
0.8055	0	10	n/a	Fail
0.8145	0	10	n/a	Fail
0.8236	0	10	n/a	Fail
0.8327	0	9	n/a	Fail
0.8418	0	9	n/a	Fail
0.8508	0	9	n/a	Fail
0.8599	0	9	n/a	Fail
0.8690	0	9	n/a	Fail
0.8781	0	9	n/a	Fail
0.8871	0	9	n/a	Fail
0.8962	0	9	n/a	Fail
0.9053	0	9	n/a	Fail
0.9144	0	9	n/a	Fail
0.9235	0	9	n/a	Fail
0.9325	0	9	n/a	Fail
0.9416	0	9	n/a	Fail
0.9507	0	9	n/a	Fail
0.9598	0	9	n/a	Fail
0.9688	0	9	n/a	Fail
0.9779	0	9	n/a	Fail
0.9870	0	9	n/a	Fail
0.9961	0	9	n/a	Fail

1.0051	0	9	n/a	Fail
1.0142	0	9	n/a	Fail
1.0233	0	9	n/a	Fail
1.0324	0	9	n/a	Fail
1.0414	0	9	n/a	Fail
1.0505	0	9	n/a	Fail
1.0596	0	9	n/a	Fail
1.0687	0	9	n/a	Fail
1.0778	0	9	n/a	Fail
1.0868	0	9	n/a	Fail
1.0959	0	9	n/a	Fail
1.1050	0	9	n/a	Fail
1.1141	0	9	n/a	Fail
1.1231	0	9	n/a	Fail
1.1322	0	9	n/a	Fail
1.1413	0	9	n/a	Fail
1.1504	0	9	n/a	Fail
1.1594	0	9	n/a	Fail

The development has an increase in flow durations from 1/2 Pre-Retrofit 2 year flow to the 2 year flow or more than a 10% increase from the 2 year to the 50 year flow.

LID Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.313

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.313

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.521732
5 year	0.702381
10 year	0.833974
25 year	1.014404
50 year	1.159443
100 year	1.31389

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.116649
5 year	0.205096
10 year	0.27893
25 year	0.390893
50 year	0.488701
100 year	0.599561

LID Duration
Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Year	Pre-Retrofit	Mitigated
1949	0.524	0.065
1950	0.544	0.139
1951	0.679	0.144
1952	0.510	0.052
1953	0.594	0.052
1954	0.808	0.079
1955	0.656	0.264
1956	0.286	0.101
1957	0.438	0.117
1958	1.158	0.369
1959	0.484	0.095
1960	0.488	0.163
1961	1.492	0.333
1962	0.599	0.218
1963	0.583	0.152
1964	0.337	0.119
1965	0.460	0.052
1966	0.458	0.052
1967	0.953	0.258
1968	0.488	0.216
1969	1.007	0.154
1970	0.420	0.052
1971	0.520	0.103
1972	0.701	0.300
1973	0.568	0.052
1974	0.691	0.128
1975	0.558	0.054
1976	0.407	0.140
1977	0.410	0.123
1978	0.310	0.051
1979	0.633	0.378
1980	0.536	0.102
1981	0.412	0.052
1982	0.453	0.206
1983	0.552	0.145
1984	0.506	0.088
1985	0.688	0.228
1986	0.670	0.298
1987	0.608	0.234
1988	0.530	0.095
1989	0.461	0.050
1990	0.413	0.052
1991	0.541	0.165
1992	0.507	0.052
1993	0.406	0.089
1994	0.438	0.064
1995	0.394	0.095
1996	0.661	0.276
1997	0.565	0.427
1998	0.671	0.109
1999	0.271	0.052
2000	1.173	0.078

2001	0.331	0.052
2002	0.359	0.079
2003	0.496	0.052
2004	0.925	0.289
2005	0.399	0.129
2006	0.578	0.207
2007	0.537	0.174
2008	0.477	0.340
2009	0.400	0.122

LID Duration
Ranked Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Rank	**Pre-Retrofit**	**Mitigated**
1	1.4919	0.4269
2	1.1734	0.3779
3	1.1577	0.3690
4	1.0066	0.3401
5	0.9531	0.3335
6	0.9252	0.3002
7	0.8078	0.2978
8	0.7015	0.2891
9	0.6906	0.2757
10	0.6884	0.2641
11	0.6792	0.2584
12	0.6706	0.2341
13	0.6703	0.2282
14	0.6611	0.2179
15	0.6564	0.2158
16	0.6325	0.2067
17	0.6079	0.2058
18	0.5992	0.1736
19	0.5944	0.1646
20	0.5828	0.1632
21	0.5784	0.1539
22	0.5681	0.1516
23	0.5655	0.1448
24	0.5575	0.1439
25	0.5520	0.1396
26	0.5435	0.1387
27	0.5414	0.1286
28	0.5367	0.1277
29	0.5358	0.1229
30	0.5298	0.1217
31	0.5241	0.1189
32	0.5199	0.1171
33	0.5102	0.1093
34	0.5069	0.1026
35	0.5064	0.1018
36	0.4959	0.1013
37	0.4882	0.0950
38	0.4878	0.0945
39	0.4842	0.0945
40	0.4768	0.0891
41	0.4613	0.0883
42	0.4601	0.0793
43	0.4581	0.0785

44	0.4530	0.0776
45	0.4376	0.0654
46	0.4375	0.0641
47	0.4201	0.0543
48	0.4125	0.0521
49	0.4120	0.0521
50	0.4097	0.0521
51	0.4071	0.0521
52	0.4058	0.0521
53	0.4000	0.0521
54	0.3987	0.0521
55	0.3940	0.0521
56	0.3586	0.0521
57	0.3374	0.0521
58	0.3308	0.0521
59	0.3105	0.0521
60	0.2859	0.0511
61	0.2707	0.0498

LID Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0417	55996	37516	66	Pass
0.0440	53258	33324	62	Pass
0.0462	49365	27720	56	Pass
0.0484	46991	23528	50	Pass
0.0506	44745	19141	42	Pass
0.0528	42713	15614	36	Pass
0.0550	39783	1877	4	Pass
0.0572	37965	1813	4	Pass
0.0594	36190	1744	4	Pass
0.0617	34543	1685	4	Pass
0.0639	32982	1621	4	Pass
0.0661	30778	1524	4	Pass
0.0683	29345	1473	5	Pass
0.0705	28083	1418	5	Pass
0.0727	26822	1336	4	Pass
0.0749	25645	1283	5	Pass
0.0772	23955	1210	5	Pass
0.0794	22907	1150	5	Pass
0.0816	21902	1088	4	Pass
0.0838	20912	1036	4	Pass
0.0860	19509	959	4	Pass
0.0882	18664	928	4	Pass
0.0904	17830	881	4	Pass
0.0926	17030	845	4	Pass
0.0949	16294	818	5	Pass
0.0971	15261	770	5	Pass
0.0993	14591	747	5	Pass
0.1015	13954	704	5	Pass
0.1037	13370	672	5	Pass
0.1059	12784	651	5	Pass

0.1081	11933	617	5	Pass
0.1104	11398	592	5	Pass
0.1126	10898	560	5	Pass
0.1148	10440	533	5	Pass
0.1170	10016	510	5	Pass
0.1192	9360	491	5	Pass
0.1214	8964	476	5	Pass
0.1236	8551	459	5	Pass
0.1258	8205	444	5	Pass
0.1281	7721	422	5	Pass
0.1303	7428	416	5	Pass
0.1325	7122	410	5	Pass
0.1347	6823	399	5	Pass
0.1369	6560	382	5	Pass
0.1391	6196	366	5	Pass
0.1413	5927	354	5	Pass
0.1436	5683	346	6	Pass
0.1458	5456	338	6	Pass
0.1480	5264	332	6	Pass
0.1502	4966	320	6	Pass
0.1524	4768	310	6	Pass
0.1546	4592	301	6	Pass
0.1568	4415	297	6	Pass
0.1590	4192	291	6	Pass
0.1613	4060	282	6	Pass
0.1635	3931	276	7	Pass
0.1657	3797	269	7	Pass
0.1679	3677	265	7	Pass
0.1701	3482	258	7	Pass
0.1723	3343	252	7	Pass
0.1745	3234	245	7	Pass
0.1768	3123	240	7	Pass
0.1790	3022	233	7	Pass
0.1812	2877	221	7	Pass
0.1834	2791	215	7	Pass
0.1856	2689	206	7	Pass
0.1878	2612	200	7	Pass
0.1900	2494	188	7	Pass
0.1923	2419	186	7	Pass
0.1945	2342	183	7	Pass
0.1967	2269	177	7	Pass
0.1989	2201	172	7	Pass
0.2011	2104	163	7	Pass
0.2033	2042	154	7	Pass
0.2055	1976	147	7	Pass
0.2077	1908	144	7	Pass
0.2100	1855	140	7	Pass
0.2122	1770	134	7	Pass
0.2144	1716	129	7	Pass
0.2166	1678	125	7	Pass
0.2188	1631	124	7	Pass
0.2210	1557	118	7	Pass
0.2232	1510	113	7	Pass
0.2255	1460	106	7	Pass
0.2277	1422	103	7	Pass
0.2299	1373	100	7	Pass
0.2321	1323	97	7	Pass

0.2343	1283	90	7	Pass
0.2365	1241	83	6	Pass
0.2387	1206	80	6	Pass
0.2409	1167	77	6	Pass
0.2432	1130	71	6	Pass
0.2454	1100	68	6	Pass
0.2476	1064	65	6	Pass
0.2498	1040	62	5	Pass
0.2520	999	59	5	Pass
0.2542	978	55	5	Pass
0.2564	953	55	5	Pass
0.2587	924	50	5	Pass
0.2609	899	48	5	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.0638 **acre-feet**
On-line facility target flow: 0.0322 **cfs.**
Adjusted for 15 min: 0.0322 **cfs.**
Off-line facility target flow: 0.0203 **cfs.**
Adjusted for 15 min: 0.0203 **cfs.**

Wetlands Fluctuation for POC 1
Average Annual Volume (acft)

Month	Predevel	Mitigated	Percent	Pass/Fail
Jan	17.8753	18.1173	101.4	Pass
Feb	12.3159	12.3836	100.5	Pass
Mar	11.7266	11.4989	98.1	Pass
Apr	8.1771	7.7392	94.6	Pass
May	6.3637	5.4992	86.4	Pass
Jun	5.5364	4.9485	89.4	Pass
Jul	2.8294	2.2289	78.8	Fail
Aug	3.8400	2.7655	72.0	Fail
Sep	5.8066	4.8892	84.2	Fail
Oct	11.4998	11.1308	96.8	Pass
Nov	19.4638	19.6471	100.9	Pass
Dec	20.3140	20.9596	103.2	Pass

Day	Predevel	Mitigated	Percent	Pass/Fail
Jan1	0.6757	0.7603	112.5	Pass
2	0.5117	0.5591	109.3	Pass
3	0.4783	0.5400	112.9	Pass
4	0.8595	0.6834	79.5	Fail
5	0.5403	0.6543	121.1	Fail
6	0.7116	0.6419	90.2	Pass
7	0.8024	0.8432	105.1	Pass
8	0.5680	0.6226	109.6	Pass
9	0.4891	0.5572	113.9	Pass
10	0.4168	0.4115	98.7	Pass
11	0.4418	0.4667	105.6	Pass
12	0.5289	0.4966	93.9	Pass
13	0.8223	0.7036	85.6	Pass
14	0.5423	0.6809	125.6	Fail
15	0.6555	0.5824	88.9	Pass

16	0.5752	0.6658	115.8	Pass
17	0.7806	0.7262	93.0	Pass
18	0.4977	0.5808	116.7	Pass
19	0.4107	0.4864	118.5	Pass
20	0.4818	0.4626	96.0	Pass
21	0.5659	0.5101	90.1	Pass
22	0.6682	0.6464	96.7	Pass
23	0.7186	0.7169	99.8	Pass
24	0.3350	0.4730	141.2	Fail
25	0.4261	0.3748	88.0	Pass
26	0.3612	0.3444	95.4	Pass
27	0.5309	0.4888	92.1	Pass
28	0.6319	0.6360	100.6	Pass
29	0.5528	0.6112	110.5	Pass
30	0.5082	0.4875	95.9	Pass
31	0.4133	0.4727	114.4	Pass
Feb1	0.3486	0.4037	115.8	Pass
2	0.3105	0.2796	90.1	Pass
3	0.4747	0.4653	98.0	Pass
4	0.4629	0.4260	92.0	Pass
5	0.4206	0.4740	112.7	Pass
6	0.3916	0.3662	93.5	Pass
7	0.5153	0.4899	95.1	Pass
8	0.2640	0.3714	140.7	Fail
9	0.3167	0.2934	92.6	Pass
10	0.3681	0.3370	91.6	Pass
11	0.5575	0.4914	88.1	Pass
12	0.4832	0.5068	104.9	Pass
13	0.4283	0.4253	99.3	Pass
14	0.4310	0.4444	103.1	Pass
15	0.5176	0.4633	89.5	Pass
16	0.5354	0.6019	112.4	Pass
17	0.5825	0.5121	87.9	Pass
18	0.3771	0.5139	136.3	Fail
19	0.3845	0.3516	91.5	Pass
20	0.5886	0.4726	80.3	Pass
21	0.3660	0.4665	127.5	Fail
22	0.3730	0.3527	94.6	Pass
23	0.5524	0.5289	95.7	Pass
24	0.5220	0.5643	108.1	Pass
25	0.3908	0.4160	106.5	Pass
26	0.3441	0.3617	105.1	Pass
27	0.4781	0.4414	92.3	Pass
28	0.4508	0.3432	76.1	Fail
29	0.4790	0.4885	102.0	Pass
Mar1	0.4616	0.4493	97.3	Pass
2	0.4507	0.4544	100.8	Pass
3	0.3986	0.4546	114.0	Pass
4	0.3715	0.3072	82.7	Pass
5	0.1520	0.2155	141.7	Fail
6	0.4304	0.3762	87.4	Pass
7	0.4129	0.3380	81.9	Pass
8	0.5941	0.6117	103.0	Pass
9	0.4069	0.4040	99.3	Pass
10	0.4360	0.4496	103.1	Pass
11	0.4121	0.3871	93.9	Pass
12	0.3183	0.3550	111.5	Pass

13	0.3274	0.3335	101.9	Pass
14	0.3934	0.3530	89.7	Pass
15	0.3627	0.3633	100.2	Pass
16	0.3775	0.3353	88.8	Pass
17	0.3870	0.3626	93.7	Pass
18	0.3395	0.3329	98.0	Pass
19	0.3661	0.3972	108.5	Pass
20	0.2510	0.2111	84.1	Pass
21	0.4989	0.4337	86.9	Pass
22	0.4441	0.4772	107.4	Pass
23	0.3540	0.3734	105.5	Pass
24	0.3300	0.3414	103.4	Pass
25	0.4364	0.3758	86.1	Pass
26	0.2675	0.2877	107.6	Pass
27	0.3805	0.3572	93.9	Pass
28	0.3221	0.3107	96.4	Pass
29	0.2615	0.2754	105.3	Pass
30	0.3037	0.2867	94.4	Pass
31	0.3347	0.3183	95.1	Pass
Apr1	0.3057	0.2876	94.1	Pass
2	0.3419	0.3100	90.7	Pass
3	0.3886	0.3640	93.7	Pass
4	0.3120	0.3287	105.4	Pass
5	0.2672	0.2981	111.6	Pass
6	0.2220	0.1723	77.6	Fail
7	0.3936	0.3714	94.4	Pass
8	0.2140	0.2533	118.4	Pass
9	0.2588	0.2090	80.7	Pass
10	0.3623	0.3397	93.8	Pass
11	0.3803	0.3293	86.6	Pass
12	0.3133	0.3018	96.3	Pass
13	0.1981	0.2025	102.2	Pass
14	0.3102	0.2495	80.4	Pass
15	0.3687	0.3660	99.3	Pass
16	0.2352	0.2638	112.2	Pass
17	0.2196	0.1609	73.3	Fail
18	0.4252	0.3126	73.5	Fail
19	0.1509	0.3059	202.7	Fail
20	0.0465	0.0473	101.6	Pass
21	0.1803	0.1024	56.8	Fail
22	0.3437	0.2492	72.5	Fail
23	0.2442	0.3406	139.5	Fail
24	0.1664	0.1618	97.2	Pass
25	0.1331	0.1008	75.7	Fail
26	0.2989	0.2249	75.2	Fail
27	0.2648	0.2962	111.8	Pass
28	0.2697	0.1988	73.7	Fail
29	0.2268	0.2724	120.1	Fail
30	0.1405	0.1453	103.5	Pass
May1	0.2008	0.1379	68.7	Fail
2	0.2224	0.2002	90.1	Pass
3	0.1669	0.1459	87.4	Pass
4	0.2440	0.2369	97.1	Pass
5	0.1603	0.1486	92.7	Pass
6	0.0434	0.0742	171.0	Fail
7	0.1538	0.0884	57.4	Fail
8	0.1753	0.1075	61.4	Fail

9	0.3088	0.2489	80.6	Pass
10	0.3230	0.3284	101.7	Pass
11	0.1396	0.1435	102.8	Pass
12	0.2211	0.1854	83.8	Pass
13	0.2533	0.1742	68.8	Fail
14	0.1424	0.2104	147.7	Fail
15	0.2242	0.1952	87.1	Pass
16	0.0920	0.0683	74.3	Fail
17	0.1729	0.0962	55.6	Fail
18	0.2487	0.1777	71.4	Fail
19	0.2252	0.2304	102.3	Pass
20	0.1705	0.1812	106.3	Pass
21	0.1139	0.0788	69.2	Fail
22	0.1544	0.1064	68.9	Fail
23	0.2219	0.1817	81.9	Pass
24	0.1547	0.1680	108.6	Pass
25	0.2248	0.1768	78.7	Fail
26	0.3242	0.2558	78.9	Fail
27	0.2080	0.2380	114.4	Pass
28	0.2756	0.1637	59.4	Fail
29	0.2063	0.2713	131.5	Fail
30	0.4509	0.3337	74.0	Fail
31	0.1423	0.2163	152.0	Fail
Jun1	0.2306	0.1694	73.5	Fail
2	0.2984	0.2621	87.8	Pass
3	0.1684	0.2050	121.8	Fail
4	0.1725	0.1457	84.5	Pass
5	0.1800	0.1267	70.4	Fail
6	0.2243	0.1990	88.7	Pass
7	0.1651	0.1636	99.1	Pass
8	0.1738	0.1519	87.4	Pass
9	0.4298	0.2816	65.5	Fail
10	0.2126	0.3037	142.9	Fail
11	0.2542	0.2014	79.2	Fail
12	0.1459	0.1630	111.7	Pass
13	0.0522	0.0362	69.4	Fail
14	0.1254	0.0746	59.5	Fail
15	0.2068	0.1512	73.1	Fail
16	0.2616	0.2261	86.4	Pass
17	0.2061	0.2011	97.6	Pass
18	0.1678	0.1757	104.7	Pass
19	0.0680	0.0614	90.2	Pass
20	0.1013	0.0878	86.7	Pass
21	0.1832	0.0976	53.3	Fail
22	0.1557	0.1767	113.5	Pass
23	0.2961	0.2146	72.5	Fail
24	0.2223	0.2297	103.3	Pass
25	0.1311	0.1712	130.7	Fail
26	0.1480	0.0892	60.2	Fail
27	0.0889	0.0885	99.6	Pass
28	0.1971	0.1685	85.5	Pass
29	0.1270	0.1088	85.7	Pass
30	0.2328	0.1250	53.7	Fail
Jul1	0.2077	0.2410	116.0	Pass
2	0.1742	0.1332	76.5	Fail
3	0.0802	0.0541	67.4	Fail
4	0.1574	0.1091	69.3	Fail

5	0.0463	0.0728	157.3	Fail
6	0.0711	0.0259	36.5	Fail
7	0.1412	0.1283	90.9	Pass
8	0.1747	0.1087	62.2	Fail
9	0.0326	0.0698	213.9	Fail
10	0.1085	0.0293	27.0	Fail
11	0.0410	0.0831	202.9	Fail
12	0.1382	0.0860	62.2	Fail
13	0.0726	0.1033	142.2	Fail
14	0.0328	0.0276	84.3	Pass
15	0.2597	0.1434	55.2	Fail
16	0.0814	0.1291	158.7	Fail
17	0.0185	0.0224	121.1	Fail
18	0.1337	0.0700	52.4	Fail
19	0.0841	0.0634	75.4	Fail
20	0.0040	0.0189	475.0	Fail
21	0.0847	0.0484	57.1	Fail
22	0.0188	0.0197	104.8	Pass
23	0.0231	0.0107	46.4	Fail
24	0.0587	0.0134	22.8	Fail
25	0.1458	0.1008	69.1	Fail
26	0.0508	0.0759	149.3	Fail
27	0.0824	0.0426	51.7	Fail
28	0.0551	0.0632	114.8	Pass
29	0.0030	0.0096	315.7	Fail
30	0.0144	0.0000	0.0	Fail
31	0.0120	0.0000	0.0	Fail
Aug1	0.0227	0.0023	10.1	Fail
2	0.0430	0.0053	12.3	Fail
3	0.0516	0.0281	54.6	Fail
4	0.0476	0.0386	81.2	Pass
5	0.2000	0.0870	43.5	Fail
6	0.1799	0.1171	65.1	Fail
7	0.0085	0.0865	1019.5	Fail
8	0.0496	0.0302	60.8	Fail
9	0.0177	0.0055	31.0	Fail
10	0.0314	0.0000	0.0	Fail
11	0.0625	0.0216	34.6	Fail
12	0.1622	0.0839	51.7	Fail
13	0.0847	0.0867	102.3	Pass
14	0.2199	0.0896	40.8	Fail
15	0.1300	0.1094	84.1	Pass
16	0.0851	0.0844	99.1	Pass
17	0.1685	0.0805	47.8	Fail
18	0.2411	0.1216	50.5	Fail
19	0.0703	0.1465	208.4	Fail
20	0.0486	0.0103	21.2	Fail
21	0.2578	0.1561	60.5	Fail
22	0.3381	0.2016	59.6	Fail
23	0.1833	0.2507	136.8	Fail
24	0.1248	0.1387	111.1	Pass
25	0.2600	0.1664	64.0	Fail
26	0.2261	0.2338	103.4	Pass
27	0.1336	0.1337	100.1	Pass
28	0.1051	0.0506	48.1	Fail
29	0.1095	0.0676	61.7	Fail
30	0.1646	0.1311	79.7	Fail

31	0.2497	0.1436	57.5	Fail
Sep1	0.1064	0.1677	157.6	Fail
2	0.1150	0.0776	67.5	Fail
3	0.1110	0.0890	80.2	Pass
4	0.1128	0.0686	60.8	Fail
5	0.2709	0.1734	64.0	Fail
6	0.1337	0.1556	116.4	Pass
7	0.1892	0.1616	85.4	Pass
8	0.2394	0.1596	66.7	Fail
9	0.2997	0.2299	76.7	Fail
10	0.2543	0.2647	104.1	Pass
11	0.0276	0.0350	126.4	Fail
12	0.1371	0.0531	38.7	Fail
13	0.2190	0.1505	68.7	Fail
14	0.1756	0.2154	122.7	Fail
15	0.2825	0.1625	57.5	Fail
16	0.3986	0.3579	89.8	Pass
17	0.0983	0.1777	180.7	Fail
18	0.1967	0.1169	59.4	Fail
19	0.2347	0.1932	82.3	Pass
20	0.1137	0.1526	134.2	Fail
21	0.3142	0.2213	70.4	Fail
22	0.2428	0.2364	97.3	Pass
23	0.1849	0.1985	107.3	Pass
24	0.1450	0.1143	78.8	Fail
25	0.1884	0.1552	82.3	Pass
26	0.1731	0.1315	75.9	Fail
27	0.1672	0.1800	107.7	Pass
28	0.1692	0.1190	70.3	Fail
29	0.2556	0.2270	88.8	Pass
30	0.2683	0.1916	71.4	Fail
Oct1	0.1771	0.1964	110.9	Pass
2	0.2498	0.2151	86.1	Pass
3	0.3630	0.2334	64.3	Fail
4	0.2853	0.2851	99.9	Pass
5	0.4052	0.3937	97.1	Pass
6	0.2412	0.3021	125.2	Fail
7	0.4243	0.3359	79.2	Fail
8	0.3173	0.3299	104.0	Pass
9	0.3111	0.2679	86.1	Pass
10	0.2853	0.2911	102.0	Pass
11	0.2210	0.2448	110.8	Pass
12	0.2815	0.2447	86.9	Pass
13	0.2878	0.2426	84.3	Pass
14	0.2200	0.2263	102.9	Pass
15	0.3573	0.3316	92.8	Pass
16	0.4813	0.4028	83.7	Pass
17	0.2960	0.3819	129.0	Fail
18	0.5178	0.4581	88.5	Pass
19	0.6191	0.6290	101.6	Pass
20	0.4528	0.4434	97.9	Pass
21	0.4176	0.4464	106.9	Pass
22	0.4080	0.4173	102.3	Pass
23	0.4949	0.4034	81.5	Pass
24	0.4503	0.5053	112.2	Pass
25	0.6073	0.5175	85.2	Pass
26	0.4992	0.5188	103.9	Pass

27	0.5357	0.6312	117.8	Pass
28	0.3095	0.3182	102.8	Pass
29	0.3907	0.3792	97.1	Pass
30	0.3246	0.3463	106.7	Pass
31	0.4995	0.4014	80.4	Pass
Nov1	0.4016	0.4835	120.4	Fail
2	0.6215	0.4921	79.2	Fail
3	0.7006	0.7389	105.5	Pass
4	0.4573	0.5018	109.8	Pass
5	0.4430	0.5114	115.4	Pass
6	0.4681	0.4512	96.4	Pass
7	0.4738	0.4451	93.9	Pass
8	0.5731	0.5720	99.8	Pass
9	0.7115	0.6643	93.4	Pass
10	0.7358	0.7149	97.2	Pass
11	0.8532	0.8622	101.0	Pass
12	0.7580	0.7810	103.0	Pass
13	0.5496	0.6821	124.1	Fail
14	0.6175	0.5674	91.9	Pass
15	0.6125	0.6510	106.3	Pass
16	0.6454	0.6813	105.6	Pass
17	0.6376	0.5981	93.8	Pass
18	0.9788	0.8781	89.7	Pass
19	0.9466	0.9704	102.5	Pass
20	0.5812	0.8269	142.3	Fail
21	0.4721	0.4908	104.0	Pass
22	0.6843	0.5542	81.0	Pass
23	0.9548	0.9162	96.0	Pass
24	0.9721	1.0233	105.3	Pass
25	0.4553	0.5973	131.2	Fail
26	0.6621	0.6509	98.3	Pass
27	0.4755	0.5265	110.7	Pass
28	0.7015	0.6442	91.8	Pass
29	0.8218	0.7693	93.6	Pass
30	0.7961	0.8706	109.4	Pass
Dec1	0.7012	0.7359	104.9	Pass
2	0.9278	0.8903	96.0	Pass
3	0.7610	0.8722	114.6	Pass
4	0.8479	0.7499	88.4	Pass
5	0.6601	0.8132	123.2	Fail
6	0.4843	0.5657	116.8	Pass
7	0.5410	0.5489	101.5	Pass
8	0.6830	0.6101	89.3	Pass
9	0.7186	0.7161	99.7	Pass
10	0.7384	0.7331	99.3	Pass
11	0.7928	0.7784	98.2	Pass
12	0.5251	0.6582	125.3	Fail
13	0.7418	0.5908	79.7	Fail
14	0.9205	0.9757	106.0	Pass
15	0.6801	0.7820	115.0	Pass
16	0.5108	0.6361	124.5	Fail
17	0.4930	0.4944	100.3	Pass
18	0.6590	0.5267	79.9	Fail
19	0.6447	0.7056	109.4	Pass
20	0.6346	0.7029	110.8	Pass
21	0.5374	0.5955	110.8	Pass
22	0.6382	0.5867	91.9	Pass

23	0.6733	0.6922	102.8	Pass
24	0.6157	0.5936	96.4	Pass
25	0.6057	0.6395	105.6	Pass
26	0.6691	0.6829	102.1	Pass
27	0.4715	0.5271	111.8	Pass
28	0.6285	0.5584	88.8	Pass
29	0.4879	0.6230	127.7	Fail
30	0.5271	0.5053	95.9	Pass
31	0.7883	0.7036	89.3	Pass

LID Report

LID Technique	Used for Treatment?	Total Volumn Needs Treatment (ac-ft)	Volumn Through Facility (ac-ft)	Infiltration Volumn (ac-ft)	Cumulative Volumn Infiltration Credit	Percent Volumn Infiltrated	Water Quality	Percent Water Quality Treated	Comment
retention 1 POC	N	139.71			N	0.00			
Total Volume Infiltrated		139.71	0.00	0.00	0.00	0.00	0%		No Treat. Credit

Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.

WWHM2012
PROJECT REPORT

Project Name: 55th and 127th WB1
Site Name: Site 3
Site Address:
City :
Report Date: 2/4/2015
Gage : Everett
Data Start : 1948/10/01
Data End : 2009/09/30
Precip Scale: 0.80
Version : 2014/09/12

Low Flow Threshold for POC 1 : 50 Percent of the 2 Year

High Flow Threshold for POC 1: 50 year

PREDEVELOPED LAND USE

Name : Predeveloped Catchment
Bypass: No

GroundWater: No

Pervious Land Use	Acres
C, Forest, Mod	13.983
SAT, Forest, Flat	1.929
Pervious Total	**15.912**

Impervious Land Use	Acres
Impervious Total	**0**
Basin Total	**15.912**

Element Flows To:

Surface	Interflow	Groundwater

Name : Pre-Retrofit Contributing
Bypass: No

GroundWater: No

Pervious Land Use	Acres

Pervious Total **0**

Impervious Land Use	Acres
ROADS MOD	1.59

Impervious Total **1.59**

Basin Total **1.59**

Element Flows To:
Surface **Interflow** **Groundwater**

MITIGATED LAND USE

Name : West Bioretention 1
Bottom Length: 154.00 ft.
Bottom Width: 4.00 ft.
Material thickness of first layer: 2
Material type for first layer: SMMWW
Material thickness of second layer: 2
Material type for second layer: GRAVEL
Material thickness of third layer: 0
Material type for third layer: GRAVEL
Underdrain used
Underdrain Diameter (ft): 0.5
Orifice Diameter (in): 6
Offset (in): 12
Flow Through Underdrain (ac-ft): 187.773
Total Outflow (ac-ft): 189.18
Percent Through Underdrain: 99.26
Discharge Structure
Riser Height: 0.5 ft.
Riser Diameter: 6 in.
Notch Type: Rectangular
Notch Width: 0.000 ft.
Notch Height: 0.000 ft.

Element Flows To:
Outlet 1 **Outlet 2**

West Bioretention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	Infilt(cfs)
0.0000	0.1144	0.0000	0.0000	0.0000
0.0549	0.1132	0.0006	0.0000	0.0000
0.1099	0.1116	0.0013	0.0000	0.0000
0.1648	0.1101	0.0021	0.0000	0.0000
0.2198	0.1085	0.0029	0.0000	0.0000

0.2747	0.1070	0.0037	0.0000	0.0000
0.3297	0.1055	0.0046	0.0000	0.0000
0.3846	0.1039	0.0055	0.0000	0.0000
0.4396	0.1024	0.0065	0.0000	0.0000
0.4945	0.1009	0.0076	0.0000	0.0000
0.5495	0.0994	0.0087	0.0000	0.0000
0.6044	0.0979	0.0099	0.0000	0.0000
0.6593	0.0964	0.0111	0.0000	0.0000
0.7143	0.0949	0.0124	0.0000	0.0000
0.7692	0.0934	0.0137	0.0000	0.0000
0.8242	0.0919	0.0151	0.0000	0.0000
0.8791	0.0904	0.0165	0.0000	0.0000
0.9341	0.0889	0.0180	0.0000	0.0000
0.9890	0.0875	0.0195	0.0000	0.0000
1.0440	0.0860	0.0211	0.0000	0.0000
1.0989	0.0845	0.0228	0.0000	0.0000
1.1538	0.0831	0.0245	0.0000	0.0000
1.2088	0.0816	0.0263	0.0000	0.0000
1.2637	0.0802	0.0281	0.0000	0.0000
1.3187	0.0787	0.0300	0.0000	0.0000
1.3736	0.0773	0.0319	0.0000	0.0000
1.4286	0.0759	0.0339	0.0000	0.0000
1.4835	0.0744	0.0360	0.0000	0.0000
1.5385	0.0730	0.0381	0.0000	0.0000
1.5934	0.0716	0.0403	0.0000	0.0000
1.6484	0.0702	0.0425	0.0000	0.0000
1.7033	0.0688	0.0448	0.0000	0.0000
1.7582	0.0674	0.0471	0.0000	0.0000
1.8132	0.0660	0.0495	0.0000	0.0000
1.8681	0.0646	0.0520	0.0000	0.0000
1.9231	0.0632	0.0545	0.0000	0.0000
1.9780	0.0618	0.0571	0.0000	0.0000
2.0330	0.0604	0.0584	0.0158	0.0000
2.0879	0.0590	0.0599	0.0169	0.0000
2.1429	0.0577	0.0613	0.0192	0.0000
2.1978	0.0563	0.0628	0.0217	0.0000
2.2527	0.0550	0.0643	0.0244	0.0000
2.3077	0.0536	0.0659	0.0273	0.0000
2.3626	0.0523	0.0675	0.0303	0.0000
2.4176	0.0509	0.0691	0.0336	0.0000
2.4725	0.0496	0.0707	0.0370	0.0000
2.5275	0.0482	0.0724	0.0407	0.0000
2.5824	0.0469	0.0741	0.0445	0.0000
2.6374	0.0456	0.0759	0.0486	0.0000
2.6923	0.0443	0.0777	0.0492	0.0000
2.7473	0.0430	0.0795	0.0574	0.0000
2.8022	0.0417	0.0813	0.0597	0.0000
2.8571	0.0404	0.0832	0.0646	0.0000
2.9121	0.0391	0.0851	0.0696	0.0000
2.9670	0.0378	0.0870	0.0749	0.0000
3.0220	0.0365	0.0890	0.0804	0.0000
3.0769	0.0352	0.0910	0.0856	0.0000
3.1319	0.0339	0.0931	0.0856	0.0000
3.1868	0.0326	0.0952	0.0856	0.0000
3.2418	0.0314	0.0973	0.0856	0.0000
3.2967	0.0301	0.0994	0.0856	0.0000
3.3516	0.0288	0.1016	0.0856	0.0000

3.4066	0.0276	0.1038	0.0856	0.0000
3.4615	0.0263	0.1061	0.0856	0.0000
3.5165	0.0251	0.1083	0.0856	0.0000
3.5714	0.0239	0.1107	0.0856	0.0000
3.6264	0.0226	0.1130	0.0856	0.0000
3.6813	0.0214	0.1154	0.0856	0.0000
3.7363	0.0202	0.1178	0.0856	0.0000
3.7912	0.0190	0.1203	0.0856	0.0000
3.8462	0.0178	0.1228	0.0856	0.0000
3.9011	0.0165	0.1253	0.0856	0.0000
3.9560	0.0153	0.1279	0.0856	0.0000
4.0000	0.0141	0.1299	0.0856	0.0000

Surface retention 1 Hydraulic Table

Stage(ft)	Area(ac)	Volume(ac-ft)	Discharge(cfs)	To Amended(cfs)	Wetted Surface
4.0000	0.1144	0.1299	0.0000	0.0879	0.0000
4.0549	0.1160	0.1363	0.0000	0.0879	0.0000
4.1099	0.1175	0.1427	0.0000	0.0903	0.0000
4.1648	0.1191	0.1492	0.0000	0.0926	0.0000
4.2198	0.1207	0.1558	0.0000	0.0950	0.0000
4.2747	0.1223	0.1624	0.0000	0.0973	0.0000
4.3297	0.1239	0.1692	0.0000	0.0997	0.0000
4.3846	0.1255	0.1761	0.0000	0.1020	0.0000
4.4396	0.1270	0.1830	0.0000	0.1044	0.0000
4.4945	0.1287	0.1900	0.0000	0.1067	0.0000
4.5495	0.1303	0.1971	0.0535	0.1091	0.0000
4.6044	0.1319	0.2043	0.1643	0.1114	0.0000
4.6593	0.1335	0.2116	0.3097	0.1138	0.0000
4.7143	0.1351	0.2190	0.4830	0.1161	0.0000
4.7692	0.1367	0.2265	0.6803	0.1185	0.0000
4.8242	0.1384	0.2340	0.8988	0.1208	0.0000
4.8791	0.1400	0.2417	1.1367	0.1232	0.0000
4.9341	0.1416	0.2494	1.3926	0.1255	0.0000
4.9890	0.1433	0.2572	1.6652	0.1279	0.0000
5.0000	0.1436	0.2588	1.9536	0.1283	0.0000

Name : Surface retention 1

Element Flows To:
Outlet 1 **Outlet 2**
West Bioretention 1

Name : Existing Catchment
Bypass: No

GroundWater: No

Pervious Land Use	Acres
SAT, Forest, Flat	**1.929**
C, Forest, Mod	**6.488**
Pervious Total	**8.417**

Impervious Land Use	Acres

ROADS MOD 7.5

Impervious Total 7.5

Basin Total 15.917

Element Flows To:

Surface	**Interflow**	**Groundwater**

Name : Pre-Retrofit Contributing
Bypass: No

Impervious Land Use	**Acres**
ROADS MOD LAT	1.59

Element Flows To:

Outlet 1	**Outlet 2**
Surface retention 1	

ANALYSIS RESULTS

Stream Protection Duration

Pre-Retrofit Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.59

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.59

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	**Flow(cfs)**
2 year	0.6318
5 year	0.850561
10 year	1.009916
25 year	1.228411
50 year	1.404049
100 year	1.591079

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	**Flow(cfs)**

2 year	0.123699
5 year	0.20683
10 year	0.279889
25 year	0.396816
50 year	0.504637
100 year	0.63282

Stream Protection Duration
Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Year	Pre-Retrofit	Mitigated
1949	0.635	0.086
1950	0.658	0.141
1951	0.822	0.146
1952	0.618	0.086
1953	0.720	0.086
1954	0.978	0.086
1955	0.795	0.315
1956	0.346	0.086
1957	0.530	0.086
1958	1.402	0.431
1959	0.586	0.086
1960	0.591	0.086
1961	1.807	0.378
1962	0.726	0.194
1963	0.706	0.181
1964	0.409	0.086
1965	0.557	0.086
1966	0.555	0.086
1967	1.154	0.282
1968	0.591	0.204
1969	1.219	0.086
1970	0.509	0.086
1971	0.630	0.086
1972	0.849	0.343
1973	0.688	0.086
1974	0.836	0.104
1975	0.675	0.086
1976	0.493	0.094
1977	0.496	0.086
1978	0.376	0.081
1979	0.766	0.345
1980	0.649	0.086
1981	0.499	0.086
1982	0.549	0.236
1983	0.669	0.087
1984	0.613	0.086
1985	0.834	0.279
1986	0.812	0.326
1987	0.736	0.188
1988	0.642	0.086
1989	0.559	0.081
1990	0.500	0.086
1991	0.656	0.187
1992	0.614	0.086
1993	0.491	0.086
1994	0.530	0.086

1995	0.477	0.086
1996	0.801	0.298
1997	0.685	0.522
1998	0.812	0.146
1999	0.328	0.086
2000	1.421	0.086
2001	0.401	0.084
2002	0.434	0.086
2003	0.601	0.086
2004	1.120	0.298
2005	0.483	0.153
2006	0.700	0.241
2007	0.650	0.148
2008	0.577	0.399
2009	0.484	0.115

Stream Protection Duration
Ranked Annual Peaks for Predeveloped and Mitigated. POC #1

Rank	**Pre-Retrofit**	**Mitigated**
1	1.8066	0.5219
2	1.4210	0.4307
3	1.4020	0.3986
4	1.2190	0.3781
5	1.1542	0.3455
6	1.1204	0.3428
7	0.9782	0.3264
8	0.8495	0.3148
9	0.8363	0.2981
10	0.8337	0.2976
11	0.8224	0.2821
12	0.8121	0.2787
13	0.8117	0.2410
14	0.8006	0.2362
15	0.7948	0.2039
16	0.7660	0.1942
17	0.7361	0.1881
18	0.7256	0.1873
19	0.7198	0.1807
20	0.7058	0.1525
21	0.7005	0.1480
22	0.6879	0.1462
23	0.6848	0.1457
24	0.6751	0.1405
25	0.6685	0.1146
26	0.6582	0.1039
27	0.6556	0.0939
28	0.6499	0.0865
29	0.6488	0.0856
30	0.6415	0.0856
31	0.6346	0.0856
32	0.6296	0.0856
33	0.6178	0.0856
34	0.6138	0.0856
35	0.6132	0.0856
36	0.6005	0.0856
37	0.5912	0.0856

38	0.5907	0.0856
39	0.5863	0.0856
40	0.5774	0.0856
41	0.5586	0.0856
42	0.5571	0.0856
43	0.5548	0.0856
44	0.5486	0.0856
45	0.5300	0.0856
46	0.5298	0.0856
47	0.5087	0.0856
48	0.4996	0.0856
49	0.4989	0.0856
50	0.4962	0.0856
51	0.4929	0.0856
52	0.4914	0.0856
53	0.4844	0.0856
54	0.4828	0.0856
55	0.4771	0.0856
56	0.4342	0.0856
57	0.4086	0.0856
58	0.4006	0.0856
59	0.3760	0.0840
60	0.3462	0.0813
61	0.3278	0.0809

Stream Protection Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.3159	897	28	3	Pass
0.3269	791	24	3	Pass
0.3379	708	19	2	Pass
0.3489	632	15	2	Pass
0.3599	563	13	2	Pass
0.3709	507	12	2	Pass
0.3818	445	9	2	Pass
0.3928	398	7	1	Pass
0.4038	372	5	1	Pass
0.4148	338	4	1	Pass
0.4258	301	4	1	Pass
0.4368	280	3	1	Pass
0.4478	254	3	1	Pass
0.4588	242	2	0	Pass
0.4698	224	2	0	Pass
0.4808	204	2	0	Pass
0.4918	190	2	1	Pass
0.5028	169	1	0	Pass
0.5137	151	1	0	Pass
0.5247	142	0	0	Pass
0.5357	132	0	0	Pass
0.5467	123	0	0	Pass
0.5577	115	0	0	Pass
0.5687	108	0	0	Pass

0.5797	101	0	0	Pass
0.5907	98	0	0	Pass
0.6017	90	0	0	Pass
0.6127	84	0	0	Pass
0.6237	77	0	0	Pass
0.6347	69	0	0	Pass
0.6456	63	0	0	Pass
0.6566	56	0	0	Pass
0.6676	52	0	0	Pass
0.6786	47	0	0	Pass
0.6896	44	0	0	Pass
0.7006	42	0	0	Pass
0.7116	37	0	0	Pass
0.7226	34	0	0	Pass
0.7336	32	0	0	Pass
0.7446	31	0	0	Pass
0.7556	31	0	0	Pass
0.7665	29	0	0	Pass
0.7775	27	0	0	Pass
0.7885	26	0	0	Pass
0.7995	23	0	0	Pass
0.8105	21	0	0	Pass
0.8215	18	0	0	Pass
0.8325	17	0	0	Pass
0.8435	14	0	0	Pass
0.8545	13	0	0	Pass
0.8655	13	0	0	Pass
0.8765	13	0	0	Pass
0.8875	12	0	0	Pass
0.8984	12	0	0	Pass
0.9094	11	0	0	Pass
0.9204	11	0	0	Pass
0.9314	11	0	0	Pass
0.9424	11	0	0	Pass
0.9534	10	0	0	Pass
0.9644	9	0	0	Pass
0.9754	9	0	0	Pass
0.9864	8	0	0	Pass
0.9974	8	0	0	Pass
1.0084	8	0	0	Pass
1.0193	8	0	0	Pass
1.0303	8	0	0	Pass
1.0413	8	0	0	Pass
1.0523	8	0	0	Pass
1.0633	8	0	0	Pass
1.0743	8	0	0	Pass
1.0853	8	0	0	Pass
1.0963	8	0	0	Pass
1.1073	8	0	0	Pass
1.1183	8	0	0	Pass
1.1293	7	0	0	Pass
1.1403	7	0	0	Pass
1.1512	6	0	0	Pass
1.1622	5	0	0	Pass
1.1732	5	0	0	Pass
1.1842	5	0	0	Pass
1.1952	5	0	0	Pass

1.2062	5	0	0	Pass
1.2172	5	0	0	Pass
1.2282	4	0	0	Pass
1.2392	4	0	0	Pass
1.2502	4	0	0	Pass
1.2612	4	0	0	Pass
1.2722	4	0	0	Pass
1.2831	4	0	0	Pass
1.2941	4	0	0	Pass
1.3051	4	0	0	Pass
1.3161	4	0	0	Pass
1.3271	4	0	0	Pass
1.3381	4	0	0	Pass
1.3491	4	0	0	Pass
1.3601	4	0	0	Pass
1.3711	4	0	0	Pass
1.3821	4	0	0	Pass
1.3931	4	0	0	Pass
1.4040	3	0	0	Pass

LID Duration

Predeveloped Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.59

Mitigated Landuse Totals for POC #1
Total Pervious Area:0
Total Impervious Area:1.59

Flow Frequency Return Periods for Pre-Retrofit. POC #1

Return Period	Flow(cfs)
2 year	0.6318
5 year	0.850561
10 year	1.009916
25 year	1.228411
50 year	1.404049
100 year	1.591079

Flow Frequency Return Periods for Mitigated. POC #1

Return Period	Flow(cfs)
2 year	0.123699
5 year	0.20683
10 year	0.279889
25 year	0.396816
50 year	0.504637
100 year	0.63282

LID Duration
Annual Peaks for Predeveloped and Mitigated. POC #1

Year	Pre-Retrofit	Mitigated
1949	0.635	0.086
1950	0.658	0.141
1951	0.822	0.146
1952	0.618	0.086
1953	0.720	0.086
1954	0.978	0.086
1955	0.795	0.315
1956	0.346	0.086
1957	0.530	0.086
1958	1.402	0.431
1959	0.586	0.086
1960	0.591	0.086
1961	1.807	0.378
1962	0.726	0.194
1963	0.706	0.181
1964	0.409	0.086
1965	0.557	0.086
1966	0.555	0.086
1967	1.154	0.282
1968	0.591	0.204
1969	1.219	0.086
1970	0.509	0.086
1971	0.630	0.086
1972	0.849	0.343
1973	0.688	0.086
1974	0.836	0.104
1975	0.675	0.086
1976	0.493	0.094
1977	0.496	0.086
1978	0.376	0.081
1979	0.766	0.345
1980	0.649	0.086
1981	0.499	0.086
1982	0.549	0.236
1983	0.669	0.087
1984	0.613	0.086
1985	0.834	0.279
1986	0.812	0.326
1987	0.736	0.188
1988	0.642	0.086
1989	0.559	0.081
1990	0.500	0.086
1991	0.656	0.187
1992	0.614	0.086
1993	0.491	0.086
1994	0.530	0.086
1995	0.477	0.086
1996	0.801	0.298
1997	0.685	0.522
1998	0.812	0.146
1999	0.328	0.086
2000	1.421	0.086
2001	0.401	0.084
2002	0.434	0.086

2003	0.601	0.086
2004	1.120	0.298
2005	0.483	0.153
2006	0.700	0.241
2007	0.650	0.148
2008	0.577	0.399
2009	0.484	0.115

LID Duration
Ranked Annual Peaks for Pre-Retrofit and Mitigated. POC #1

Rank	Pre-Retrofit	Mitigated
1	1.8066	0.5219
2	1.4210	0.4307
3	1.4020	0.3986
4	1.2190	0.3781
5	1.1542	0.3455
6	1.1204	0.3428
7	0.9782	0.3264
8	0.8495	0.3148
9	0.8363	0.2981
10	0.8337	0.2976
11	0.8224	0.2821
12	0.8121	0.2787
13	0.8117	0.2410
14	0.8006	0.2362
15	0.7948	0.2039
16	0.7660	0.1942
17	0.7361	0.1881
18	0.7256	0.1873
19	0.7198	0.1807
20	0.7058	0.1525
21	0.7005	0.1480
22	0.6879	0.1462
23	0.6848	0.1457
24	0.6751	0.1405
25	0.6685	0.1146
26	0.6582	0.1039
27	0.6556	0.0939
28	0.6499	0.0865
29	0.6488	0.0856
30	0.6415	0.0856
31	0.6346	0.0856
32	0.6296	0.0856
33	0.6178	0.0856
34	0.6138	0.0856
35	0.6132	0.0856
36	0.6005	0.0856
37	0.5912	0.0856
38	0.5907	0.0856
39	0.5863	0.0856
40	0.5774	0.0856
41	0.5586	0.0856
42	0.5571	0.0856
43	0.5548	0.0856
44	0.5486	0.0856
45	0.5300	0.0856

46	0.5298	0.0856
47	0.5087	0.0856
48	0.4996	0.0856
49	0.4989	0.0856
50	0.4962	0.0856
51	0.4929	0.0856
52	0.4914	0.0856
53	0.4844	0.0856
54	0.4828	0.0856
55	0.4771	0.0856
56	0.4342	0.0856
57	0.4086	0.0856
58	0.4006	0.0856
59	0.3760	0.0840
60	0.3462	0.0813
61	0.3278	0.0809

LID Duration
POC #1
The Facility PASSED

The Facility PASSED.

Flow(cfs)	Predev	Mit	Percentage	Pass/Fail
0.0505	55589	39013	70	Pass
0.0532	52231	35976	68	Pass
0.0559	50114	34415	68	Pass
0.0586	47120	31249	66	Pass
0.0613	44360	26244	59	Pass
0.0639	42692	24319	56	Pass
0.0666	40232	21581	53	Pass
0.0693	37965	19060	50	Pass
0.0720	36489	17490	47	Pass
0.0747	34457	15391	44	Pass
0.0773	32511	13415	41	Pass
0.0800	30736	11537	37	Pass
0.0827	29517	10275	34	Pass
0.0854	27955	8282	29	Pass
0.0881	26415	780	2	Pass
0.0907	25453	758	2	Pass
0.0934	24084	725	3	Pass
0.0961	22779	703	3	Pass
0.0988	21924	691	3	Pass
0.1015	20713	662	3	Pass
0.1042	19554	641	3	Pass
0.1068	18856	621	3	Pass
0.1095	17821	600	3	Pass
0.1122	16824	578	3	Pass
0.1149	16238	560	3	Pass
0.1176	15391	534	3	Pass
0.1202	14559	511	3	Pass
0.1229	14029	494	3	Pass
0.1256	13306	471	3	Pass
0.1283	12574	440	3	Pass
0.1310	12108	419	3	Pass
0.1336	11443	392	3	Pass

0.1363	10823	370	3	Pass
0.1390	10448	360	3	Pass
0.1417	9914	342	3	Pass
0.1444	9379	333	3	Pass
0.1470	8881	317	3	Pass
0.1497	8541	314	3	Pass
0.1524	8121	304	3	Pass
0.1551	7721	299	3	Pass
0.1578	7460	293	3	Pass
0.1604	7099	287	4	Pass
0.1631	6729	281	4	Pass
0.1658	6521	279	4	Pass
0.1685	6226	271	4	Pass
0.1712	5899	267	4	Pass
0.1738	5700	262	4	Pass
0.1765	5422	254	4	Pass
0.1792	5170	243	4	Pass
0.1819	5020	238	4	Pass
0.1846	4772	233	4	Pass
0.1872	4552	229	5	Pass
0.1899	4406	222	5	Pass
0.1926	4222	217	5	Pass
0.1953	4060	210	5	Pass
0.1980	3951	207	5	Pass
0.2006	3786	204	5	Pass
0.2033	3640	200	5	Pass
0.2060	3478	195	5	Pass
0.2087	3360	194	5	Pass
0.2114	3219	192	5	Pass
0.2140	3091	188	6	Pass
0.2167	3001	184	6	Pass
0.2194	2881	175	6	Pass
0.2221	2772	163	5	Pass
0.2248	2689	162	6	Pass
0.2274	2597	156	6	Pass
0.2301	2494	151	6	Pass
0.2328	2434	151	6	Pass
0.2355	2340	145	6	Pass
0.2382	2248	137	6	Pass
0.2408	2194	132	6	Pass
0.2435	2113	130	6	Pass
0.2462	2038	126	6	Pass
0.2489	1983	122	6	Pass
0.2516	1902	120	6	Pass
0.2543	1835	117	6	Pass
0.2569	1786	116	6	Pass
0.2596	1720	108	6	Pass
0.2623	1666	102	6	Pass
0.2650	1631	100	6	Pass
0.2677	1567	94	5	Pass
0.2703	1510	91	6	Pass
0.2730	1451	88	6	Pass
0.2757	1421	82	5	Pass
0.2784	1366	75	5	Pass
0.2811	1322	68	5	Pass
0.2837	1286	63	4	Pass
0.2864	1238	59	4	Pass

0.2891	1189	53	4	Pass
0.2918	1165	49	4	Pass
0.2945	1132	44	3	Pass
0.2971	1096	43	3	Pass
0.2998	1064	39	3	Pass
0.3025	1036	38	3	Pass
0.3052	1000	36	3	Pass
0.3079	983	34	3	Pass
0.3105	953	33	3	Pass
0.3132	920	31	3	Pass
0.3159	897	28	3	Pass

Water Quality BMP Flow and Volume for POC #1
On-line facility volume: 0.0638 **acre-feet**
On-line facility target flow: 0.0322 **cfs.**
Adjusted for 15 min: 0.0322 **cfs.**
Off-line facility target flow: 0.0203 **cfs.**
Adjusted for 15 min: 0.0203 **cfs.**

Wetlands Fluctuation for POC 1
Average Annual Volume (acft)

Month	Predevel	Mitigated	Percent	Pass/Fail
Jan	21.6463	22.0290	101.8	Pass
Feb	14.9144	15.1002	101.2	Pass
Mar	14.2009	14.1988	100.0	Pass
Apr	9.9020	9.7575	98.5	Pass
May	7.7064	7.1068	92.2	Pass
Jun	6.7046	6.2854	93.7	Pass
Jul	3.4263	2.8870	84.3	Fail
Aug	4.6501	3.5556	76.5	Fail
Sep	7.0318	6.2240	88.5	Pass
Oct	13.9260	13.7665	98.9	Pass
Nov	23.5698	23.9524	101.6	Pass
Dec	24.5999	25.2467	102.6	Pass

Day	Predevel	Mitigated	Percent	Pass/Fail
Jan1	0.8183	0.8991	109.9	Pass
2	0.6197	0.6497	104.9	Pass
3	0.5792	0.6344	109.5	Pass
4	1.0408	0.9202	88.4	Pass
5	0.6543	0.7289	111.4	Pass
6	0.8618	0.8010	93.0	Pass
7	0.9716	1.0117	104.1	Pass
8	0.6878	0.7781	113.1	Pass
9	0.5923	0.6229	105.2	Pass
10	0.5047	0.4947	98.0	Pass
11	0.5350	0.5769	107.8	Pass
12	0.6405	0.6176	96.4	Pass
13	0.9958	0.9079	91.2	Pass
14	0.6566	0.7946	121.0	Fail
15	0.7937	0.7035	88.6	Pass
16	0.6965	0.7815	112.2	Pass
17	0.9453	0.8875	93.9	Pass

18	0.6027	0.7047	116.9	Pass
19	0.4973	0.5655	113.7	Pass
20	0.5834	0.5751	98.6	Pass
21	0.6853	0.6456	94.2	Pass
22	0.8091	0.8051	99.5	Pass
23	0.8702	0.8797	101.1	Pass
24	0.4056	0.4959	122.3	Fail
25	0.5160	0.4691	90.9	Pass
26	0.4373	0.4131	94.5	Pass
27	0.6428	0.6320	98.3	Pass
28	0.7652	0.7825	102.3	Pass
29	0.6695	0.7146	106.7	Pass
30	0.6155	0.5920	96.2	Pass
31	0.5005	0.5719	114.3	Pass
Feb1	0.4222	0.4777	113.2	Pass
2	0.3760	0.3414	90.8	Pass
3	0.5749	0.5719	99.5	Pass
4	0.5606	0.5304	94.6	Pass
5	0.5093	0.5704	112.0	Pass
6	0.4742	0.4411	93.0	Pass
7	0.6240	0.6413	102.8	Pass
8	0.3197	0.3907	122.2	Fail
9	0.3835	0.3709	96.7	Pass
10	0.4458	0.4179	93.7	Pass
11	0.6752	0.6242	92.4	Pass
12	0.5852	0.6049	103.4	Pass
13	0.5187	0.5267	101.5	Pass
14	0.5220	0.5357	102.6	Pass
15	0.6268	0.5841	93.2	Pass
16	0.6483	0.7306	112.7	Pass
17	0.7054	0.6271	88.9	Pass
18	0.4567	0.5846	128.0	Fail
19	0.4656	0.4395	94.4	Pass
20	0.7128	0.6084	85.4	Pass
21	0.4432	0.5414	122.1	Fail
22	0.4516	0.4292	95.0	Pass
23	0.6690	0.7025	105.0	Pass
24	0.6322	0.6444	101.9	Pass
25	0.4732	0.5019	106.1	Pass
26	0.4167	0.4312	103.5	Pass
27	0.5789	0.5496	94.9	Pass
28	0.5459	0.4163	76.3	Fail
29	0.5800	0.6034	104.0	Pass
Mar1	0.5589	0.5377	96.2	Pass
2	0.5458	0.5650	103.5	Pass
3	0.4827	0.5299	109.8	Pass
4	0.4498	0.3779	84.0	Pass
5	0.1841	0.2550	138.5	Fail
6	0.5212	0.5053	96.9	Pass
7	0.5000	0.4234	84.7	Pass
8	0.7194	0.7665	106.5	Pass
9	0.4927	0.4788	97.2	Pass
10	0.5280	0.5546	105.0	Pass
11	0.4991	0.4784	95.9	Pass
12	0.3855	0.4225	109.6	Pass
13	0.3965	0.3980	100.4	Pass
14	0.4764	0.4530	95.1	Pass

15	0.4393	0.4376	99.6	Pass
16	0.4571	0.4344	95.0	Pass
17	0.4686	0.4550	97.1	Pass
18	0.4112	0.4403	107.1	Pass
19	0.4434	0.4503	101.6	Pass
20	0.3040	0.2653	87.3	Pass
21	0.6041	0.5567	92.1	Pass
22	0.5378	0.5876	109.3	Pass
23	0.4287	0.4369	101.9	Pass
24	0.3996	0.4178	104.6	Pass
25	0.5285	0.5113	96.8	Pass
26	0.3239	0.3127	96.5	Pass
27	0.4607	0.4610	100.1	Pass
28	0.3901	0.3788	97.1	Pass
29	0.3167	0.3402	107.4	Pass
30	0.3677	0.3639	99.0	Pass
31	0.4053	0.4013	99.0	Pass
Apr1	0.3702	0.3553	96.0	Pass
2	0.4141	0.3993	96.4	Pass
3	0.4706	0.4743	100.8	Pass
4	0.3778	0.3898	103.2	Pass
5	0.3236	0.3511	108.5	Pass
6	0.2689	0.2245	83.5	Pass
7	0.4767	0.4805	100.8	Pass
8	0.2592	0.2947	113.7	Pass
9	0.3134	0.2759	88.0	Pass
10	0.4387	0.4432	101.0	Pass
11	0.4606	0.4251	92.3	Pass
12	0.3794	0.3702	97.6	Pass
13	0.2399	0.2507	104.5	Pass
14	0.3756	0.3305	88.0	Pass
15	0.4465	0.4562	102.2	Pass
16	0.2848	0.3209	112.7	Pass
17	0.2659	0.2189	82.3	Pass
18	0.5149	0.4321	83.9	Pass
19	0.1827	0.3289	180.0	Fail
20	0.0564	0.0476	84.5	Pass
21	0.2183	0.1569	71.9	Fail
22	0.4163	0.3371	81.0	Pass
23	0.2958	0.4062	137.4	Fail
24	0.2015	0.1994	98.9	Pass
25	0.1612	0.1282	79.5	Fail
26	0.3620	0.3066	84.7	Pass
27	0.3207	0.3765	117.4	Pass
28	0.3266	0.2434	74.5	Fail
29	0.2747	0.3322	120.9	Fail
30	0.1701	0.1712	100.7	Pass
May1	0.2432	0.1852	76.2	Fail
2	0.2693	0.2557	95.0	Pass
3	0.2021	0.1829	90.5	Pass
4	0.2955	0.3065	103.7	Pass
5	0.1941	0.1925	99.2	Pass
6	0.0526	0.0695	132.2	Fail
7	0.1863	0.1433	76.9	Fail
8	0.2122	0.1416	66.7	Fail
9	0.3739	0.3408	91.1	Pass
10	0.3911	0.4248	108.6	Pass

11	0.1690	0.1419	84.0	Pass
12	0.2678	0.2611	97.5	Pass
13	0.3067	0.2283	74.5	Fail
14	0.1725	0.2588	150.0	Fail
15	0.2715	0.2549	93.9	Pass
16	0.1114	0.0857	76.9	Fail
17	0.2094	0.1452	69.4	Fail
18	0.3012	0.2412	80.1	Pass
19	0.2727	0.2876	105.5	Pass
20	0.2065	0.2264	109.6	Pass
21	0.1379	0.1014	73.5	Fail
22	0.1869	0.1448	77.5	Fail
23	0.2687	0.2423	90.2	Pass
24	0.1873	0.2075	110.7	Pass
25	0.2722	0.2390	87.8	Pass
26	0.3925	0.3366	85.7	Pass
27	0.2518	0.2799	111.2	Pass
28	0.3337	0.2398	71.9	Fail
29	0.2498	0.3137	125.6	Fail
30	0.5460	0.4566	83.6	Pass
31	0.1723	0.2428	140.9	Fail
Jun1	0.2792	0.2179	78.0	Fail
2	0.3614	0.3384	93.7	Pass
3	0.2039	0.2534	124.3	Fail
4	0.2089	0.1779	85.1	Pass
5	0.2179	0.1728	79.3	Fail
6	0.2717	0.2546	93.7	Pass
7	0.1999	0.2049	102.5	Pass
8	0.2104	0.1995	94.8	Pass
9	0.5204	0.3992	76.7	Fail
10	0.2574	0.3541	137.6	Fail
11	0.3079	0.2540	82.5	Pass
12	0.1766	0.1981	112.1	Pass
13	0.0632	0.0365	57.8	Fail
14	0.1519	0.1147	75.5	Fail
15	0.2504	0.2043	81.6	Pass
16	0.3167	0.3037	95.9	Pass
17	0.2495	0.2348	94.1	Pass
18	0.2032	0.2156	106.1	Pass
19	0.0824	0.0666	80.9	Pass
20	0.1226	0.1233	100.5	Pass
21	0.2218	0.1320	59.5	Fail
22	0.1886	0.2216	117.5	Pass
23	0.3586	0.2930	81.7	Pass
24	0.2692	0.2655	98.6	Pass
25	0.1587	0.2124	133.8	Fail
26	0.1793	0.1271	70.9	Fail
27	0.1076	0.1003	93.2	Pass
28	0.2387	0.2305	96.6	Pass
29	0.1538	0.1363	88.6	Pass
30	0.2819	0.1733	61.5	Fail
Jul1	0.2515	0.3053	121.4	Fail
2	0.2110	0.1711	81.1	Pass
3	0.0971	0.0580	59.8	Fail
4	0.1906	0.1612	84.5	Pass
5	0.0560	0.0754	134.5	Fail
6	0.0861	0.0430	49.9	Fail

7	0.1710	0.1678	98.2	Pass
8	0.2116	0.1573	74.4	Fail
9	0.0395	0.0727	184.0	Fail
10	0.1314	0.0545	41.4	Fail
11	0.0496	0.0975	196.6	Fail
12	0.1673	0.1291	77.2	Fail
13	0.0879	0.1086	123.5	Fail
14	0.0397	0.0302	76.1	Fail
15	0.3145	0.2316	73.6	Fail
16	0.0985	0.1319	133.9	Fail
17	0.0224	0.0139	62.2	Fail
18	0.1619	0.1050	64.9	Fail
19	0.1019	0.0848	83.2	Pass
20	0.0048	0.0154	320.3	Fail
21	0.1025	0.0673	65.7	Fail
22	0.0228	0.0209	91.7	Pass
23	0.0279	0.0188	67.3	Fail
24	0.0711	0.0236	33.2	Fail
25	0.1766	0.1388	78.6	Fail
26	0.0616	0.0856	139.0	Fail
27	0.0998	0.0679	68.1	Fail
28	0.0667	0.0688	103.3	Pass
29	0.0037	0.0076	205.1	Fail
30	0.0174	0.0000	0.0	Fail
31	0.0146	0.0000	0.0	Fail
Aug1	0.0275	0.0106	38.6	Fail
2	0.0521	0.0107	20.5	Fail
3	0.0624	0.0379	60.6	Fail
4	0.0576	0.0478	82.9	Pass
5	0.2422	0.1290	53.3	Fail
6	0.2179	0.1448	66.4	Fail
7	0.0103	0.0848	825.6	Fail
8	0.0601	0.0447	74.4	Fail
9	0.0214	0.0014	6.6	Fail
10	0.0381	0.0017	4.4	Fail
11	0.0757	0.0400	52.8	Fail
12	0.1965	0.1246	63.4	Fail
13	0.1026	0.0976	95.1	Pass
14	0.2663	0.1314	49.4	Fail
15	0.1575	0.1310	83.2	Pass
16	0.1031	0.1053	102.2	Pass
17	0.2040	0.1175	57.6	Fail
18	0.2919	0.1813	62.1	Fail
19	0.0851	0.1574	184.9	Fail
20	0.0589	0.0135	22.9	Fail
21	0.3122	0.2276	72.9	Fail
22	0.4094	0.2604	63.6	Fail
23	0.2219	0.3131	141.1	Fail
24	0.1512	0.1577	104.3	Pass
25	0.3149	0.2233	70.9	Fail
26	0.2739	0.2800	102.2	Pass
27	0.1617	0.1605	99.3	Pass
28	0.1273	0.0658	51.7	Fail
29	0.1326	0.0863	65.1	Fail
30	0.1993	0.1679	84.3	Pass
31	0.3024	0.2050	67.8	Fail
Sep1	0.1289	0.2095	162.6	Fail

2	0.1393	0.0864	62.1	Fail
3	0.1344	0.1155	85.9	Pass
4	0.1367	0.0967	70.7	Fail
5	0.3280	0.2502	76.3	Fail
6	0.1619	0.1660	102.5	Pass
7	0.2291	0.2008	87.6	Pass
8	0.2899	0.2212	76.3	Fail
9	0.3630	0.3007	82.8	Pass
10	0.3080	0.3278	106.4	Pass
11	0.0335	0.0151	45.0	Fail
12	0.1660	0.0876	52.8	Fail
13	0.2653	0.1993	75.1	Fail
14	0.2126	0.2729	128.3	Fail
15	0.3421	0.2143	62.6	Fail
16	0.4827	0.4565	94.6	Pass
17	0.1191	0.1861	156.3	Fail
18	0.2382	0.1627	68.3	Fail
19	0.2843	0.2451	86.2	Pass
20	0.1377	0.1825	132.5	Fail
21	0.3805	0.2877	75.6	Fail
22	0.2941	0.3244	110.3	Pass
23	0.2239	0.2147	95.9	Pass
24	0.1755	0.1367	77.9	Fail
25	0.2282	0.2190	96.0	Pass
26	0.2097	0.1501	71.6	Fail
27	0.2025	0.2336	115.4	Pass
28	0.2049	0.1576	76.9	Fail
29	0.3095	0.2986	96.5	Pass
30	0.3249	0.2436	75.0	Fail
Oct1	0.2144	0.2299	107.2	Pass
2	0.3025	0.2779	91.8	Pass
3	0.4396	0.3061	69.6	Fail
4	0.3454	0.3453	100.0	Pass
5	0.4907	0.4844	98.7	Pass
6	0.2921	0.3772	129.1	Fail
7	0.5138	0.4381	85.3	Pass
8	0.3842	0.3974	103.4	Pass
9	0.3767	0.3152	83.7	Pass
10	0.3455	0.3794	109.8	Pass
11	0.2676	0.2951	110.3	Pass
12	0.3409	0.3155	92.5	Pass
13	0.3485	0.3170	91.0	Pass
14	0.2664	0.2658	99.8	Pass
15	0.4326	0.4333	100.2	Pass
16	0.5829	0.5020	86.1	Pass
17	0.3584	0.4651	129.8	Fail
18	0.6271	0.5934	94.6	Pass
19	0.7497	0.7423	99.0	Pass
20	0.5483	0.5649	103.0	Pass
21	0.5057	0.5377	106.3	Pass
22	0.4941	0.5067	102.6	Pass
23	0.5993	0.5159	86.1	Pass
24	0.5453	0.6056	111.1	Pass
25	0.7354	0.6611	89.9	Pass
26	0.6045	0.6553	108.4	Pass
27	0.6487	0.7414	114.3	Pass
28	0.3748	0.3671	97.9	Pass

29	0.4731	0.4801	101.5	Pass
30	0.3931	0.4068	103.5	Pass
31	0.6049	0.5352	88.5	Pass
Nov1	0.4863	0.5841	120.1	Fail
2	0.7527	0.5954	79.1	Fail
3	0.8484	0.9460	111.5	Pass
4	0.5537	0.5727	103.4	Pass
5	0.5365	0.6080	113.3	Pass
6	0.5669	0.5621	99.2	Pass
7	0.5738	0.5263	91.7	Pass
8	0.6940	0.7215	104.0	Pass
9	0.8616	0.8504	98.7	Pass
10	0.8910	0.8630	96.9	Pass
11	1.0332	1.0649	103.1	Pass
12	0.9179	0.9124	99.4	Pass
13	0.6655	0.8077	121.4	Fail
14	0.7478	0.6914	92.5	Pass
15	0.7418	0.7914	106.7	Pass
16	0.7816	0.8241	105.4	Pass
17	0.7721	0.7435	96.3	Pass
18	1.1853	1.0942	92.3	Pass
19	1.1463	1.2134	105.9	Pass
20	0.7039	0.9037	128.4	Fail
21	0.5717	0.5713	99.9	Pass
22	0.8287	0.6769	81.7	Pass
23	1.1562	1.2044	104.2	Pass
24	1.1771	1.2452	105.8	Pass
25	0.5513	0.6431	116.6	Pass
26	0.8018	0.7992	99.7	Pass
27	0.5759	0.6265	108.8	Pass
28	0.8495	0.8312	97.9	Pass
29	0.9952	0.9438	94.8	Pass
30	0.9641	1.0266	106.5	Pass
Dec1	0.8491	0.8668	102.1	Pass
2	1.1236	1.1180	99.5	Pass
3	0.9215	1.0541	114.4	Pass
4	1.0268	0.9179	89.4	Pass
5	0.7993	0.9664	120.9	Fail
6	0.5865	0.6313	107.7	Pass
7	0.6552	0.6826	104.2	Pass
8	0.8271	0.7570	91.5	Pass
9	0.8702	0.8959	103.0	Pass
10	0.8942	0.8850	99.0	Pass
11	0.9601	0.9526	99.2	Pass
12	0.6359	0.7401	116.4	Pass
13	0.8982	0.7281	81.1	Pass
14	1.1147	1.2645	113.4	Pass
15	0.8236	0.8732	106.0	Pass
16	0.6186	0.7507	121.4	Fail
17	0.5970	0.5748	96.3	Pass
18	0.7980	0.6605	82.8	Pass
19	0.7807	0.9114	116.7	Pass
20	0.7684	0.8106	105.5	Pass
21	0.6508	0.6875	105.6	Pass
22	0.7728	0.7233	93.6	Pass
23	0.8153	0.8467	103.9	Pass
24	0.7456	0.7194	96.5	Pass

25	**0.7334**	**0.7611**	**103.8**	**Pass**
26	**0.8103**	**0.8698**	**107.3**	**Pass**
27	**0.5710**	**0.5777**	**101.2**	**Pass**
28	**0.7611**	**0.7245**	**95.2**	**Pass**
29	**0.5908**	**0.6986**	**118.2**	**Pass**
30	**0.6383**	**0.5712**	**89.5**	**Pass**
31	**0.9546**	**0.9446**	**98.9**	**Pass**

LID Report

LID Technique   Used for   Total Volumn   Volumn   Infiltration Cumulative
Percent   Water Quality Percent   Comment
                             Treatment? Needs   Through   Volumn   Volumn
Volumn   Water Quality
                                         Treatment   Facility (ac-ft)   Infiltration
Infiltrated   Treated
                                         (ac-ft)   (ac-ft)   Credit

retention 1 POC   N   172.15   N
0.00
Total Volume Infiltrated   172.15   0.00   0.00   0.00
0.00   0%   No Treat. Credit
Compliance with LID Standard 8
Duration Analysis Result = Passed

Perlnd and Implnd Changes

No changes have been made.
